# Rustlers Roost Project Area

# Care and Maintenance Operations

# Mining Management Plan 2018-2019

## Submission Date: 10 July 2020

## Authorisation Number 0738-01

Hanking Australia Investments Pty Ltd
Charles Hastie
Chief Mining Engineer
Charles.Hastie@hanking.com.au
0419 963 250

# MMP Distribution List

| Stakeholder | Organisation |
|---|---|
| Internal | Primary Gold (a subsidiary of Hanking Australia Investment Pty Ltd) |
| External | Department of Primary Industry and Resources (DPIR) |

# MMP Endorsement

| Version | Date | Author | Reviewer | Approved |
|---|---|---|---|---|
| Resubmission | 15/06/2020 | **Various** | **Charles Hastie**<br>Hanking Australia – Chief Mining Engineer | **Mark Qiu**<br>Hanking Australia – Managing Director |

I declare that to the best of my knowledge the information contained within this Mining Management Plan is true and correct and commit to undertake the works detailed in this plan in accordance with the relevant Local, Northern Territory and Commonwealth Government legislation.

Name: **Mark Qiu** Signed: 

Position: **Managing Director** Date: **10 July 2020**

# MMP Submissions

Primary Gold has prepared this Care and Maintenance - Mining Management Plan (MMP) to outline planned activities and management actions at the Rustlers Roost Project Area (RRPA) in accordance with Authorisation 0738-01. A MMP is required for new projects, on an annual (or as agreed) basis for existing projects, or when activities or environmental management practices are changed. The following table outlines a history of Authorisation 0738 MMPs and Amendments.

| Date | Title |
|---|---|
| 17 February 2013 | PG RRPA MMP 2012-2013 |
| 28 May 2014 | PG RRPA MMP 2013-2014 |
| 21 July 2015 | PG RRPA MMP 2014-2015 |
| 3 December 2015 | PR RRPA MMP 2014-2015 (Amendment) |
| 24 June 2016 | PG RRPA MMP 2015-2016 |
| October 2016 | PG RRPA MMP 2015-2016 (Resubmission) |
| 23 July 2017 | PG RRPA MMP 2016-2017 |
| 22 January 2018 | PG RRPA MMP 2016-2017 (Resubmission) |
| 27 May 2019 | PG RRPA MMP 2018-2019 |

# Table of Contents

# List of Tables

# List of Figures

# 1 MMP Amendments

The Department of Primary Industry and Resources (DPIR) requires that when a Mining Management Plan (MMP) is revised that a summary of changes is included. Table 1-1 provides a summary of the changes made in this reviewed MMP (when compared to the previously submitted PG RRPA MMP 2018-2019 (MR2019/0154)).

**Table 1-1: MMP Revision Summary**

| Section | Page | Key Changes |
|---|---|---|
| 1 MMP Amendments | 4 | Revision summary added (Table 1-1) and DPIR comments to be addressed updated (Table 1-2). |
| 2 Operator Details | 8 | Minor format changes. Added Chief Mining Engineer to Figure 2-1. |
| 3 Project Details | 10 | Minor format changes. |
| 4 Previous Activities and Current Status | 14 | General revision and addition of Work Programs Summary (Table 4-1). |
| 5 Current Project Site Conditions | 18 | General revision and update.<br>Added material characterisation and water beneficial use declaration summary. |
| 6 Environmental Management System | 40 | Detailed revision and update based on DPIR feedback.<br>Added new Environmental Policy (Figure 6-1).<br>Addition of Required Licensing, Approvals, Permits or Reports (Table 6-1).<br>Updated Stakeholder Engagement Register (Appendix 10.5).<br>Revision of site Aspects and Impacts (Table 6-4) and Risk Assessment (Appendix 10.6).<br>Added and updated Water Monitoring Programs and added new Guideline Values (Table 6-13) and Management Actions (Table 6-14).<br>Added Objectives and Targets Summary (Table 6-17).<br>Expanded Performance Reporting Section (updated with information previously provided in EMPs).<br>Consolidated EMPs to reduce duplication (Appendix 10.9).<br>Added Incident Reporting information (previously provided in EMPs). |
| 7 Closure Plan | 71 | Additional context added. Previous design information has been incorporated into the 2020 RRPA MCP (Appendix 10.4). |

Table 1-2 provides a summary of the aspects identified by the DPIR for improvement for the PG RRPA MMP 2018-2019 (MR2019/0154) and what changes have been made to address these comments.

**Table 1-2: DPIR Comments to be Addressed in the MMP Revision**

| Section | DPIR Comments | Changes |
|---|---|---|
| General – Consultant Recommendations | The Departmental review of the MMP notes that consultants have adequately identified knowledge gaps and provided recommendations to monitor potential effects on the receiving environment, however, these recommendations have not been fully addressed in the MMP.<br>Primary Gold Limited (PG) must address all recommendations made by consultants in the revised MMP, including a timeline for implementation. Justification must be provided where a consultant recommendation will not be implemented. | Addressing consultant recommendations (including timelines) have been included in the Work Programs Summary (Table 4-1). |
| General – Closure Plan | Whilst the MMP refers to a closure plan at Appendix 7.10, no closure plan was provided.<br>PG must provide a conceptual closure plan for the site that addresses all aspects of rehabilitation and closure including:<br>• post-mining end land use as agreed with relevant stakeholders;<br>• closure objectives;<br>• final landform designs;<br>• risk-assessment of closure activities and residual; environmental and social risks;<br>• completion criteria;<br>• schedules for progressive rehabilitation; and<br>• monitoring of rehabilitation success.<br>In general, the closure plan should satisfy the following closure objectives for post-mining land use:<br>• Be physically safe to humans and animals, geo-technically stable, geo-chemically non-polluting/non-contaminating and capable of sustaining an agreed post-mining land use.<br>• Ensure that premises are decommissioned and rehabilitated in an ecologically sustainable manner. | The RRPA Mine Closure Plan has been fully revised and updated and is provided in Appendix 10.4. |
| General – Environmental Management System | It is a requirement under Section 36(5) of the Mining Management Act 2001 that the operator demonstrate the environmental management system (EMS) is appropriate for the site.<br>The EMS provided by PG does not yet demonstrate that systems are in place to identify and manage all potential impacts from the site. For example, impacts to underlying aquifer and nearby surface waters from | The EMS has been fully revised and updated and is provided in Section 6. |

| Section | DPIR Comments | Changes |
|---|---|---|
| | uncapped heap leach pad (via erosion and leaching of contaminants entrained within or on the surface) and ponds have not been adequately identified and described in the MMP.<br><br>In addition, the management plans provided as part of the EMS (e.g. weed and pest, erosion and sediment control, flora and fauna) are outdated and do not describe trigger points for the implementation of robust management actions.<br><br>As management actions are generally informed by the severity of exceedance of monitoring results to nominated criteria, PG is advised to engage an environmental practitioner to provide a comprehensive interpretation of monitoring data against trends and nominated trigger levels (especially for the water quality).<br><br>This environmental management framework needs to be extended and applied to all types of environmental monitoring. PG must revise and update the environmental management system for the site. The EMS should:<br>• define environmental objectives;<br>• identify all environmental risks from the historical mining;<br>• provide appropriate monitoring and mitigation measures for each identified risk;<br>• define trigger values for the analysis of monitoring data;<br>• provide trends of monitoring data; and<br>• describe robust management actions that will be implemented when nominated trigger values are exceeded. | |

# 2 Operator Details

The Rustlers Roost Project Area (RRPA) Operator is Primary Gold (a fully owned subsidiary of Hanking Australia Investment Pty Ltd) and contact details are provided in Table 2-1.

**Table 2-1: RRPA Operator Details**

| Operator Details | | |
|---|---|---|
| **Company or Individual Name** | Primary Gold Limited | |
| **ACN/ABN** | ACN: 122 726 283 | |
| **Address** | Level 26, 140 St Georges Terrace, Perth WA 6000 | |
| **Postal Address** | Level 26, 140 St Georges Terrace, Perth WA 6000 | |
| **Key MMP Contact Representative** | **Name** | Charles Hastie |
| | **Position** | Chief Mining Engineer |
| | **Phone Number** | 0419 963 250 |
| | **Email** | Charles.Hastie@hanking.com.au |

## 2.1 Organisational Structure

The overall management/organisational structure of Primary Gold is shown in Figure 2-1. The structure reflects the relatively new nature of the Company. As the Primary Gold assets develop the organisational structure is expected to expand and will be updated accordingly.

The Managing Director and Departmental Managers are responsible for:

- Ensuring compliance with all relevant Statutory Acts and Regulations;
- Ensuring compliance with Safety Management and Emergency Response Plans;
- Ensuring MMPs and Water Management Plans (WMPs) are adhered to; and
- Establishing and maintaining environmental and safety performance monitoring.

Overall responsibility for environmental management and compliance at the RRPA lies with the Managing Director. Resourcing and maintaining environmental management as documented in this MMP is the responsibility of the Chief Mining Engineer and delegated personnel.

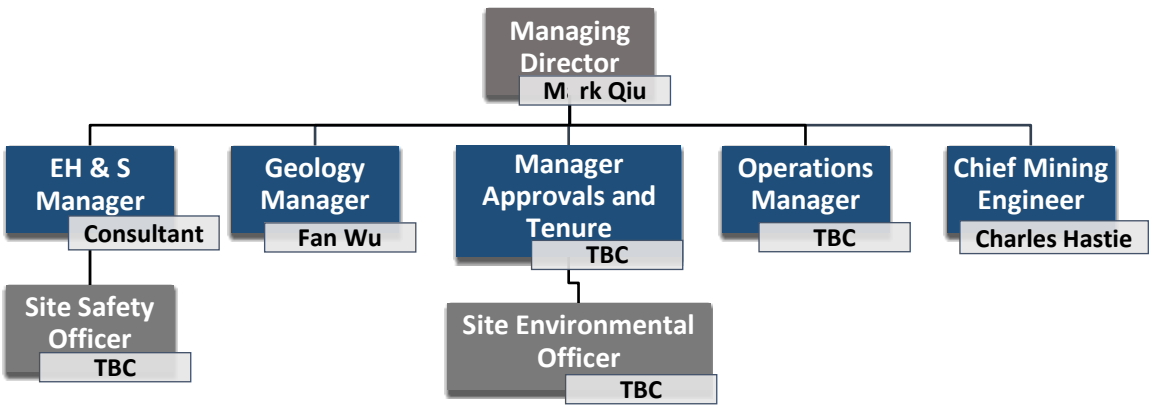



**Figure 2-1: Organisational Structure**

## 2.2 Workforce

During Care and Maintenance, the onsite workforce is limited to two (2) local contractors conducting caretaker duties, inspections, and water sampling. The two (2) contractors include the Mount Bundey Pastoralist and Station Manager acting on behalf of Primary Gold. The Contractors are local personnel residing on the Mount Bundey Pastoral Station. Key activities include:

- Conduct water sampling around the RRPA;
- Inspect the RRPA site on a regular basis;
- Report any rise in water in dams or pits;
- Maintenance of fences;
- Spraying weeds near infrastructure; and
- Assist in letting any Primary Gold consultants or other contractors in accessing the pastoralist lease to visit the RRPA.

Primary Gold staff and other contractors visit site to inspect the mine and conduct ongoing exploration activities. An environmental consultant was also employed for the project based in Darwin. The consultant was used to ensure quality control of the water sampling and conduct environmental site inspections. These Primary Gold staff and contractors stay in Darwin or the local Corroboree Roadhouse while working at the RRPA.

# 3 Project Details

## 3.1 Authorisation and Title Details

Activities at the RRPA are undertaken in accordance with Authorisation 0738-01 and the approved MMP. The RRPA is located on tenement MLN 1083, granted in accordance with the Northern Territory (NT) *Mineral Titles Act* (Table 3-1). Majority tenement holder Primary Minerals Pty Ltd is a wholly owned subsidiary of Primary Gold.

**Table 3-1: RRPA Tenements**

| Tenement | Holder | Grant Date | Expiry Date | Area – hectares (ha) |
|---|---|---|---|---|
| MLN 1083 | Primary Minerals Pty Ltd (80%)<br>Karen On (10%)<br>Stanley Fletcher (10%) | 04/03/1991 | 31/12/2020 | 755.6 |

## 3.2 Location

The RRPA is in the Mount Bundey Region in the NT. The Project is approximately 100 kilometres (km) south-east of Darwin, 20km south of the Arnhem Highway and 11km south-west of the Toms Gully Project Area (TGPA) (Figure 3-1). Access to the fenced site is from the Arnhem Highway via a private gravel access road which has locked gates at the highway and mine entry points.

The RRPA is located entirely on the Old Mount Bundey Pastoral Station – Pastoral Lease No: PPL 1163, NT Portion 4937 (Figure 3-2). During 2013, fencing was established around the Heap Leach Pad, Leach/Storm Water Ponds, and mine area to prevent livestock access to contaminated water or salts and restrict public access. The plan showing the existing infrastructure is provided in Figure 3-3.

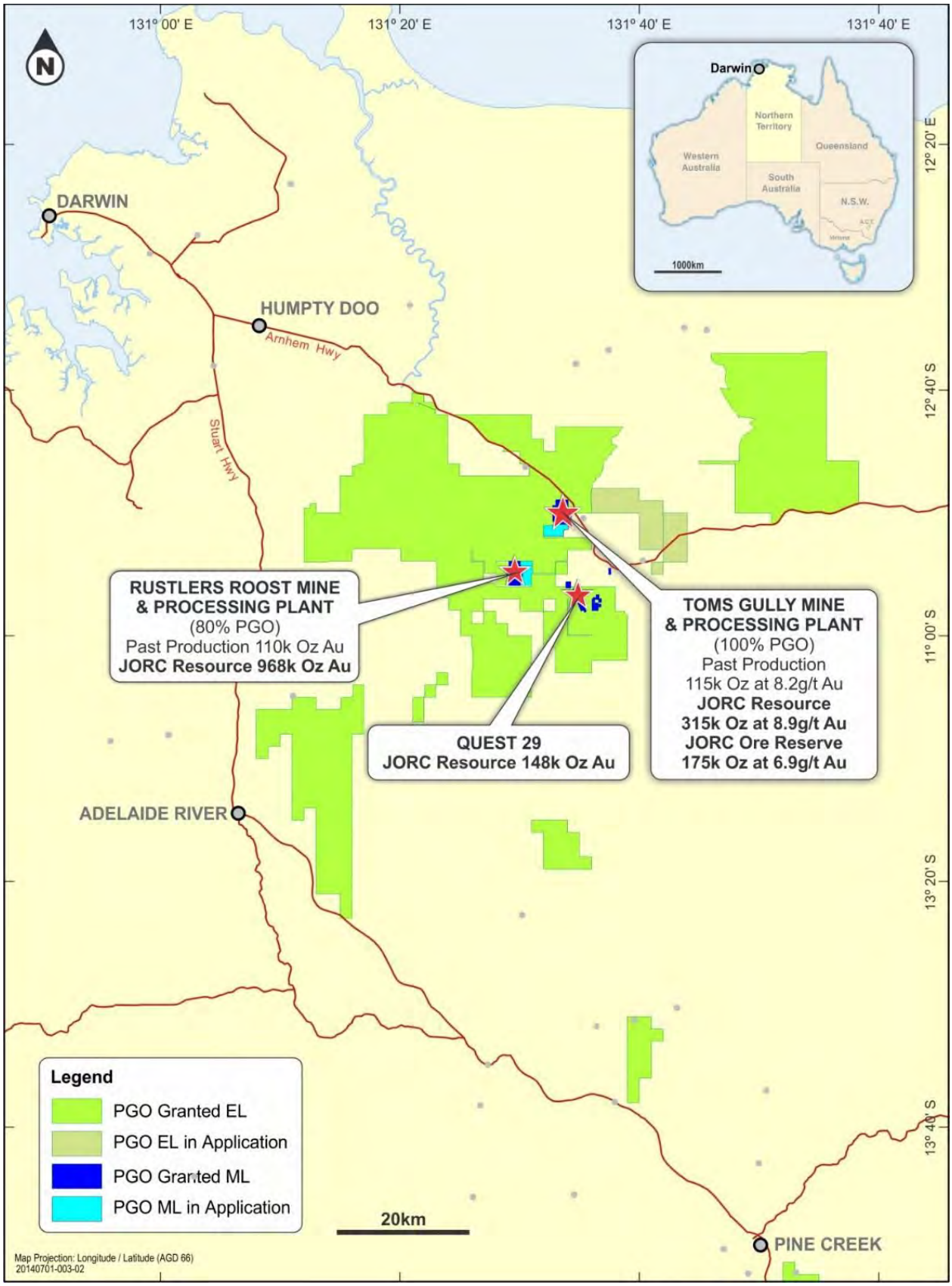



**Figure 3-1: RRPA Regional Location**

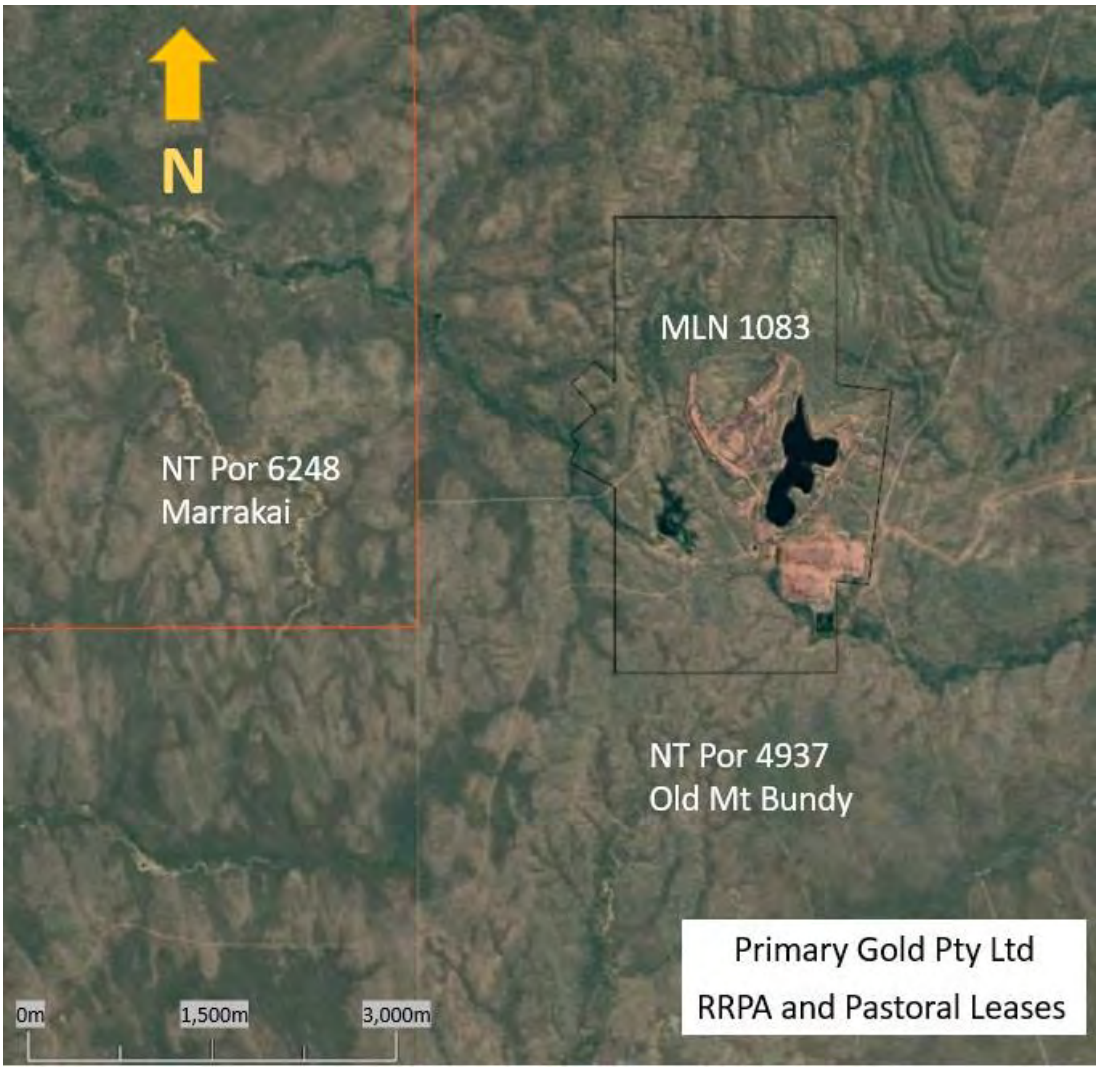



**Figure 3-2: RRPA Tenement and Pastoral Lease Area**

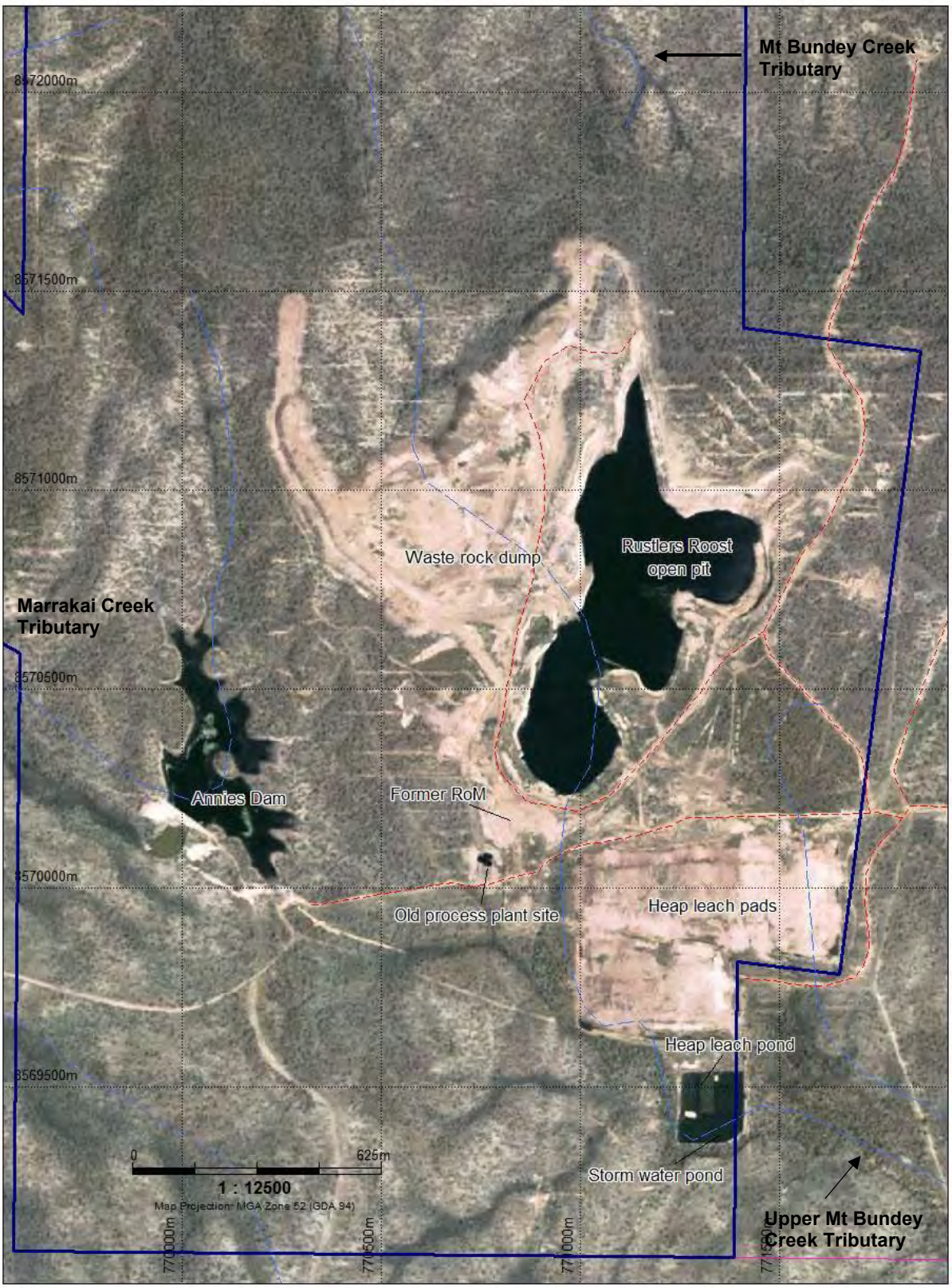



**Figure 3-3: RRPA Existing Infrastructure Plan**

# 4 Previous Activities and Current Status

## 4.1 History and Ownership

Gold was first discovered at the RRPA in the 1940's and an 8-hectare (ha) mining claim was pegged and worked for 3 to 4 years. Ore was trucked to a nearby stamp battery and approximately 120 ounces (oz) of gold was produced from 200-250 tonnes(t) of ore. The mine was abandoned until the 1970's when sporadic alluvial gold mining was undertaken until the early 1980's.

In 1988, reconnaissance exploration over the RRPA was undertaken by Kintaro Mines Pty Ltd (Kintaro) and their Joint Venture (JV) partners. In 1991, the RRPA tenement MLN 1083 was granted to Kintaro (80%) and JV partners Ben Hall (10%) and Stanley Fletcher (10%). In 1993, Valdora Mining Pty Ltd (Valdora) acquired the Kintaro interest in the RRPA.

A Preliminary Environmental Report (PER) was lodged by Valdora with the NT Government in January 1994. The PER outlined the proposed mining of four (4) oxide pits, construction of two (2) Waste Rock Landforms (WRLs), four (4) Heap Leach Pads, surface water containment infrastructure, crushing site, processing facilities and haul/access roads over an area of 110.5ha. Approval to mine was granted in April 1994 and the first gold was poured in October 1994.

Valdora was taken over by William Resources Inc in late 1995 and in 1996 Valdora was renamed to Rustlers Roost Mining Pty Ltd (RRMPL). In August 1996, RRMPL lodged a Notice of Intent (NOI) for the Stage 2 expansion of the RRPA. A Draft Environmental Impact Statement (EIS) was prepared in January 1997 which outlined the proposed combining and deepening of the existing pits, combining and increasing the height of the WRLs, installation of a new Resin In Leach process and the addition of a Tailings Storage Facility (TSF) over an area of 181ha.

The assessment of the Draft EIS (and supplementary information) was completed by the Department of Lands, Planning and Environment – Environment Protection Division (now the NT Environmental Protection Authority (EPA)) in August 1997. The Environmental Assessment Report and Recommendations accepted the proposal and noted that several matters needed to be further addressed before granting approval to proceed via a MMP.

Due to low commodity prices, the RRPA never realised planned production levels and the Stage 2 expansion did not proceed. Mining ceased in August 1997 and ore processing was completed in June 1998. Approximately 4.5 million tonnes (Mt) of ore was mined and processed at the RRPA from July 1994 to June 1998 for around 110,000oz of gold and 11,000oz of silver. The RRPA was effectively placed into "Care and Maintenance" from July 1998.

A RRPA Decommissioning Plan and Rehabilitation Plan were prepared for William Resources Inc in 1997 however these plans were not fully implemented. All plant, buildings and other mining infrastructure have been removed from the site, although three (3) large tanks, lined Leach/Storm Water Ponds and some minor concrete footings remain. Following the cessation of mining, the pits have flooded and for practical purposes are now considered as one pit. Final stabilisation and closure of built landforms has not been undertaken and there has been no further progress towards closure.

In June 2003, RRMPL conducted exploration work within the RRPA, drilling deep holes underneath pits in the transitional and fresh rock material. In July 2007, GBS Gold Australia Pty Ltd (GBS) acquired mining and exploration assets in the Mount Bundey Region, including the RRPA. However, prior to undertaking any work GBS went into administration and in July 2010 Crocodile Gold Australian Operations (CGAO) acquired ownership of the RRPA. In 2013, CGAO sold the RRPA (and other nearby assets) to Primary Gold and the site remains on Care and Maintenance.

Material from the WRL has historically been removed for use as an ornamental stone landscaping material in the greater Darwin Region. Under an agreement with the lease holder, the Old Mount Bundey Pastoralist gained the rights to access this material shortly after mining ceased in 1997. Removal of this material was first authorised on 12 February 2004 (Authorisation 0202-01), however it is understood that this Authorisation has since lapsed.

## 4.2 Current Status

Since its purchase in 2013, Primary Gold has undertaken reconnaissance and desktop geological work and maintained site environmental monitoring, maintenance and reporting at the RRPA. In 2017 Primary Gold completed an exploration drilling program, targeting areas of known gold mineralised and anomalous gold occurrences including the RRPA. Of the 37 approved exploration drill holes, 29 sites were drilled (16 on MLN1083 and 13 on EL30809).

Primary Gold aim to return the TGPA to operational status and utilise this infrastructure to develop the unmined gold resource at the RRPA. The 2019 RRPA Pre-Feasibility Study assessment of the Mineral Resource has defined a Mineable Reserve of ~19Mt at 0.93g/t for 578koz of gold and a resource of 1.5 million oz.

It is because of this large resource that the site has not undergone substantial rehabilitation over the last 20 years. With the current strong price for gold it is anticipated that a large open cut mining operation and CIL plant will be established at RRPA.

A Life of Mine (LOM) Plan is currently being developed by Primary Gold to return the RPPA into operational status in the next 2-5 years. The development of the LOM Plan will help shape the long-term options for the RRPA, be that remaining on Care and Maintenance, returning to operational status, or transitioning to planned closure. Until the RRPA mine plans have been finalised (and approvals granted) the site will remain in Care and Maintenance.

During Care and Maintenance, Primary Gold will continue to manage monitoring, maintenance, and caretaking activities in accordance with the MMP as the nominated operator of the RPPA. Primary Gold will also undertake any priority site remediation works or studies identified as part of this MMP to reduce (or better understand) the risk of potential long-term environmental impacts arising from historical mining infrastructure.

### 4.2.1 Activities Undertaken During the Previous Reporting Period

Production in the last 12 months (2018 to 2019) was nil and during this period no land was cleared. In addition to routine monitoring activities, Primary Gold engaged consultants CDM Smith (CDMS) in 2019 to conduct assessments of the site surface water, groundwater, and geochemistry to address previous DPIR comments and better understand the RRPA environment.

The Surface Water Assessment (Appendix 10.1) reviewed the site water balance, flood modelling and erosion and sediment controls. This assessment concluded that the Open Pt water level is near equilibrium and the site is unlikely to be adversely affected by flooding. Flood modelling indicates that it is highly unlikely that the Open Pit, Annie's Dam, Processing Ponds, and the Stormwater Pond will overtop. It was recommended as part of site erosion and sediment control that existing berms need to be maintained and repaired and this has been included in the MMP Work Program (Table 4-1).

The Groundwater Assessment (Appendix 10.2) identified data gaps related to the effects of historical mining activities. This assessment concluded that the available groundwater quality data, which is very limited, suggests the potential for groundwater contamination due to prior mining and processing activities is low. It was recommended that an additional 6-10 monitoring sites (and parameters) are established for future mining and this has been included in the MMP Work Program (Table 4-1).

Three new water monitoring bores are proposed to be drilled in the dry season of 2020. Some additional recommended bores close to the pit edge will not be drilled, as future mining will immediately destroy

them. The positions will be adjusted so they remain outside the future pit. They will be drilled once final design of the pit is completed.

The Geochemical Assessment (Appendix 10.3) provides advice on the likelihood of acid or neutral metalliferous drainage to be released from site. This assessment concluded that for the waste materials currently stored on the sites surface, the potential to leach a significant dissolved chemical load to surface or groundwater is low. It was recommended that additional material characterisation is required for future mining and this has been included in the MMP Work Program (Table 4-1).

### 4.2.2 Activities Planned for the Next Reporting Period

Production in the next 12 months (2019 to 2020) will be nil and during this period no land will be cleared. In addition to routine monitoring activities, rehabilitation of exploration areas and repairs to existing berms are planned. The 2020 RRPA MCP is provided in Appendix 10.4.

## 4.3 Work Programs

The care and maintenance activities to be conducted during the MMP period are provided in Table 4-1.

**Table 4-1: Work Programs**

| Work Program | Proposed Activities | Responsibility and Timeframe | Current Status |
|---|---|---|---|
| **Routine Actions** | | | |
| **Incidents** | Report any identified environmental hazard, incident, emergency, or public complaint. | All Personnel.<br>As Required. | Ongoing. |
| **Inspections** | Undertake a general site inspection to identify any water, erosion, weed, fire, or fauna (or livestock) risks and any items requiring follow up action or additional controls.<br>Record the occurrence of any fauna, fire, pests, or weeds in the site registers. | Chief Mining Engineer / Contractor / Pastoralist Monthly | Ongoing. |
| **Water Monitoring Program** | Undertake Water Monitoring in accordance with MMP. | Chief Mining Engineer / Contractor / Pastoralist Monthly | Ongoing. |
| **Erosion and Sediment Control** | Undertake an inspection (and photographic monitoring) of landforms, berms, roads, and drainage lines (downstream of disturbance areas) for erosion and sedimentation and undertake required maintenance in a timely manner. | Chief Mining Engineer / Contractor<br>Annual | Ongoing. |
| **Weeds** | Review weed mapping and implementation of weed control (spraying/burning) where required. | Chief Mining Engineer / Contractor / Pastoralist | Ongoing. |
| **Fire** | Maintain established fire breaks. | Chief Mining Engineer / Contractor<br>Annual | Ongoing. |
| **Improvement Actions** | | | |

| Work Program | Proposed Activities | Responsibility and Timeframe | Current Status |
|---|---|---|---|
| **Water Monitoring Program** | One (1) additional surface water monitoring location added to program and revise parameters and frequency based on the 2019 CDMS Groundwater Assessment. | Chief Mining Engineer<br>June 2020 | Site SW23 added and monitoring parameters and frequency reviewed (Section 6.7.1). |
| **Water Monitoring Program** | Revise parameters and frequency based on the 2019 CDMS Groundwater Assessment. | Chief Mining Engineer<br>June 2020 | Monitoring parameters and frequency reviewed (Section 6.7.2). |
| | Review location of additional 6-10 groundwater monitoring bores based on the 2019 CDMS Groundwater Assessment. | Chief Mining Engineer<br>December 2020 | Review and confirm based on future LOM Plan layout. |
| **Erosion and Sediment Control** | Repair and maintain existing berms in accordance with the 2019 CDMS Surface Water Assessment. | Chief Mining Engineer / Contractor<br>Dry Season 2021 (Delay due to Covid-19) | Planned. |
| **Materials Characterisation** | Undertake additional material characterisation as part of Exploration Drilling Program for future mining operations in accordance with the 2019 CDMS Geochemical Assessment. | Chief Mining Engineer<br>June 2021 | Planned. |
| **Exploration Rehabilitation** | Complete the rehabilitation of exploration areas (Section **Error! Reference source not found.**). | Chief Mining Engineer<br>June 2021 to May 2022 | Planned after exploration complete. |
| **Mine Closure Plan** | Update the 2016 MCP. | Chief Mining Engineer<br>June 2020 | The 2020 RRPA MCP is provided in Appendix 10.4. |

# 5 Current Project Site Conditions

## 5.1 Physical Environment

### 5.1.1 Climate

The climate of the Darwin-Katherine region is broadly classified as tropical monsoonal. It is characterised by seasonal shifting of the prevailing winds and consequently marked changes of air mass properties. Two distinct seasons can be identified – the dry and wet season, with two subsidiary transitional periods between them. The dry season occurs from May to September and the transition period from dry to wet season occurs in October and November. The wet season occurs from December to March and the second transition period, from wet to dry season, occurs in April.

#### *5.1.1.1 Climate Zone*

The Bureau of Meteorology (BoM) provide climate classification maps using three (3) methods of classifying the climate of Australia. These different classification schemes are based on temperature/humidity, vegetation (Köppen) and seasonal rainfall.

The temperature and humidity zones map (Figure 5-1) shows the climate of Australia classified according to temperature and humidity properties across the country. This map is based on temperature and humidity data collected over the period 1961 to 1990. This method of classification identifies six (6) key zones across Australia, based on a set of definitions relating to summer and winter conditions. This map indicates that the RRPA is within the hot humid summer climate zone.

The Köppen classification map (Figure 5-2) show six (6) major groups of climate zones across Australia. This method of classification is based on the concept that native vegetation is the best expression of climate in an area and the six (6) major classes are identified predominantly on native vegetation type. This map indicates that the RRPA is within the tropical classification zone.

The seasonal rainfall map (Figure 5-3) use the differences between summer and winter rainfall across Australia to identify six (6) major climate zones. These maps use the median annual rainfall (based on the 100 year period from 1900 to 1999) and seasonal incidence (the ratio of the median rainfall over the period November to April to the period May to October) to identify these six (6) major zones. This map indicates that the RRPA is within the summer dominant climate class with a marked wet summer and dry winter.

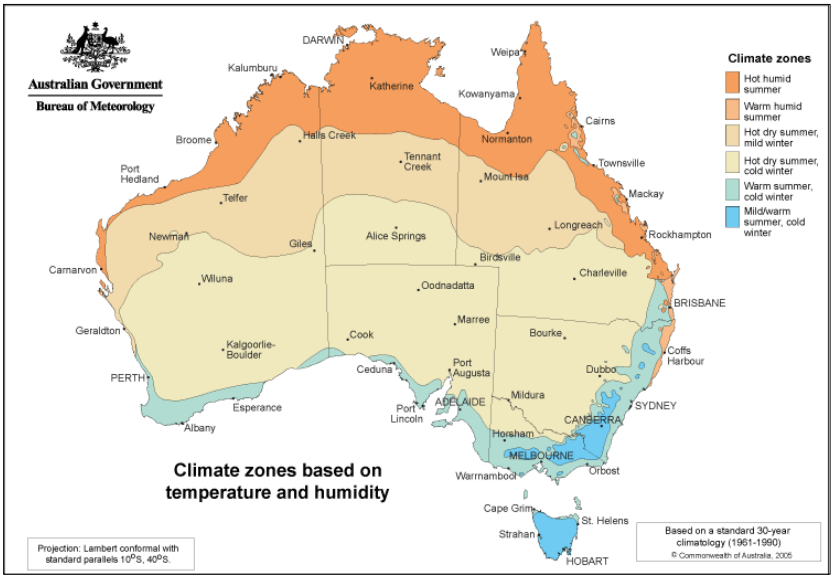



**Figure 5-1: Australian Climate Zones based on Temperature and Humidity (BoM, 2005)**

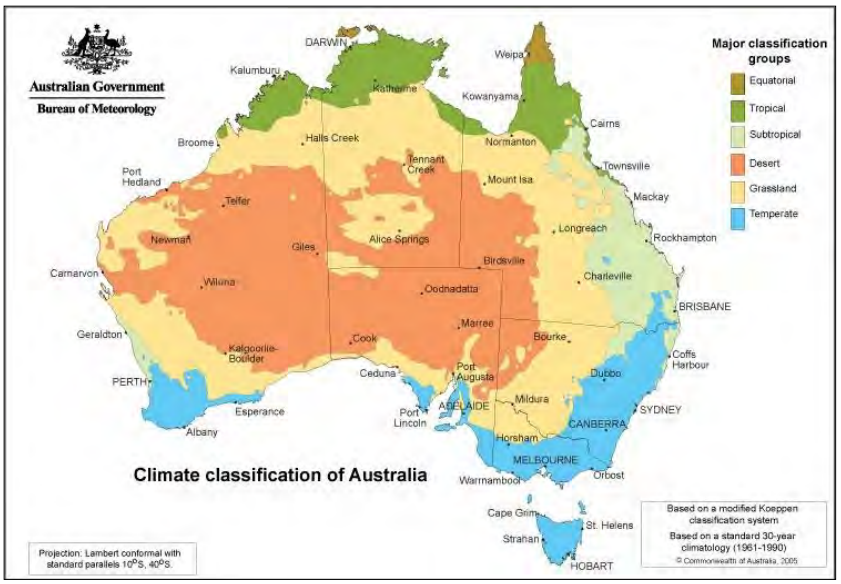



**Figure 5-2: Australian Climate Zones based on Vegetation (BoM, 2005)**

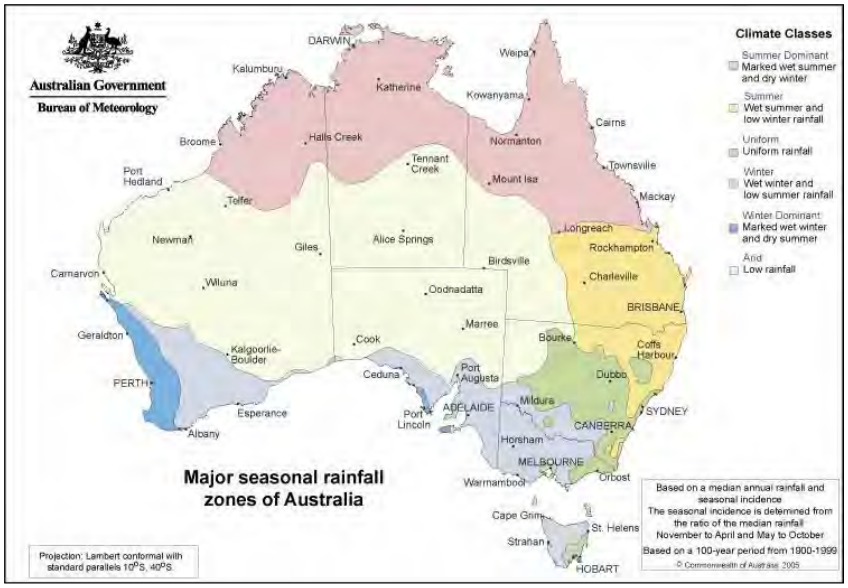



**Figure 5-3: Australian Climate Zones based on Rainfall (BoM, 2005)**

#### *5.1.1.2 Temperature*

The closest long-term BoM weather station is the Middle Point Rangers Weather Station (#14090) located approximately 42km south of the RRPA. Summary temperature data (1965-1998) from this weather station is provided in Table 5-1 and Figure 5-4 and indicates the following key statistics regarding temperature in the region:

- Mean daily maximum temperatures range from 35.6°C in October to 31.3°C in June/July;
- Mean daily minimum temperatures range from 23.9°C in December/February to 14.9°C in July;
- Highest temperature recorded was 40.3°C in October 1990;
- Lowest temperature recorded was 4.6°C in July 1965;
- Mean number of days that temperature is ≥35°C is 72.0 (mostly September to November); and
- Mean number of days that temperature is ≤2°C is 0.0.

Variation in temperature is relatively moderate in the region and is consistent, particularly in the dry season.

**Table 5-1: Middle Point Rangers Weather Station Monthly Temperature (1965-1998)**

| Month | Mean Daily Maximum | Mean Daily Minimum | Highest Daily Maximum | Lowest Daily Minimum | Mean No. Days Maximum ≥ 35.0°C | Mean No. Days Minimum ≤ 2.0°C |
|---|---|---|---|---|---|---|
| Jan | 32.6 | 23.8 | 38.2 | 20.2 | 3.2 | 0.0 |
| Feb | 32.0 | 23.9 | 36.2 | 19.3 | 1.0 | 0.0 |
| Mar | 32.4 | 23.6 | 37.5 | 17.3 | 1.5 | 0.0 |
| Apr | 33.1 | 22.1 | 39.0 | 13.1 | 1.6 | 0.0 |
| May | 32.5 | 19.4 | 35.9 | 8.2 | 0.5 | 0.0 |
| Jun | 31.3 | 16.1 | 34.9 | 5.4 | 0 | 0.0 |
| Jul | 31.3 | 14.9 | 35.5 | 4.6 | 0.1 | 0.0 |
| Aug | 32.9 | 16.8 | 37.1 | 5.0 | 2.6 | 0.0 |
| Sep | 34.7 | 20.1 | 38.8 | 9.0 | 13.7 | 0.0 |
| Oct | 35.6 | 22.7 | 40.3 | 13.5 | 21.5 | 0.0 |
| Nov | 35.1 | 23.7 | 40.2 | 19.0 | 16.9 | 0.0 |
| Dec | 33.8 | 23.9 | 38.7 | 18.0 | 9.4 | 0.0 |
| **Annual** | **33.1** | **20.9** | **40.3** | **4.6** | **72.0** | **0.0** |

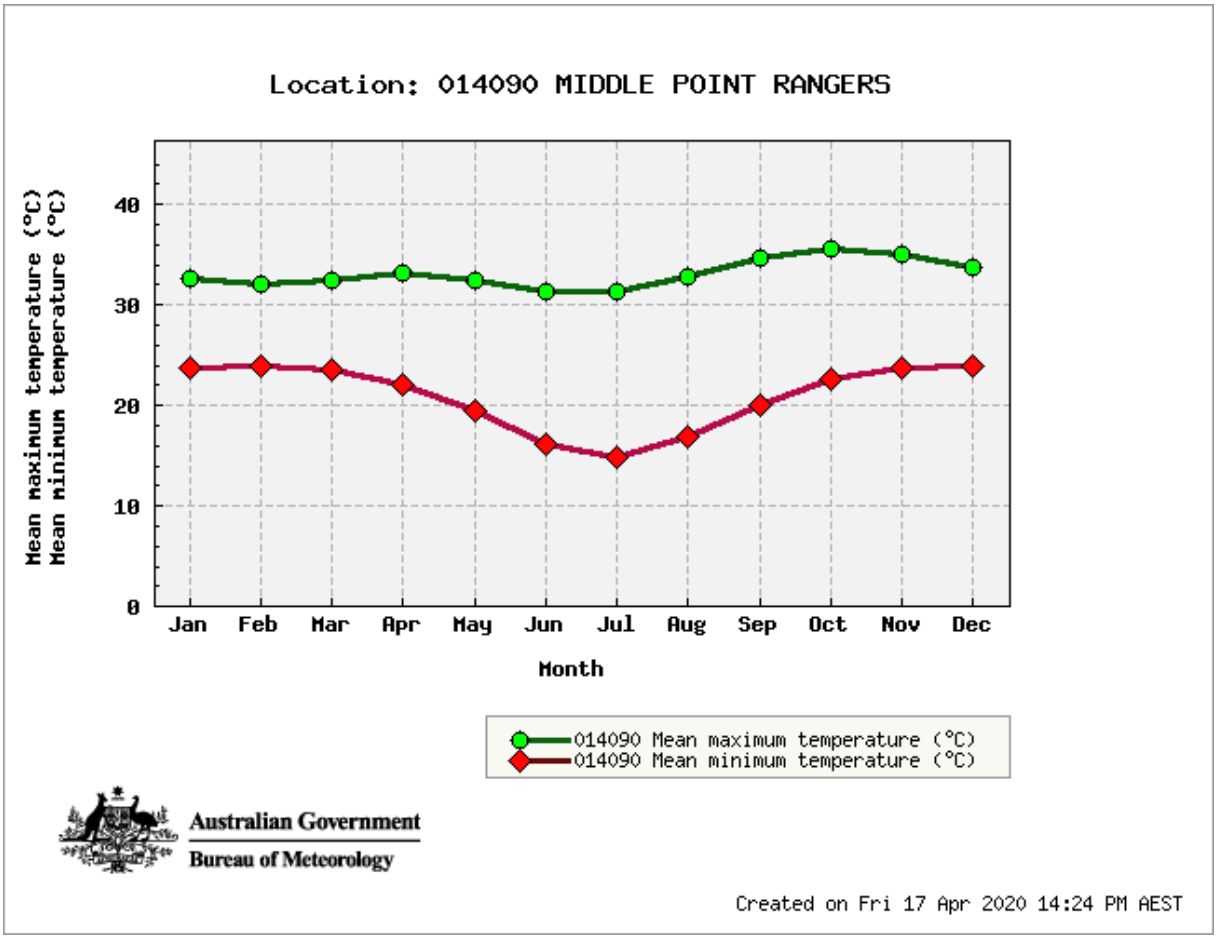



**Figure 5-4: Middle Point Rangers Weather Station Mean Maximum and Minimum Temperature (BoM, 2020a)**

#### *5.1.1.3 Rainfall*

The Middle Point Rangers Weather Station (#14090) summary rainfall data (1957-2019) is provided in Table 5-2 and indicates the following key statistics regarding rainfall in the region:

- Mean annual rainfall is 1,433.5mm;
- Majority of rainfall is in summer (December to March);
- Mean monthly rainfall ranges from 0.7mm in July to 346.5mm in January;
- Highest monthly rainfall recorded was 942.1mm in January 2018;
- Highest daily rainfall recorded was 242.3mm in December 1965;
- Highest mean number of days of rain is 20.9 in January;
- Lowest mean number of days of rain is 0.3 in June;
- Mean number of days of rain ≥10mm is 41.0; and
- Mean number of days of rain ≥25mm is 17.3.

A review of the mean and highest rainfall trends indicates that there can be a large variation in rainfall received in the region (Figure 5-5).

**Table 5-2: Middle Point Rangers Weather Station Monthly Rainfall (1957-2019)**

| Month | Mean Rainfall | Highest Rainfall | Lowest Rainfall | Mean No. Days of Rain | Mean No. Days ≥ 10mm | Mean No. Days ≥ 25mm |
|---|---|---|---|---|---|---|
| Jan | 346.5 | 942.1 | 40.8 | 20.9 | 9.6 | 4.4 |
| Feb | 279.9 | 638.8 | 78.0 | 20.3 | 7.9 | 3.4 |
| Mar | 249.2 | 552.9 | 0.0 | 17.8 | 7.2 | 3.3 |
| Apr | 88.7 | 488.2 | 0.8 | 7.9 | 2.6 | 0.9 |
| May | 23.9 | 298.4 | 0.0 | 2.6 | 0.6 | 0.3 |
| Jun | 1.4 | 30.0 | 0.0 | 0.3 | 0.0 | 0.0 |
| Jul | 0.7 | 22.4 | 0.0 | 0.4 | 0.0 | 0.0 |
| Aug | 2.2 | 38.5 | 0.0 | 0.5 | 0.1 | 0.0 |
| Sep | 12.9 | 67.8 | 0.0 | 2.0 | 0.4 | 0.1 |
| Oct | 57.3 | 162.6 | 0.0 | 6.1 | 1.9 | 0.7 |
| Nov | 130.0 | 300.8 | 29.0 | 12.3 | 4.2 | 1.4 |
| Dec | 227.8 | 484.3 | 19.0 | 17.5 | 6.5 | 2.8 |
| **Annual** | **1,433.5** | **2,198.3** | **874.9** | **108.6** | **41.0** | **17.3** |

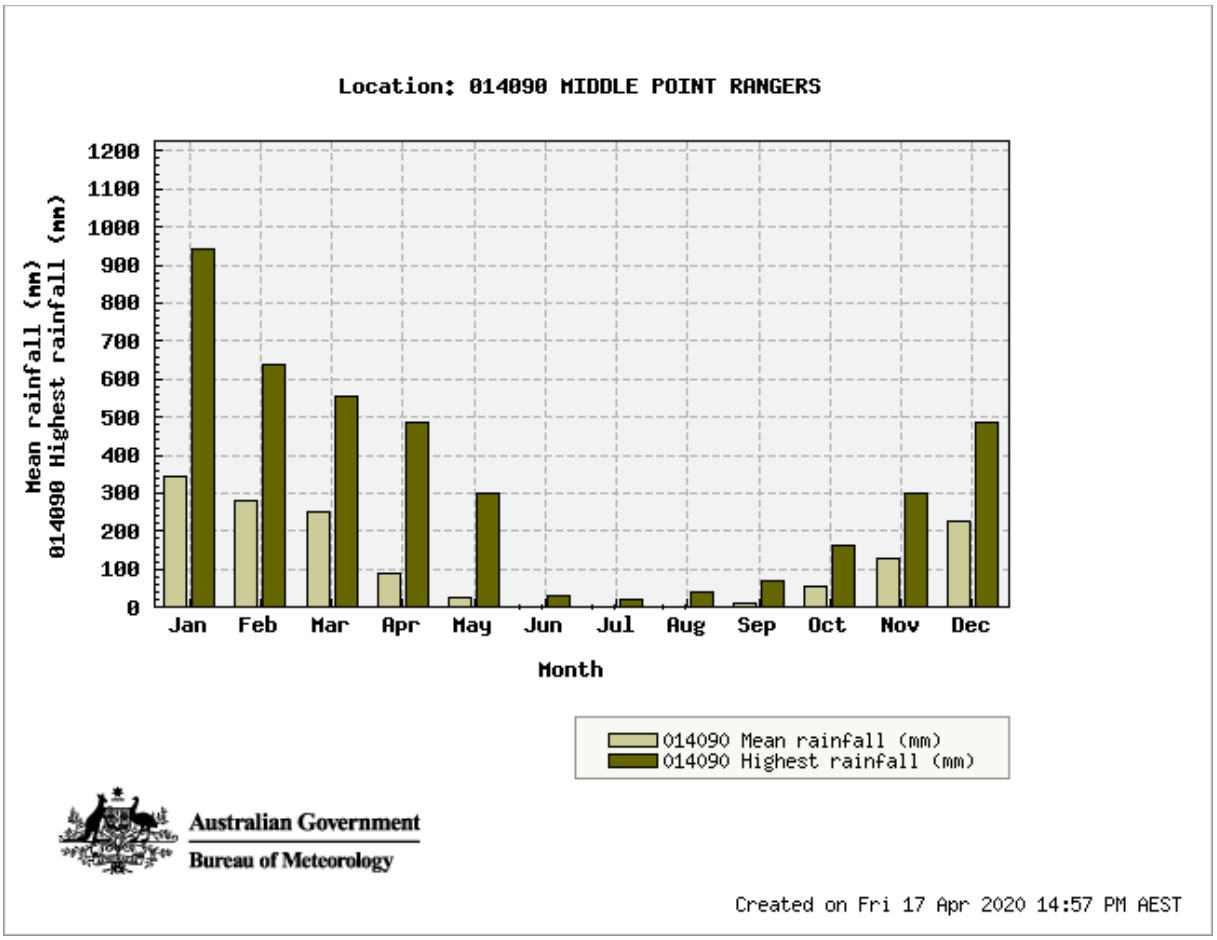



**Figure 5-5: Middle Point Rangers Weather Station Mean and Highest Rainfall (BoM, 2020a)**

#### *5.1.1.4 Cyclones*

There are on average 7.7 days per season when a cyclone exists in the northern region of Australia. The north-western Gulf of Carpentaria near Gove has the highest concentration of cyclone days. The Gulf of Carpentaria averages two cyclones a year, while the Arafura and Timor Seas average one a year.

Cyclones in the Gulf of Carpentaria move very erratically, whereas those in the Arafura and Timor Seas tend to follow more regular tracks to the southwest. Over half the cyclones generated in the Northern region, move either southwest or southeast into adjoining regions. Cyclone events and associated winds and rainfall may affect the RRPA. Cyclones occur most frequently in the wet season months, particularly from December to March (Figure 5-6).

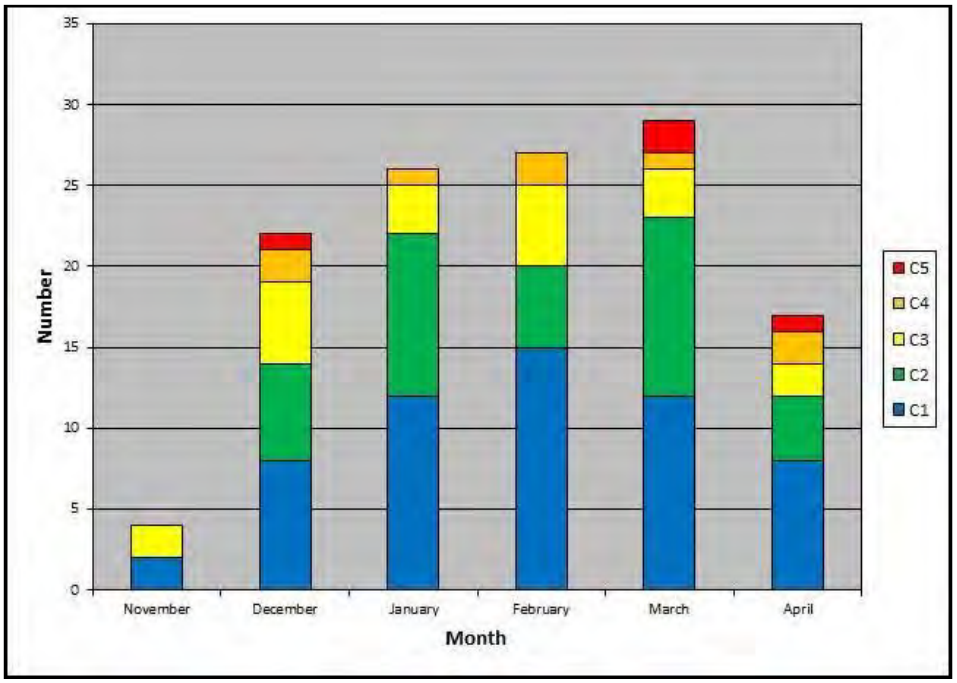



**Figure 5-6: Tropical Cyclones in the Northern Region of Australia, 1964 to 2015 (BOM, 2020b)**

#### *5.1.1.5 Rainfall Intensity Frequency Duration*

Analyses of data from rainfall gauges and the use of statistical theory enables the estimation of the probability that a particular rainfall depth (mm) will be equalled or exceeded at a particular place, within a particular time interval (duration), and over any given period of time. This analysis is known as rainfall intensity-frequency-duration (IFD). The BoM website provides a Design Rainfall Data System (2016) which enables the estimation of the IFD at a specified location in Australia.

The probability of a particular rainfall depth for a specified duration being equalled or exceeded in any 1 year period can be expressed as a percentage (the Annual Exceedance Probability or AEP) or as "on the average once in every x years" (an Average Recurrence Interval, or ARI). The use of AEP to describe the chance of a rainfall event is preferred as it conveys the probability for each year. The alternative, ARI, is a term which has been frequently used in the past but is easily misunderstood.

The IFD calculated for the RRPA is provided in Table 5-3. An example interpretation of these results is that a rainfall amount of 92.5mm in 1 hour can be expected to be equalled or exceeded on average once every 100 years. In this case, the AEP is 1% and the ARI is 100 years.

It is important to note that an ARI of 100 years does not mean that the event will only occur once every 100 years. Rather that for every year, there is a 1% chance (a 1 in 100 chance) that the event will be equalled or exceeded (once or more than once). The 1% AEP (100-year ARI flood) is frequently used as the defined flood event. The floodplain of a defined flood event should be used as the area over which controls on land use and development need to recognise the impacts of flooding.

**Table 5-3: RRPA Calculated Rainfall Intensity-Frequency-Duration**

| | Annual Exceedance Probability (AEP) | | | | | |
|---|---|---|---|---|---|---|
| **Duration** | **50%#** | **20%*** | **10%** | **5%** | **2%** | **1%** |
| 5 mins | 12.0 | 14.9 | 16.7 | 18.2 | 20.1 | 21.3 |
| 30 mins | 38.8 | 48.0 | 53.6 | 58.8 | 65.0 | 69.4 |
| 1 hour | 51.7 | 64.2 | 71.9 | 78.8 | 86.9 | 92.5 |
| 2 hours | 63.0 | 79.3 | 89.4 | 98.6 | 110 | 117 |
| 3 hours | 68.5 | 87.2 | 99.2 | 110 | 124 | 134 |
| 6 hours | 76.8 | 101 | 117 | 133 | 154 | 170 |
| 12 hours | 86.7 | 117 | 140 | 163 | 195 | 222 |
| 24 hours | 103 | 143 | 174 | 207 | 254 | 295 |
| 72 hours | 154 | 217 | 265 | 317 | 387 | 443 |
| **ARI** | **1 in 1.44 #** | **1 in 4.48 *** | **1 in 10** | **1 in 20** | **1 in 50** | **1 in 100** |

Note: # The 50% AEP IFD **does not** correspond to the 2-year ARI IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5-year ARI IFD. Rather it corresponds to the 4.48 ARI.

#### *5.1.1.6 Evaporation*

The Middle Point Rangers Weather Station (#14090) mean daily pan evaporation (1965-1998) ranges from 4.5 to 7.1mm, with an annual average of 5.5mm. This is the equivalent of around 2,000mm/year and exceeds the annual average rainfall (1,434mm). Evaporation is highest from August to November. This is consistent with the BoM map showing the average annual evaporation rates across Australia (Figure 5-7) which indicates that the RRPA is in the zone of around 2,000mm evaporation a year.

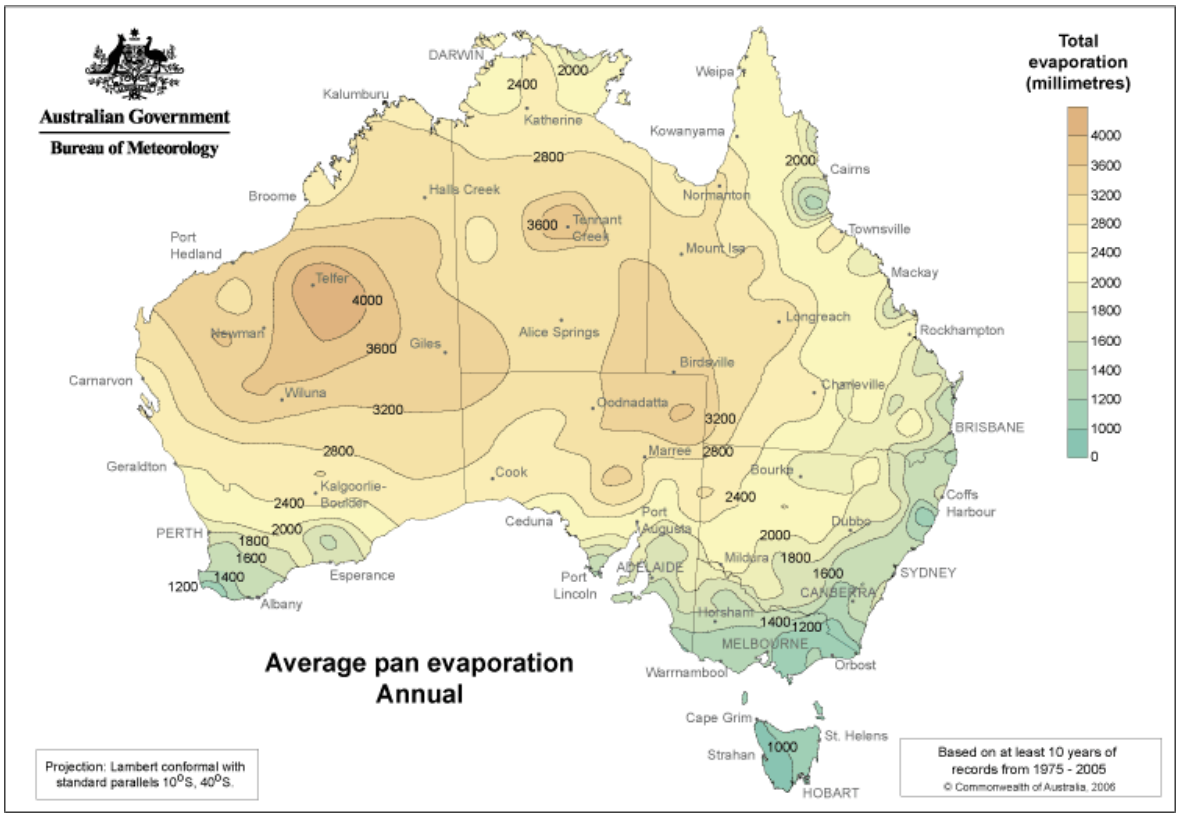



**Figure 5-7: Australian Annual Average Pan Evaporation (BoM, 2006)**

#### *5.1.1.6.1 Wind Speed and Direction*

Wind is one of the most highly variable meteorological elements, both in speed and direction. It is influenced by a wide range of factors, from large scale pressure patterns, to the time of day and the nature of the surrounding terrain. Because the wind is highly variable it is often studied by means of frequency analyses, provided in the form of wind roses, rather than as simple averages.

Wind roses are available for the Middle Point Rangers Weather Station (#14090) based on data from 1965 to 1998. During the dry season (i.e. July), winds are expected to be predominantly south-easterly and during the transition from dry to west season (i.e. October) winds are more variable and trending towards north-easterly (Figure 5-8). During the wet season (i.e. January) winds are more variable and trending towards west north-westerly and during the transition from wet to dry (i.e. April) winds are south-easterly (Figure 5-9).

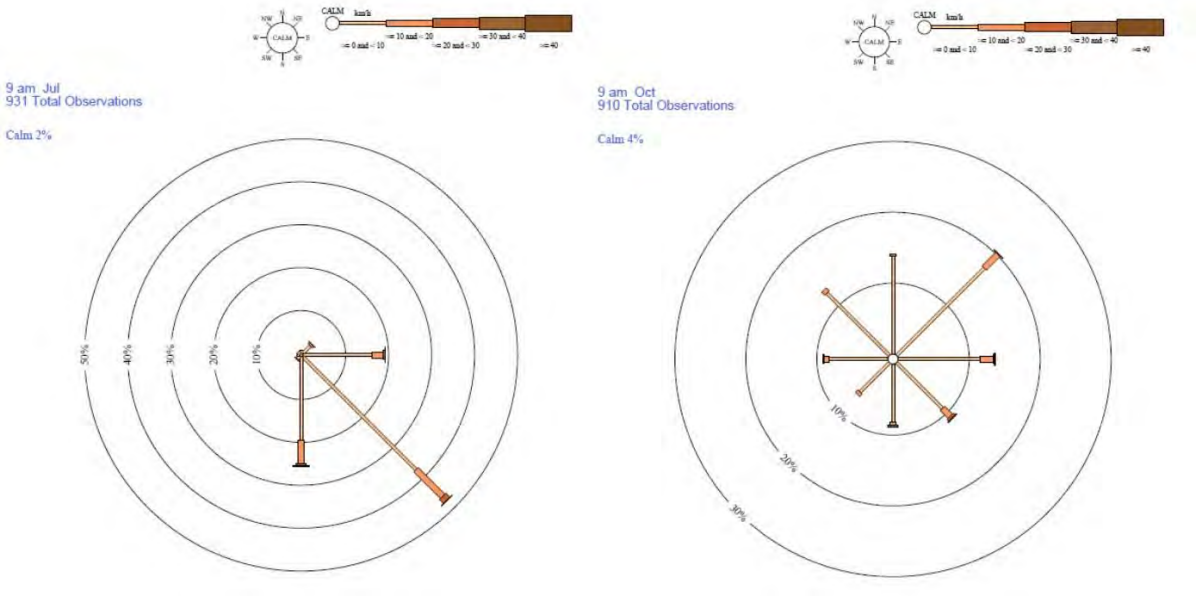



**Figure 5-8: Middle Point Rangers Weather Station Wind Roses July and Oct 9am (BoM, 2020a)**


**Figure 5-9: Middle Point Rangers Weather Station Wind Roses Jan and April 9am (BoM, 2020a)**

### 5.1.2 Landscape

The RRPA occurs in the Pine Creek (PCK) bioregion, as defined by the Commonwealth Department of the Environment and Energy (DotEE) Interim Biogeographic Regionalisation for Australia (IBRA) classification system (DotEE, 2012). The region has one (1) major component the Pine Creek subregion (PCK01) which has an area of 28,520km$^2$. Land types of the Pine Creek bioregion are mainly hilly to rugged ridges with undulating plains.

The RRPA is located on the slopes of a northerly trending ridge which has Mount Bundey as the main regional feature. It encompasses an area of low rolling hills with minimal soil development and level plateaus with deeper soils and outcropping laterite. The hills have moderate to gentle slopes and topography ranges between 40-100m AHD (Figure 5-10). The RRPA is situated along a catchment divide, with the eastern portion of the site draining to the Mary River catchment via Mount Bundey Creek, and the western portion of the site draining into the Adelaide River via an unnamed tributary of the Marrakai Creek.

Vegetation is characterised by eucalypt woodlands with tropical grass understories. The vegetation of the hills is low, open, and largely deciduous, the dominants of the plateaus are taller and for the most part evergreen. Creek lines in the hills have a minimum of alluvium with the vegetation indistinguishable from the adjoining slopes and the lowermost basins and creek lines have varying degrees of silty alluvium and support a distinctive tree and grass flora.

The 1993 Kinhill Flora, Fauna and Soils Study (Kinhill, 1993a – provided in the MCP Appendix 10.4) identified three vegetation communities associated with distinctive soil types in the RRPA:

1 **Low Woodland**

- Extreme runoff conditions on the steep slopes of the dissected hills have maintained rock outcrop or shallow gravelly soils.
- Gravelly yellow lithosols are on the gentler slopes and saddles of dissected hills.

2 **Open Forrest**

- Shallow lithosols occur on the plateau surfaces in the northern part of the site and are well drained, gravelly, with ironstone nodules at the surface and lateritic outcrop.
- The best quality forest occurred on the deep red earths on the margin of the residual plateau. The soils are dark red, well drained with lateritic outcrop.

3 **Low Open Woodland / Grassland**

- Alluvium soils develop in the erosional products of siltstones and greywackes. The alluvium is grey, fine, and clayey, poorly drained and dries out rapidly in the Dry Season.
- The soils are also characterised by earthworm activity or “Debil debil” in the Wet Season.
- In the Dry Season, the surface layers are easily disturbed and produce yellow “bulldust”. Soils observed at the project site appear to be solodized solonetz or shallow yellow earths.

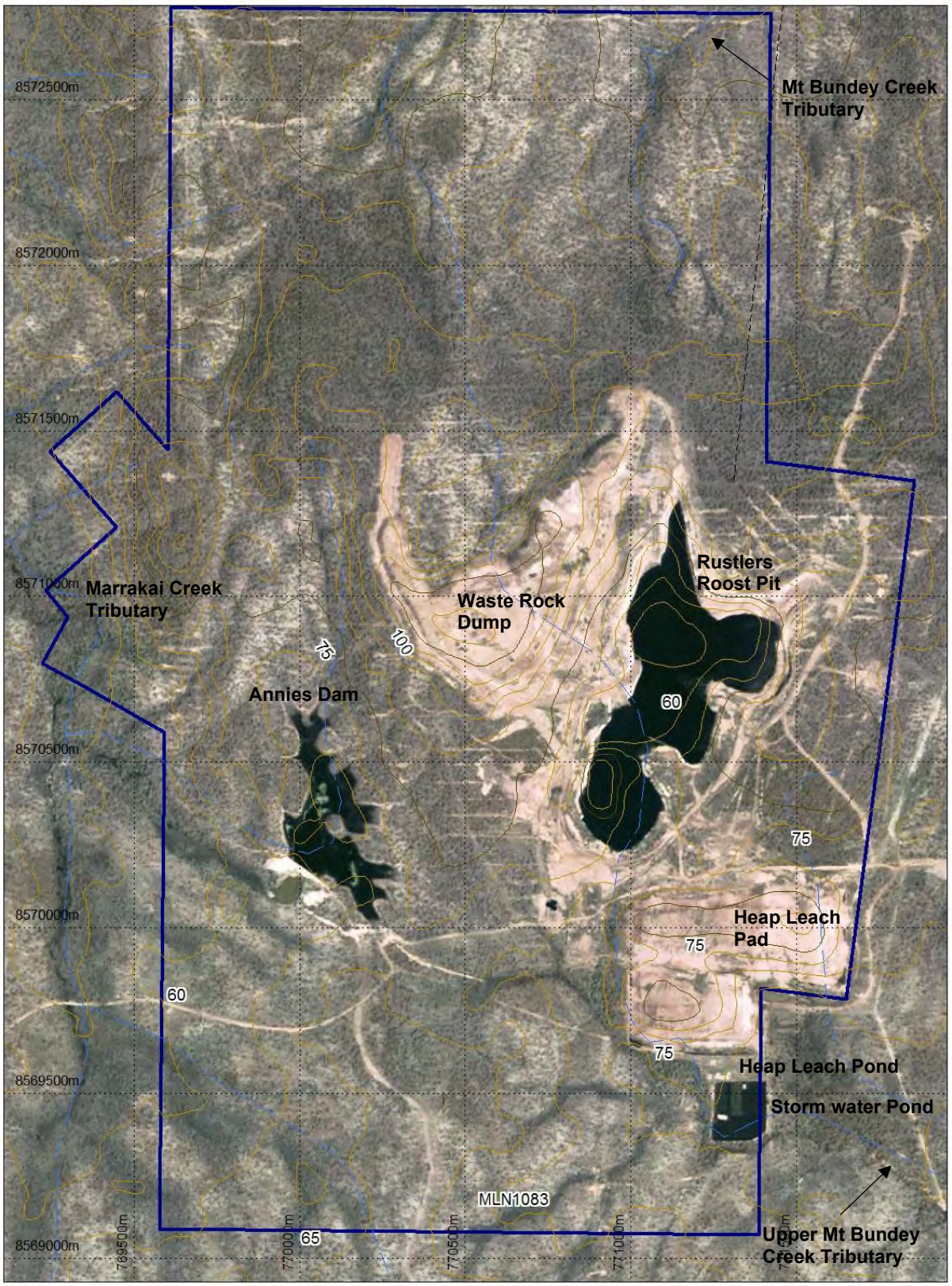



**Figure 5-10: RRPA Local Topography and Key Features**

### 5.1.3 Geology

The RRPA is located within the Pine Creek Orogen (PCO), a deformed and metamorphosed sedimentary basin up to 14km thick and covering an area of approximately 66,000km$^2$ and extending from Katherine in the south to Darwin in the north. It hosts significant resources of gold, uranium, and platinum group elements, as well as substantial base metals, silver, iron, and tin-tantalum mineralisation.

The PCO comprises a series of late Archaean granite-gneiss basement domes overlain by fluvial to marine sedimentary sequences with the central region of the geosyncline. These are dominated by very low-grade metasediments and metavolcanics of the South Alligator and Finniss River groups.

Gold mineralisation within the PCO is preferentially developed within strata of the upper part of the Mount Partridge Group, the South Alligator Group, and lower parts of the Finniss River Group. The regional geology of the RRPA includes the Burrell Creek Formation of the Finniss River Group and Mt Bonnie Formation of the South Alligator Group (Figure 5-11).

A turbidite sequence in the Mount Bonnie Formation hosts the Rustlers Roost Deposit. The sequence is at least 1,500m thick and comprises shale, siltstone, minor tuff, greywacke, and banded iron formation. In the deposit area, the sequence outcrops as banded carbonaceous siltstone and mudstone. The sediments have undergone regional greenschist grade metamorphism and later contact metamorphic events.

The sediments, volcanics and dolerite sills were then subjected to a major folding episode along the north-northeast trending regional fold axes. The folds are open to tight in style and plunge consistently to the south at approximately 35°. Gold mineralisation is hosted in a planar, south dipping quartz-sulphide vein set that postdates the folding event.

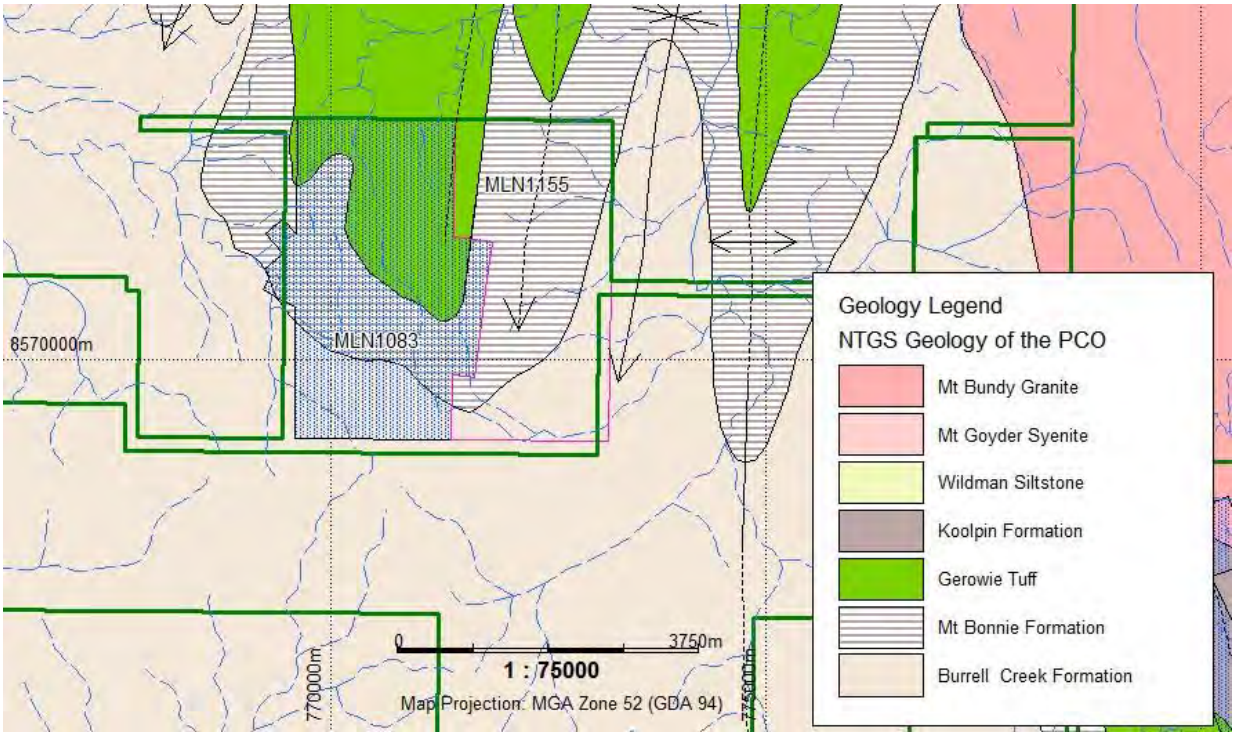



**Figure 5-11: Geology of the Pine Creek Orogen and RRPA**

### 5.1.4 Material Characterisation

Prior to the commencement of operations in 1994 Valdora commissioned a study into the characterisation of ore and waste material from the RRPA. The study was undertaken by Environmental and Earth Sciences Pty Ltd (ESS) and the findings were outlined in the report "Waste and Ore Characterisation Study of the Proposed Rustlers Roost Gold Mine January 1994" (ESS, 1994 - provided in the MCP Appendix 10.4). The objective of the report was to characterise samples of oxide, transitional and fresh material from both the waste rock and ore material in the Dolly Pot and Backhoe Pits.

In 1997 RRMPL engaged Graeme Campbell and Associates Pty Ltd (GCA) to undertake further characterisation of ore and waste material from the RRPA (GCA, 1997 – provided in the MCP Appendix 10.4). The objective of the study was to characterise samples of oxide, transitional and fresh material from both the waste rock and ore material in the Dolly Pot, Backhoe, Sweat Ridge and Beef Bucket Pits.

Major long-term environmental impacts from mining usually originate from leachate and runoff generated during the weathering of waste rock, tailings, spent ore and abandoned low grade ore stockpiles. Only waste rock and heap leach pad spent ore are relevant to the RRPA. The principal adverse impacts resulting from weathered waste rock and spent ore piles is the development of acidic or neutralised metal rich leachate, saline runoff, or dispersive water with a high sediment load (ESS, 1994).

In 2019 Primary Gold commissioned CDMS to undertake a desktop and limited field geochemical assessment of the RRPA (Appendix 10.3). While this report also considered the potential mine extension (and data limitations), the high-level assessment suggested that for the waste materials currently stored at surface, the potential to leach a significant dissolved chemical load to surface or groundwater is low (CDMS, 2019a).

The assessment of low risk was based on multiple lines of evidence including historical geological and mining depth data, recent field observations, surface and groundwater quality data and targeted surface rock geochemical data. It has been demonstrated that the total sulphide content of all weathered materials sampled is low. All samples collected in the current study were classified as Non-Acid Forming (NAF), this is consistent with previous geochemical assessments of the weathered materials within the geological profile (CDMS, 2019a).

#### *5.1.4.1 Acid and Metalliferous Drainage*

Mine drainage may consist of acid drainage and/or metalliferous drainage (AMD). AMD originates when sulphide material is exposed to air and water. Metalliferous drainage can occur when acid is neutralised, but concentrations of some metals remain elevated at near neutral or alkaline conditions. Following is a high-level summary based on the 1994 and 1997 studies for oxide and transitional material (given that fresh material was not mined).

##### *5.1.4.1.1 Oxide Material*

**Waste** - Samples of oxidised waste rock were barren of sulphur with a negative Net Acid Producing Potential (NAPP). Total sulphur ranged from 0.02% to 0.13%. Arsenic in the waste material ranged up to 390mg/kg which is at the upper end of the range known to naturally occur in shales. Groundwater studies found no arsenic and what sulphides were present are oxidised, it is likely that arsenic released from sulphides during oxidation have been bound into clays and are likely to remain so. There were no caveats as to the placement of this material on WRLs. However, it was noted that phosphate fertilisers can displace arsenic and as such should not be used in rehabilitation (specifically for Dolly Pot waste).

**Ore** - Total sulphur ranged from 0.02% to 0.21% and was essentially barren to slightly positive NAPP. Characterisation indicated that this material could be placed anywhere in the Heap Leach Pad without causing problems at the completion of gold extraction. Arsenic levels to 416mg/kg were noted and as with the waste material is likely to be bound to clays in the leach material. Arsenic was not expected to be present in the spent ore leachate.

#### *5.1.4.1.2 Transitional Material*

**Waste** - Sulphur content in transitional waste material ranged from 0.04% 1.37%, NAPP values were generally negative with some samples from Beef Bucket having a positive NAPP. The transitional waste scheduled to be mined was around 6% of the total waste and because of this minimal tonnage and assuming a low risk, the transition material should not produce any notable acidic leachate. However, it was recommended that transition waste material, particularly from deeper areas of the pits was not deposited within 2m of the WRL surface or should be retained within the pit.

**Ore** – Total sulphur in transitional ore ranged from 0.09% to 0.72% and all samples tested had a positive NAPP. It was noted that the excess alkalinity remaining after processing (using a high pH leach and inclusion of cement/lime) was likely to offset the acidity. The transitional ore was unlikely to result in adverse leachate (given the low proportion of material mined) except if placed on the outer walls. It was recommended that transitional ore was placed within the centre of the Heap Leach Pad as a precaution.

#### *5.1.4.1.3 Exposed Pit Walls*

The exposure of oxide and transitional material in the pit walls and floors and mine de-watering undertaken during operations also has the potential to generate AMD. At the RRPA this is mitigated by the predominantly oxide nature of the pit and the fact that during Care and Maintenance the pits have been allowed to flood above the transitional material. This minimises potential oxidation due to exposure to air.

### *5.1.4.2 Dispersion and Saline Discharge*

Dispersion is a process that occurs in soils that are particularly vulnerable to erosion by water. In soil layers where clays are saturated with sodium ions ("sodic soils"), soil can break down very easily into fine particles and wash away. This can lead to a variety of soil and water quality problems, including:

- Large soil losses by gully erosion and tunnel erosion;
- Soil structural degradation, clogging and sealing where dispersed particles settle; and
- Suspended soil causing turbidity in water and transporting nutrients off the land.

Waste rock containing sodium feldspars or reactive clays in the presence of excess exchangeable sodium will disperse, causing the waste rock to rapidly weather and erode. All clays have an unbalanced negative charge that is balanced by pore water cations, known as exchangeable cations. The unbalanced negative charge is known as cation exchange capacity (CEC). As an increasing portion of the CEC is occupied by sodium, then the clay is more likely to disperse (ESS,1994).

As it disperses, the material erodes rapidly to small particles which remain suspended in water. As well as eroding rapidly, the WRL surface can crust when dry, reducing infiltration of rainfall and retarding seed emergence. This effect is measured by the exchangeable sodium percentage (ESP) of the material. The ESP is defined as exchangeable sodium divided by the CEC and is expressed as a percentage (ESS, 1994).

The 1994 ESS report described the oxide and transitional waste rock and ore as non-dispersive (will not weather rapidly), as indicated by the ESP, Emerson dispersion testing and mineralogy results. The 1996 MCP noted that empirical observations of the WRL suggest that it remains for the most part intact with little evidence of dispersion.

Saline leachate is usually derived from the initial pore water, which was saline, containing either connate salts emplaced during deposition or highly saline groundwaters. Usually, saline leachate decreases with time by dilution, as the salinity is not a result of an on-going reaction (ESS, 1994). The 1994 ESS report determined that salts leaching from the oxidised and transitional waste and ore will not be a problem as indicated by the low salinity groundwater in the underlying extensively fractured aquifer.

### 5.1.5 Surface Water

#### *5.1.5.1 Hydrology*

The RRPA lies within the Adelaide and Mary River catchments. The western third of MLN1083 forms the headwaters of Marrakai Creek which flows into the Adelaide River (i.e. Annie's Dam). The remainder of the lease (historical mining area) is situated in the head waters of Mount Bundey Creek (Figure 5-12) which has a catchment of around 150km$^2$. The RRPA surface drainage lines are shown in Figure 5-13.

Mount Bundey Creek changes its flow direction and eventually drains via Hardies Creek into the Mary River which is located approximately 20km east of the RRPA. Mount Bundey Creek is an ephemeral creek with limited flow and isolated pools during the dry season. The Creek typically flows during the wet season and only flows strongly for around 3-4 weeks a year.

Mount Bundey Creek water usage is for stock drinking water (during the wet season) and the support of the ephemeral aquatic flora, fauna. The nearest permanent water thought capable of providing suitable year-round habitation for aquatic fauna is located some 12km downstream of the RRPA and is a dam located at Goanna Park (AGC, 1994a).

The local catchment is comprised of a series of ridges and dissected hills which are drained by small steep rivulets. These small valley systems converge into a single creek channel in the south-east of the RRPA. Most of the catchment contains outcropping rock and the mining area has a small external catchment area of around 2.2km$^2$.

Runoff from the catchment is expected to occur rapidly following rainfall events and recession of storm events is also expected to be rapid. The RRPA is unlikely to be affected by riverine flooding (i.e. flooding generated from further upstream). The dominant flooding mechanism is expected to be the rapid generation of overland flow in response to local catchment rainfall.

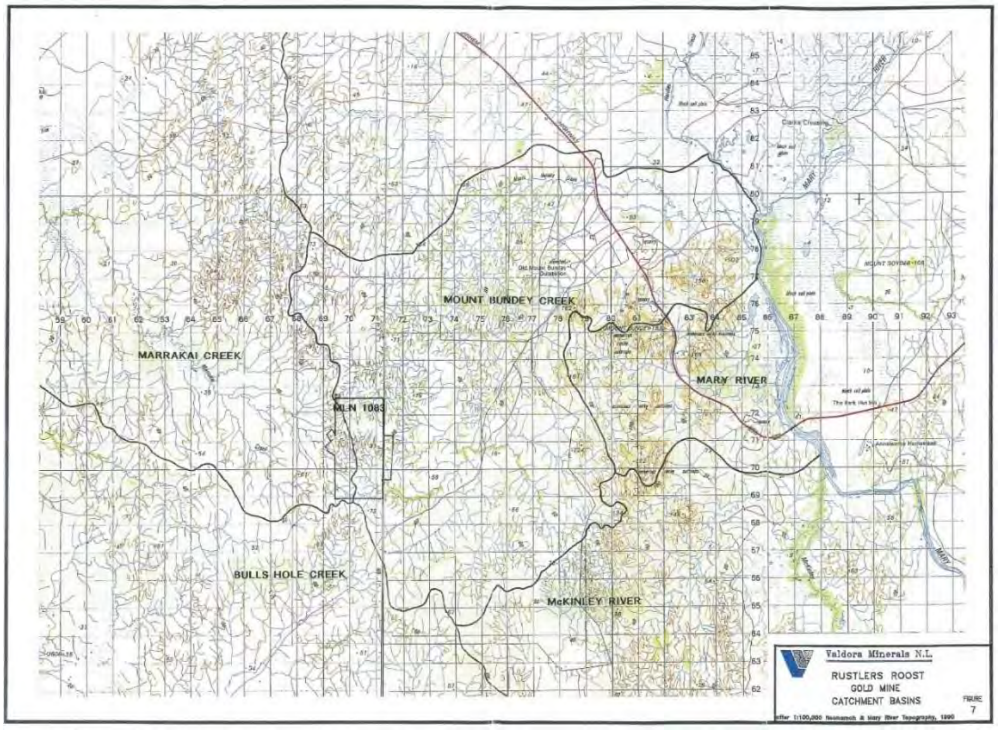



**Figure 5-12: RRPA Catchment Areas (Valdora, 1994)**

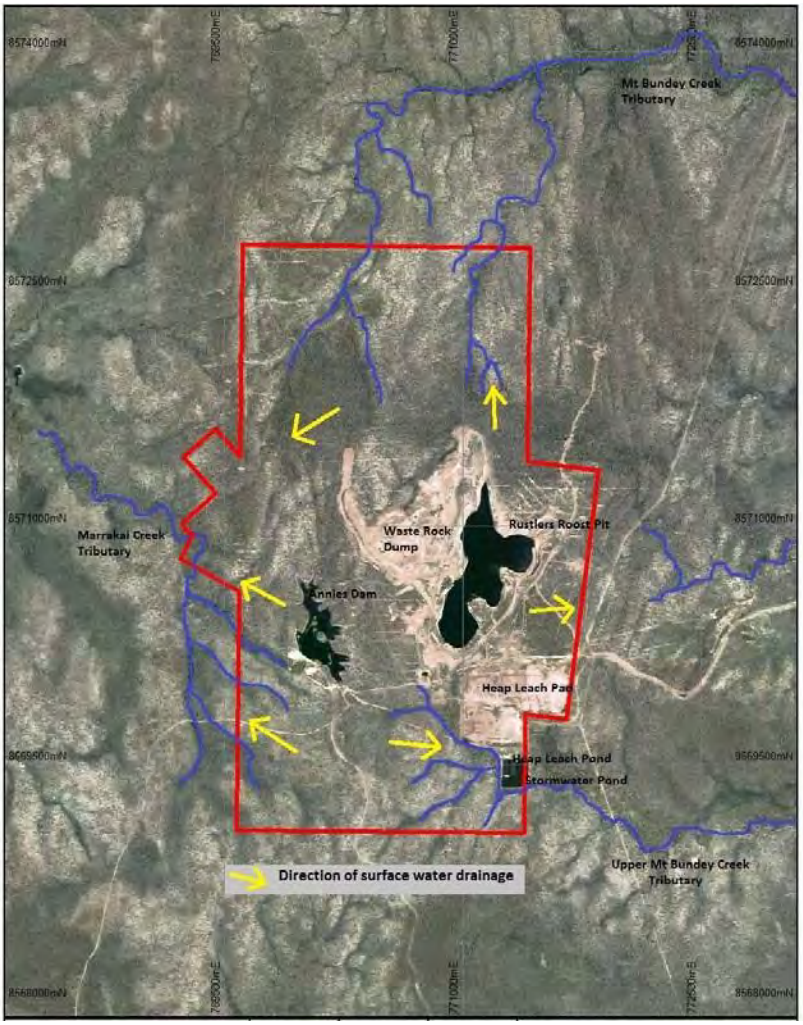



**Figure 5-13: RRPA Surface Drainage Lines**

#### *5.1.5.2 Beneficial Use*

An important part of water quality management is to identify how the community values and uses a water resource. Beneficial uses describe how a water resource benefits the community. Throughout the NT, beneficial uses or values have been set for major aquifers and river catchments. There are seven categories used to describe values for surface water and groundwater and these values are used to set water quality targets. The same water quality is not required for all types of water use.

Beneficial Use Declarations (BUDs) assist in the development of water management plans. The plans may result in an aim to improve the current water conditions, achieve different water quality in parts of a catchment or recognise that a water resource cannot achieve a certain quality in the short term. A BUD is also used to inform a Waste Discharge Licence (WDL); they establish the objectives or guidelines for a water resource to protect against unwanted water quality impacts.

A BUD for the Mary River surface water catchment (including all tributaries, lakes, lagoons, swamps, and marshes) has been set and the defined beneficial uses are environment, riparian and cultural. The objectives that apply are specified the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC Guidelines). This BUD was gazetted on 13 February 2002 (Gazette G6) and is shown in Figure 5-14. The Mary River Surface Water BUD transects the RRPA and includes the historical mine area but not Annie's Dam (Figure 5-15).

There is also a BUD for the Mount Bundey Creek which is located around 6km north-east of the RRPA tenement. Beneficial uses are stock water supply for the defined part of the waterway and aquatic ecosystem protection for the remainder (Figure 5-16). This BUD was gazetted on 11 June 1997 (Gazette G23). The nearest location to the RRPA is an aquatic ecosystem protection zone.

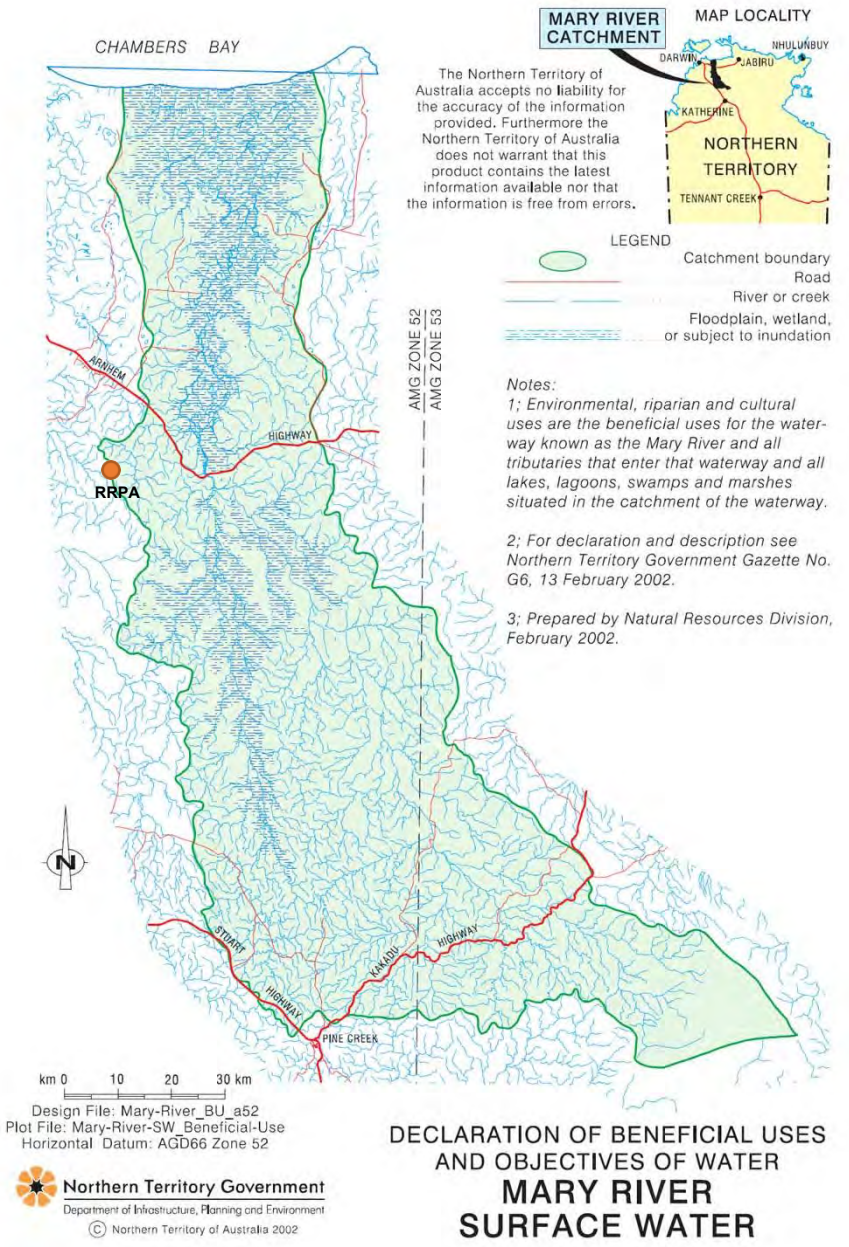



**Figure 5-14: Mary River Surface Water BUD Area (NTG, 2002b)**


**Figure 5-15: RRPA Relative to the Mary River Surface Water BUD (NTG, 2020b)**

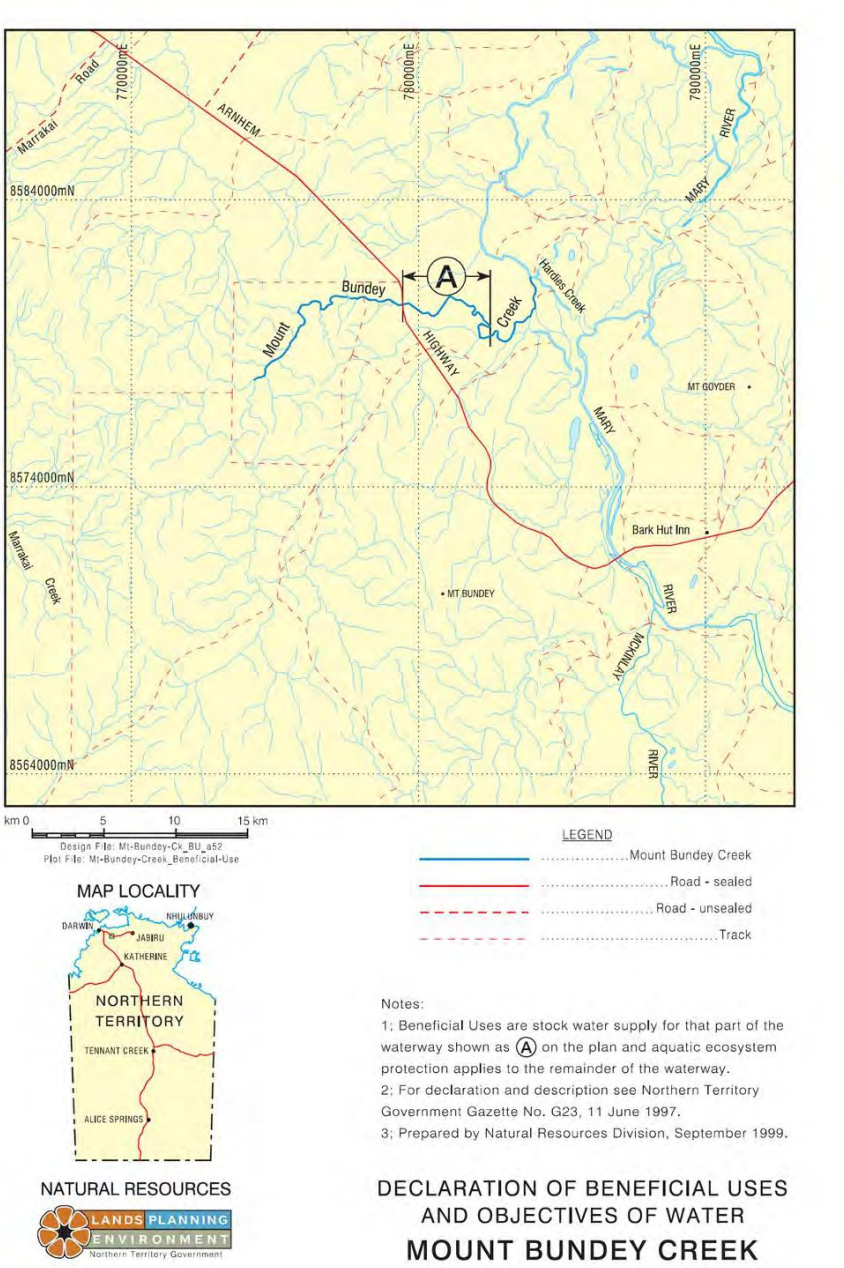



**Figure 5-16: Mount Bundey Creek Surface Water BUD Area (NTG, 1999)**

### 5.1.6 Groundwater

Valdora commissioned a baseline study into the hydrogeological environment as part of the 1994 PER. The study was undertaken by ESS and the findings were outlined in the report “Preliminary Groundwater Investigation of the Proposed Rustlers Roost Gold Mine December 1993” (ESS, 1993 - provided in the MCP Appendix 10.4). The RRPA groundwater environment was also assessed as part of the 1997 RMMPL Draft EIS. More recently, in 2019 Primary Gold commissioned CDMS to undertake a desktop groundwater assessment of the RRPA (Appendix 10.2).

#### *5.1.6.1 Hydrogeology*

The RRPA is situated near the northern flank of the Pine Creek Inlier which is comprised of predominantly Proterozoic metasediments of the South Alligator Group. Aquifers are typically associated with increased structural deformation within the metasediments. The local aquifer system recharges by direct infiltration of rainfall and run-off through areas of aquifer outcrop or shallow subcrop and overlying cover materials (RRMPL, 1997).

The groundwater gradient is flat, sloping gradually at 0.2 to 0.3% toward the Mary River (approximately 20km) in the east. The groundwater level falls approximately 1.7m over 900m from west to east, (i.e. 0.2%) and 0.7 metres over 900m from the north to the south. The measured depths indicate that the level falls 2.3m over 600m from south of the lateritic plateau (0.3%) to the north. The standing water level (SWL) over the RRPA is around 25 to 30m below surface (ESS, 1993).

The confined aquifer is extensive through secondary fracture permeability within the mudstone and greywacke matrix. The maximum depth of the aquifer is not known but was estimated at 30 to 80m. Using a transmissivity range of 80 to 100m$^2$/day the hydraulic conductivity was assessed at 1 to 3.3m/day. (ESS, 1993).

The direction of the groundwater flow was expected in the north/south direction which is parallel to the main strike of the surrounding lithologies. The aquifer behaves in an infinite isotropic, confined, non-leaky artesian manner. Groundwater flow is affected on a local scale by wet season recharge (ESS, 1993). The local aquifer system recharges by direct infiltration of rainfall and run-off through areas of aquifer outcrop or shallow subcrop and overlying cover materials. These conditions typify the RRPA. There are no reliable records available for the prediction of wet season recharge (RRMPL, 1997).

#### *5.1.6.2 Beneficial Use*

A BUD for the Mary River groundwater catchment (including all groundwater within the boundary) has been set and the defined beneficial uses are environment, riparian and agriculture. The objectives that apply are specified in the ANZECC Guidelines. This BUD was gazetted on 13 February 2002 (Gazette G6). The RRPA is located near the western boundary of the Mary River Groundwater BUD as shown in Figure 5-17.

The 1994 PER and 1997 EIS noted that the nearest identified groundwater user was the Old Mount Bundey Homestead (around 12km north-east). It was considered that impacts on the water quality of supply were unlikely as the bores at the Homestead are located across the regional strike and in a different drainage system.

## 5.2 Biophysical Environment

### 5.2.1 Ecosystem

The RRPA occurs in the PCK Bioregion and vegetation communities include eucalypt woodlands, with patches of monsoon forests. The 1993 Flora, Fauna and Soils Study (Kinhill, 1993a) identified three vegetation communities associated with distinctive soil types in the RRPA:

**1 Low Woodland**

- *Eucalyptus dichromophloia, Eucalyptus tintinnans*.
- Dominant community of the hills and slopes.
- Equates to a variant of Unit 21 which extends from Mary River to Katherine with an area of around 7,500km$^2$.

**2 Open Forrest**

- *Eucalyptus miniate, Eucalyptus tetrodonta.*
- Deeper soils on relatively flat lateratised plateau surfaces.
- Most widely distributed of any community in the Top End.

**3 Low Open Woodland / Grassland**

- *Eucalyptus polcarpa, Eriachne bukittii.*
- Confined to alluvial flats in drainage lines.
- Common in the region.

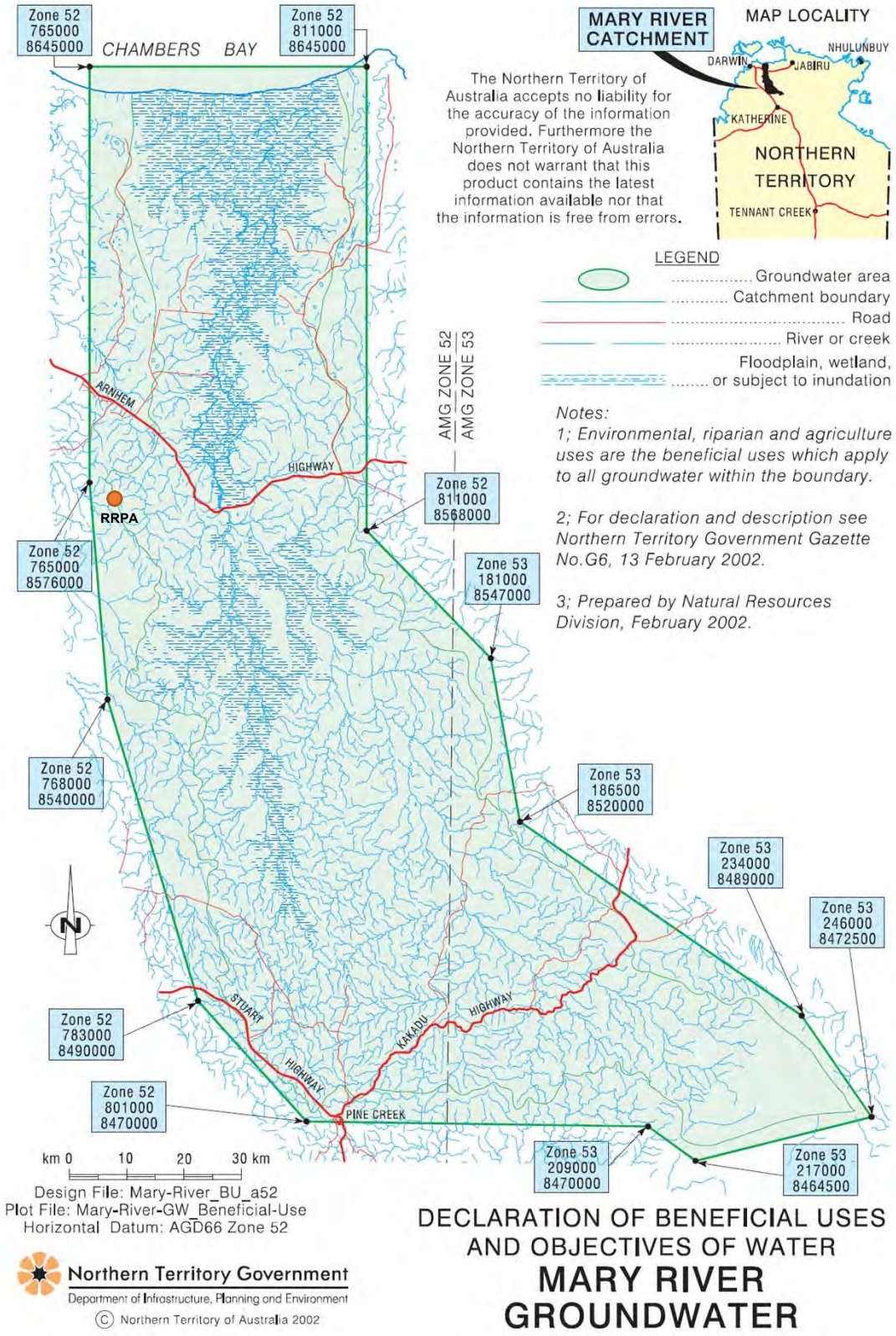



**Figure 5-17: Mary River Groundwater BUD Area (NTG, 2002c)**

### 5.2.2 Flora and Weeds

No flora species recorded during the 1993 Flora, Fauna and Soils Study (Kinhill, 1993a) were listed as of conservation significance. In 2016, Primary Gold engaged Low Ecological Services P/L (LES) to undertake a Flora and Fauna Survey of the Toms Gully, Quest 29 and Rustlers Roost Project Areas (LES, 2016 - provided in the MCP Appendix 10.4).

The 2016 Survey was conducted in identified habitat areas suitable for target threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) and *Territory Parks and Wildlife Conservation* (TPWC) Acts and identified by the NT EPA as occurring or potentially occurring within the study areas. No flora species of conservation significance were recorded during the surveys (LES, 2016).

The *Weeds Management Act* identifies those flora species that are listed as declared weeds for the NT. All declared weeds are divided into three classes:

- Class A (must be eradicated);
- Class B (growth and spread to be controlled); and
- Class C (species not to be introduced).

Thirty-two Weeds of National Significance (WoNS) have been agreed by Australian governments based on an assessment process that prioritised these weeds based on their invasiveness, potential for spread and environmental, social, and economic impacts. Landowners and land managers at all levels are responsible for managing WoNS.

The 1993 Flora, Fauna and Soils Study (Kinhill, 1993a) identified few weed species and the 2016 Flora and Fauna Survey (LES, 2016) identified three weed species at the study sites in the RRPA. Previous land use activities within the RRPA have contributed to a patchy distribution of weeds.

Highest weed densities are observed at stock watering points, along drainage lines (particularly on highly disturbed creek banks), fringing vehicle access tracks and in areas of terrain disturbance from previous mining. Declared or WoNS weed species identified at the RRPA are provided in Table 5-4.

**Table 5-4: RRPA Identified Declared Weeds and WONS**

| Common Name | Scientific Name | WM Act Declaration | WoNS | Notes |
|---|---|---|---|---|
| Hyptis | *Hyptis suaveolens* | Class B | No | - |
| Mission Grass | *Cenchrus polystachios* | Class B | No | - |
| Mimosa | *Mimosa pigra* | Class A/B | Yes | RRPA within the Class B Management Zone. |
| Flannel Weed | *Sida cordifolia* | Class B | No | - |
| Gamba Grass | *Andropogon gayanus* | Class A/B | Yes | RRPA within the Class B Management Zone. |
| Sicklepod | *Senna obtusifolia* | Class B | No | - |
| Olive Hymanechne | *Hymenachne amplexicaulis* | Class B | Yes | - |
| Snake Weeds | *Stachytarpheta spp.* | Class B | No | - |
| Spinyhead Sida | *Sida acuta* | Class B | No | - |

### 5.2.3 Fauna and Pests

According to the 1993 Flora, Fauna and Soils Study (Kinhill, 1993a), no identified fauna species were listed as rare or endangered. The Study indicated that the fauna of the RRPA was typical of the region and surmised that the loss of vegetation due to mining activity would not be considered significant. The loss habitat in regional terms is minor and the impact on fauna was expected to be minimal.

Records indicate that the Mertens Water Monitor (*Varanus mertensi*) – listed as vulnerable under the TPWC Act has previously been observed at the RRPA within one of the Leach Ponds (2015-2016). The 2016 Fauna Survey did not detect any threatened species despite targeted surveys in identified habitat areas being conducted. Two species listed as data deficient under the TPWC Act, *Sminthopsis virginiae* (red-cheeked dunnart) and *Varanus baritji* (black-spotted ridge-tailed monitor) were recorded in the Rustlers Roost survey area (LES, 2016).

The 1993 Flora, Fauna and Soils Study (Kinhill, 1993a) identified seven (7) introduced species including the dingo, cat, horse, donkey, pig, water buffalo and cattle. Similar introduced species were also recorded during the 2016 Survey with the addition of cane toads.

### 5.2.4 Fire

The PCK Bioregion, as with other northern bioregions is characterised by extensive fire (AG, 2008). Mapping obtained from the North Australia Fire Information website indicates that fire generally occurs within the RRPA on an annual basis. Between 2011 and 2016 the RRPA 2016 Flora and Fauna Survey area (17.4km$^2$) had between 40.9% to 91.38% of the area burnt (LES, 2016).

Fire breaks and their maintenance are managed by the Pastoralist and the Station Manager.

## 5.3 Social Environment

### 5.3.1 Heritage Sites

The *Heritage Act* sets a system for assessing, declaring, and protecting heritage places. Heritage places are areas that have been declared as significant for their historical, scientific, aesthetic, or social significance. All Aboriginal or Macassan archaeological places have been declared to be heritage places. According the Northern Territory Government (NTG) Heritage Register there are no Registered Heritage Places in the Mount Bundey area (NTG, 2020c).

Sacred sites are places within the landscape that have a special meaning or significance under Aboriginal tradition. Aboriginal sacred sites are recognised and protected as an integral part of NT and Australian cultural heritage, under the *Aboriginal Land Rights (Northern Territory) Act 1976* and the *Aboriginal Sacred Sites Act*. All sacred sites, including those not recorded or registered in the NT are protected by the *Aboriginal Sacred Sites Act*.

Valdora commissioned an archaeological investigation as part of the 1994 PER. The study was undertaken by Kinhill Engineers Pty Ltd (Kinhill) and the findings were outlined in the report “Archaeological Investigations of the Proposed Rustlers Roost Gold Mine November 1993” (Kinhill, 1993b – provided in the MCP Appendix 10.4). Four prehistoric archaeological sites and several background scatters were located during the survey.

Sites 1, 2 and 3 are best described as small, low density artefact scatters and like many others located in the wider Mount Bundey region. Site 4 consists of an artefact scatter and knapping location. The mining history of the region is recent, having commenced in the 1940's. One six metre shaft with a metal ladder remains (partially disturbed).

The Aboriginal Areas Protection Authority (AAPA) is an independent statutory authority responsible for overseeing the protection of Aboriginal sacred sites across the NT. All sacred sites in the NT are protected and the AAPA maintains records of all sacred sites that it has identified. There are strict secrecy provisions and Aboriginal cultural traditions covering these sites.

Anyone proposing to use or work on land in the NT may apply to the AAPA for an Authority Certificate to cover their proposed activities. The AAPA will only issue an Authority Certificate when it is satisfied that the use of, or work on, the area in question can proceed without there being a substantive risk of damage to, or interference with, a sacred site on or in the vicinity of the area. An AAPA Certificate (C93/153) was issued to Valdora Minerals in October 1993 for the construction of open pits, tailings ponds, leach pads and infrastructure associated with development and operation of the Rustlers Roost Gold Project.

In December 1994, Primary Gold requested an update on the location or registration of Sacred Sites or Restricted Work Areas in an area (including the RRPA) from the AAPA. The AAPA confirmed that no sites were known to exist in or around the RRPA. An AAPA Certificate (C2016/168) was issued to Primary Gold in December 2016 for the works associated with exploration drilling at areas of old mining activities and gold anomalies and ongoing maintenance. This exploration drilling included the RRPA.

### 5.3.2 Native Title

A native title claim exists over the Mount Bundey Pastoral Lease. The details of the claim are NTD 6033 of 2000.

### 5.3.3 Community

The nearest major town is Batchelor which is around 50km south-west from the RRPA. The RRPA is located entirely on the Old Mount Bundey Pastoral Station – Pastoral Lease No: PPL 1163, NT Portion 4937 (Figure 3-2). No sensitive receptors have been identified within or surrounding the RRPA and the impacts of dust and noise generation on populated areas are unlikely.

### 5.3.4 Conservation Values

Sites of Conservation Significance (SoCS) are 67 sites identified as the most important sites for biodiversity that need further protecting in the NT. Sites of Botanical Significance (SoBS) are defined as area that have botanical features distinguishing them from the surrounding landscape, and that are important for general plant conservation and for specifically mentioned species.

The RRPA is not located within any significant conservation or botanical areas. There are several identified conservation areas or national parks in the region including the:

- Mary River Coastal Floodplain around 10km north-east (SoCS 13).
- Mary River National Park around 11km to the east.
- Djukdinj National Park around 15km to the north.
- Adelaide River Foreshore Conservation Area around 24km to the west.
- Adelaide River Coastal Floodplain around 28km to the west (SoCS 12).
- Kakadu National Park around 50km to the east.

### 5.3.5 Land Use

The RRPA is located on the Old Mount Bundey Pastoral Station – Pastoral Lease No: PPL 1163, NT Portion 4937 (Figure 3-2). The Old Mount Bundey Station comprises a total area of 384km$^2$ and was sub divided from the original Mount Bundey Station in 1985. During 2013, fencing was established around the Heap Leach Pad, Leach and Storm Water Ponds and mine area to prevent livestock access to potentially contaminated water or salts and restrict public access.

The current land use of the RRPA and the immediate land surrounding the mine is beef cattle grazing on unimproved pasture. Mining and cattle grazing are widespread in neighbouring areas including Adelaide River, Jabiru, and Pine Creek and further afield in the larger Darwin and Katherine Regions.

# 6 Environmental Management System

Primary Gold will continue to develop its Environmental Management System (EMS) which includes an Environmental Policy, Environmental Management Plans (EMPs) and Standard Operating Procedures (SOPs) which enable the systematic review and management of site environmental aspects and impacts. Electronic records of all key environmental information and data are stored digitally on a server, with appropriate back up procedures.

## 6.1 Environmental Policy and Responsibilities

Primary Gold believes that effective environmental management is paramount to a successful future. The company is committed to compliance with legal and other requirements, developing an effective EMS, continuous improvement, and minimising environmental impacts. The Primary Gold Environmental Policy outlines these commitments and is provided in Figure 6-1.

The Chief Mining Engineer and onsite personal are responsible for defining and communicating relevant environmental responsibilities and accountabilities to employees, consultants, and contractors within their area of responsibility. The environmental performance of all contractors is an integral component of their compliance to their contract and prior to and during a contract, their environmental performance is assessed.

PRIMARY GOLD

ENVIRONMENTAL POLICY

Primary Gold is committed to promote sound environmental and community engagement practises into all facets of our business.

Primary Gold acknowledges and believes that effective environmental management is paramount to a successful future.

To promote our commitment to Environmental Management, Primary Gold commits to:

- **Comply** with all corporate requirements, environmental legislation, licenses and regulations;
- **Develop** and maintain a comprehensive and effective Environmental Management System;
- **Foster** mutually beneficial environmental partnerships in all phases of our operations;
- **Conduct** business in a manner that minimises any potential environmental impacts;
- **Instil** behaviour of primary environmental performance in all persons involved in our operations;
- **Foster** mutually beneficial environmental partnerships with host communities;
- **Implement** and maintain a culture where appropriate environmental, social, cultural and economic considerations are effectively integrated into all planning and decision making processes;
- **Seek** continuous improvement in the management and use of resources in environmentally responsible exploration, mining, processing, waste management and rehabilitation;
- **Understand**, encourage and promote eco-cultural and cross cultural awareness, and identify and protect sites of environmental or cultural significance;
- **Maintain** appropriate and effective communication with all stakeholders, who may be directly affected by our operations;
- **Provide** for the reclamation and rehabilitation of areas affected by our operations, considering future end land use.

To fulfil our commitment to the environment we will aim to continually improve our environmental performance by regularly;

- Reviewing objectives and targets;
- Monitoring performance against objectives and targets;
- Evaluating our environmental risks and striving to implement appropriate controls.

Dr Mark Qiu
Managing Director
12 May 2020

**Figure 6-1: Primary Gold Environmental Policy**

## 6.2 Statutory and Non-Statutory Requirements

The Primary Gold Management Team identifies and tracks the legal and other requirements applicable to its activities in accordance with the MMP. Primary Gold is committed to compliance with applicable statutory legislation, a list of the key legislation is provided in Table 6-1.

**Table 6-1. Relevant legislation to RRPA**

| Legislation | Regulation/approval | Project relevance |
|---|---|---|
| **Mining Activities** | | |
| *Environmental Assessment Act (EA Act)* | Currently not applicable. | The NT EPA is responsible for administering the EA Act, the key legislation used to perform the EIA of proposed actions in the NT. The primary purpose of the EIA process is to provide for appropriate examination of proposed projects that may cause significant environmental impact |
| *Mineral Titles Act* (*MT Act*) | Mineral Licence | The DPIR oversees the approval and regulation of mining activities. Under the *MT Act*, Primary Gold has been granted MLN1083. |
| *Mining Management Act* (*MM Act*) | Mining Authorisation | The mining authorisation is the key regulatory instrument used by the NT Government for approval and compliance monitoring of mining operations in the NT. This MMP will form the basis for the application for mining authorisation.<br>Authorisation Number 0738-01. |
| **Flora and Fauna** | | |
| *Planning Act* | Land Clearing Permit | Vegetation clearing on mining interests is controlled by application of the *MM Act* and MMP's. No permit is required. |
| *Territory Parks and Wildlife Conservation Act* (*TPWC Act*) | Permit to take or interfere with wildlife that is threatened | Pursuant to Section 56, the taking or interfering with wildlife that is listed as threatened, requires approval at the Ministerial level. No threatened species' populations are expected to occur within RRPA. No permit is required. |
| *Environmental Protection and Biodiversity Conservation Act* (*EPBC Act*)<br>(Commonwealth) | Not applicable | Provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – matters of national environmental significance (MNES). |
| *Weed Management Act* (*WM Act*) | Applicable | Occupiers of land (including mine sites) have an obligation to ensure listed weeds are not introduced or spread. Weed management is addressed in Section 6.8.2.4 of this MMP. |
| **Land and Soils** | | |
| *Soil Conservation and Land Utilisation Act* | Not applicable | This Act provides for the prevention of soil erosion, and for the conservation and reclamation of soil. |
| *Pastoral Lands Act* | Applicable | The RRPA overlies Mt Bundey Pastoral Lease. |

| Legislation | Regulation/approval | Project relevance |
|---|---|---|
| **Water Quality and Hydrological Processes** | | |
| *Water Act* | Waste Discharge Licence (WDL) – Not Applicable | Any off-site discharge from operational areas to a watercourse would require a Waste Discharge Licence (WDL). The licencing system is managed by the NT EPA. |
| | Permit to construct or alter works<br>Licence to take or use surface water or groundwater<br>Not Applicable | A recent amendment to the *Water Act* now requires mining activities to hold both permits where they are applicable. |
| *Public and Environmental Health Act* | Wastewater works design approval<br>Not Applicable | A septic tank that complies with the Department of Health's (DOH) definitions of a 'standard conventional septic systems' will be installed. |
| **Social, Economic and Cultural Aspects** | | |
| *Native Title Act* | Applicable | There is a native title claims over the Pastoral Lease. |
| *Aboriginal Sacred Sites Act* | Authority Certificate | Primary Gold has obtained an Aboriginal Areas Protection Authority (AAPA) Certificate, which documents any restrictions to protect Aboriginal sacred sites. There are no currently registered or recorded sites in the project area. AAPA Certificates C93/153 and C2016/168 (Section 5.3.1). |
| *Heritage Act* | Work Approval | There are no sites on the NT Heritage Register within the project area. |
| **Other** | | |
| *Bushfires Management Act* | Permit to Burn | Permit to Burn will be applied for as required in accordance with the Fire Management Plan. |
| *Work Health and Safety (National Uniform Legislation) Act* | Risk Management Plan (RMP)<br>Not Currently Applicable | Mine sites in the NT must not permit any mining activity or a related mining activity to be carried out unless the mine operator has given to the regulator an RMP for the mine site that has been certified in accordance with regulation 614. |
| *Dangerous Goods Act* & Regulations | Explosive Permits<br>Not Currently Applicable | The storage and transport of explosives requires an approval to be obtained from Worksafe NT. |
| *Waste Management and Pollution Control Act* (*WMPC Act*) | Environmental Protection Approval or Licence (EPA and EPL)<br>Not Currently Applicable | EPA and EPL are required for construction and operation of facilities that store and handle listed wastes. |
| *National Greenhouse and Energy Reporting Act* (*NGER Act*) | GHG reporting<br>Not Currently Applicable | Corporations must register and report if they emit greenhouse gases (GHG), produce energy, or consume energy at or above specified quantities in a given financial year. The project will not trigger the reporting thresholds for reporting. |

## 6.3 Identified Stakeholders and Consultation

### 6.3.1 Principles of Stakeholder Engagement

Consultation with stakeholders regarding the RRPA is important at all stages from exploration to mining to mine closure. Primary Gold are focused on developing relationships and maintaining regular communication with stakeholders in accordance with the Stakeholder Engagement Principles outlined in Table 6-2. These principles have been adapted from the Ministerial Council on Mineral and Petroleum Resources (MCMPR) Principles for Engagement with Communities and Stakeholders 2005.

**Table 6-2: Principles of Stakeholder Engagement**

| Principle | Requirement |
|---|---|
| Communication | Communication must be open, accessible, clearly defined, two-way and appropriate. |
| Transparency | The process and outcomes of community and stakeholder engagement should, wherever possible, be made open and transparent, agreed upon and documented. |
| Collaboration | A cooperative and collaborative approach to seek mutually beneficial outcomes is considered key to effective engagement. |
| Inclusiveness | Inclusiveness involves identifying and involving communities and stakeholders early and throughout the process, in an appropriate manner. |
| Integrity | Community and stakeholder engagement should establish and foster mutual trust and respect. |

In addition, Primary Gold has also considered and incorporated the Stakeholder Involvement Principles from the Strategic Framework for Mine Closure (ANZMEC/MCA, 2000) into its Stakeholder Engagement Strategy. These Principles require that:

1. Stakeholders and interested parties are identified;
2. Effective consultation occurs regularly and throughout the life of the mine;
3. A targeted communication strategy reflects the needs of the stakeholders and interested parties;
4. Adequate resources have been allocated to ensure the effectiveness of the consultation process; and
5. Wherever practical, the company will work with communities to manage the potential impacts of mine operations and closure.

### 6.3.2 Targeted Stakeholder Engagement Strategy

The purpose of the Primary Gold Stakeholder Engagement Strategy is to ensure the effective involvement of stakeholders throughout the proposed life of the RRPA. This involvement is required for all phases of the operation from exploration, planning and approvals; to construction, commissioning, and operation; to final decommissioning and closure. The Stakeholder Engagement Strategy is used to:

- Identify the full range of stakeholders with an interest in the RRPA;
- Establish and maintain a consistent and coordinated approach for communication with the local community, government agencies, special interest groups and industry;
- Identify known and emerging environmental, social, and cultural heritage aspects of the RRPA which might be of interest or concern to stakeholders;
- Inform stakeholders about key environmental, social, and cultural heritage factors associated with the RRPA, the potential impacts and management strategies to minimise or mitigate the potential impacts;

- Consider stakeholder concerns during all phases of the RRPA decision making process; and
- Ensure that there is timely and accurate feedback and provision of information on how any impacts and issues will be managed.

Primary Gold stakeholder engagement and consultation activities for the RRPA commenced in 2013 and are ongoing. A summary of identified RRPA stakeholders, communication tools and key interests is provided in Table 6-3 and the Stakeholder Consultation Register is provided in Appendix 10.5. Primary Gold will continue to engage with stakeholders regarding the RRPA to ensure that they are informed, concerns are addressed, and potential impacts are managed.

**Table 6-3: RRPA Stakeholders and Communication Tools**

| Group | Stakeholder | Communication Tools | Key Interests |
|---|---|---|---|
| NT Government Agency | Aboriginal Areas Protection Authority (AAPA) | Meeting / Email / Phone / Applications | • Authority Certificates<br>• Work Approvals<br>• Aboriginal Heritage Sites |
| | Bushfires NT | Meeting / Email / Phone / Applications in conjunction with Pastoralist | • Permits to Burn<br>• Fire Warnings |
| | Department of Environment and Natural Resources (DENR) | Meeting / Email / Phone / Applications | • Waste Discharge Licences<br>• Weed Management<br>• Threatened Flora and Fauna |
| | Department of Primary Industry and Resources (DPIR) | Meeting / Email / Phone / Applications | • Mineral Titles<br>• Authorisations<br>• Mining Management Plans<br>• Mine Closure Plans<br>• Rehabilitation Securities |
| | NT Environmental Protection Authority (EPA) | Meeting / Email / Phone / Applications | • Environmental Impact Assessments |
| | Work Safe NT | Meeting / Email / Phone / Applications | • Electrical Installations<br>• Risk Management Plans<br>• Dangerous Goods and Hazardous Chemicals |
| Landholders | Old Mount Bundey Station Pastoral Lease Holder (Tony Harrower) | Phone / Meeting / Letter / Agreements | • Weed Control<br>• Fire Break and Maintenance<br>• Water Sampling and Monitoring<br>• Fence Maintenance<br>• Caretaker Duties |
| Non-Government Organisations | Northern Land Council | Meeting / Email / Phone | • Native Title |

### 6.3.3 Ongoing Stakeholder Engagement

Primary Gold understands that expectations regarding the types and level of stakeholder engagement are not static and will shift according to the Project phase and the social, economic, and environmental conditions of the day. To maintain an effective Stakeholder Engagement Strategy and its relevance over the long term, Primary Gold maintain a Stakeholder Consultation Register (Appendix 10.5) and undertake a regular review of the strategy as part of its EMS. Primary Gold aims to remain alert and sensitive to any changes in public perception of the RRPA and will continue to investigate, define, and discuss any issues with relevant stakeholders.

## 6.4 Induction and Training

Primary Gold will provide all employees and contractors working on the site with an induction. The induction will include an introduction to the site and establish the minimum standards required of all persons to the site. An overview of environmental management will be included along with individual responsibilities regarding the environment and health and safety. All Contractors will be required to ensure their employees have the required level of competence and training and provide evidence to Primary Gold.

All health, safety and environmental policies will be communicated to employees and contractors. All employees/contractors will be responsible for adherence to corporate and site policies as part of their duty of care and employment contract conditions. Implementation of the policies is achieved by:

- Employment strategies;
- Copies of policies included in tender documents and contracts;
- Induction of employees, contractors, contractor's employees and visitors;
- Displaying of policies in work areas;
- Training programs; and
- Policies available on the internal server.

Ongoing awareness and communication of environmental issues will be reinforced, and meetings are regularly held, and environmental issues raised and discussed as needed. All staff are required to follow guidelines for off-road driving, safety, ground clearing, rehabilitation, weed management, and report native and feral animal sightings to their supervisor. They are also expected to report any environmental incidents to their supervisor or manager and take appropriate action.

## 6.5 Identification of Environmental Aspects and Impacts

Environmental aspects and impacts identified for the RRPA and considered as part of the environmental risk assessment are provided in Table 6-4.

.

**Table 6-4: RRPA Environmental Aspects, Potential Impacts and Controls**

| Area | Environmental Aspects | Potential Environmental Impacts | Controls |
|---|---|---|---|
| Heap Leach Pads | Erosion of materials from rainfall runoff | Increased sedimentation in catchment and natural drainage channels | Successful rehabilitation. |
| | | Reduction in rehabilitation success due to loss of soil or seeds | Successful rehabilitation. |
| Waste Rock Landform | Erosion of materials from rainfall runoff | Increased sedimentation in catchment and natural drainage channels | Successful rehabilitation. |
| | | Reduction in rehabilitation success due to loss of soil or seeds | Successful rehabilitation. |
| Hard Rock Pit(s) | Overtopping release of pit lake water | Release of water causing native vegetation death and/or decline in vegetation condition or surface water contamination | Studies show that pit does not overtop. |
| | Inadequate bunding, barriers and signage | Inadvertent access by the Public or Livestock resulting in serious injury | Appropriate closure plan for pit implemented. |
| General RRPA and Rehabilitation Activities | Uncontrolled fire generated by activities within the mine area | Decline in vegetation health/condition or vegetation death<br>Alteration of fauna habitat or fauna injury/death<br>Destruction of neighbouring landholder vegetation, buildings, or infrastructure | Fire break maintained and managed by Pastoralist and Station Manager. |
| | Introduction and/or spread of weed species | Decline in vegetation health/condition or vegetation death and/or reduction in rehabilitation success | Weed control implemented by Pastoralist and Station Manager. |
| | Dust emissions generated during earthworks, haulage, and material handling | Decline in vegetation health/condition. | Dust control implemented during earthworks. |
| | Driving off authorised roads through native vegetation | Decline in vegetation health/condition. | Driving on maintained tracks and roads. |
| | Clearing outside of the disturbance areas | Decline in vegetation health/condition. | Clearing controls implemented by Primary Gold. |
| General RRPA and Rehabilitation Activities | Clearing or activities damage heritage site | Damage to heritage sites | No heritage sites exist. |
| | Ineffective establishment of vegetation | Reduction in rehabilitation success due to topsoil or seed viability and/or loss of topsoil or seed via erosion | Repeat rehabilitation program. |

| Area | Environmental Aspects | Potential Environmental Impacts | Controls |
|---|---|---|---|
| Dams (Leach Ponds and Storm Water Pond) | Fauna or Livestock entrapment in dams | Fauna or Livestock illness, injury, or death | Dams are fenced. |
| | Overtopping release of water from dams | Release of water causing native vegetation death, decline in vegetation condition and/or soil or surface water contamination | Water quality in ponds is suitable for livestock. |
| Exploration Activities | Inadequate rehabilitation of drill holes, sumps, and tracks | Increased sedimentation in catchment and natural drainage channels<br>Fauna or Livestock injury or death | Rehabilitation of drill sites and sumps and tracks. |

### 6.5.1 Environmental Risk Assessment

Primary Gold has a risk assessment process to identify significant risks and ensure that appropriate management strategies are implemented to reduce potential impacts to people, the environment or community. The risk assessment identifies the hazards associated with planned activities, the likelihood of it occurring and the consequence of the potential impact. Risk assessments are utilised to:

1. Identify activities that could result in safety, environmental or community impacts;
2. Quantify the level of inherent risk (pre-treatment) of the activity i.e. no control measures applied;
3. Develop appropriate control measures to reduce the residual risk (post-treatment);
4. Document these processes so they form part of the EMS; and
5. Routinely monitor and review the effectiveness of these processes and control measures aiming for continuous improvement.

A key outcome of risk management is to rank potential impacts, so that specific management measures (controls or treatments) can be developed for high risk impacts. The aim of the process is to reduce the residual risk to 'As Low as Reasonably Practicable' (ALARP). The best way to control a risk is to eliminate the hazard altogether, however this is not always reasonably practicable. Primary Gold use the Hierarchy of Control which is widely used as a systematic approach to managing risks. It provides a structure to select the most effective control measures to eliminate or reduce the risk of identified hazards.

The Hierarchy of Control ranks risk control measures from the highest level of protection and reliability to the lowest level of protection and reliability. Eliminating the hazard is the most effective, followed by substituting the hazard with something safer, isolating the hazard or reducing risk using engineering controls. Administrative actions (and Personal Protective Equipment) sit as the last line of defence and are only used after all other controls have been assessed or as a supplementary control. A combination of controls is used whenever a single control measure is not adequate.

#### *6.5.1.1 Risk Assessment Criteria*

Risk levels for identified impacts are evaluated based on the maximum reasonable consequence and the likelihood of that consequence occurring. The likelihood and consequence definition tables are provided in Table 6-5 and Table 6-6 respectively.

**Table 6-5: Risk Assessment Likelihood Definition**

| Level | Likelihood | Frequency | Description |
|---|---|---|---|
| a | Almost Certain | Twice or more per year | The event is common or frequent occurrence or an ongoing impact. High number of known incidents. |
| b | Likely | Once per year | The event is expected to occur under some conditions. Regular incidents known. |
| c | Possible | Once in 5 years | The event will probably occur or has occurred under some conditions. Occasional incidents known. |
| d | Unlikely | Once in 10 years | Known to have occurred but not often. Some occurrences known. |
| e | Rare | Once in 20 years | Very unlikely/may occur in exceptional circumstances. Very few or no known occurrences. |

**Table 6-6: Risk Assessment Consequence Definition**

| Environmental Factor | Insignificant (1) | Minor (2) | Moderate (3) | Major (4) | Catastrophic (5) |
|---|---|---|---|---|---|
| Biodiversity | None or insignificant impact to ecosystem component (physical, chemical, or biological) with no effect on ecosystem function.<br>Impact confined to immediate area. | Moderate to minor impact to ecosystem component (physical, chemical, or biological).<br>Impact confined to an isolated area. | Minor and short-term impact to high value or sensitive ecosystem expected.<br>Impact confined to the Project site. | Long term impact to significant high value or sensitive ecosystem expected.<br>Impact extends beyond Project site. | Irreversible impact to significant high value or sensitive ecosystem expected.<br>Impact occurs on a wide scale. |
| Land and Soils | Negligible impact to isolated area. | Contained low impact, not impacting on any environmental value. | Uncontained impact, able to be rectified in short-term without causing pollution or contamination. | Extensive hazardous impact requiring long-term rectification. | Uncontained hazardous impact with residual effect. |
| Rehabilitation and Mine Closure | Site is safe, stable, and non-polluting.<br>Post mining land use is not adversely affected. | Site is safe, all major landforms are stable, and any stability or pollution issues are contained and require no residual management.<br>Post mining land use is not adversely affected. | Site is safe and any stability or pollution issues require minor ongoing maintenance by end land user.<br>Post mining land use cannot proceed without some management. | Site cannot be considered safe, stable, or non-polluting without long-term management or intervention.<br>Post mining land use cannot proceed without ongoing management. | Site is unsafe, unstable and/or causing pollution or contamination that will cause an ongoing residual affect.<br>Post mining land use cannot be achieved. |
| Social | No institutional, community or social impacts. | Inconvenience to a small sector of the community.<br>Some communication and education required involving local community | Considerable disruption or inconvenience to isolated sectors of the community.<br>Prior consultation required. | Long term social disruption, quality of life for large sector of the community.<br>Potential significant change to community function.<br>Loss of local support networks, services and/or heritage.<br>Community consultation critical. | Significant community impact.<br>Community outrage leading to breakdown of company relations with local community.<br>Future approvals extremely difficult. |
| Water Resources | Low impact to isolated area without affecting any use of the water. | Contained low impact with negligible effect on the use of water. | Uncontained impact that will materially affect the use of the water, but able to be rectified in the short-term. | Extensive hazardous impact requiring long-term rectification. | Uncontained hazardous impact with residual effect. |

The risk matrix detailed in Table 6-7 combines the level of likelihood and consequence to determine the associated risk level. A risk priority is assigned to each of the 25 possible outcomes and risks are categorised as Critical (Red), High (Orange), Moderate (Yellow) and Low (Green). As different activities differ in scale and nature of impact, control measures are tailored to ensure they are relevant and

effective in mitigating the identified risk. Detailed management plans may be required for critical or high-level risks while routine procedures are considered adequate to manage lower level risks.

**Table 6-7: Risk Matrix**

| Risk Matrix | | Consequence | | | | |
|---|---|---|---|---|---|---|
| | | **Insignificant (1)** | **Minor (2)** | **Moderate (3)** | **Major (4)** | **Catastrophic (5)** |
| **Likelihood** | **Almost Certain (a)** | Moderate (15) | High (19) | Critical (22) | Critical (24) | Critical (25) |
| | **Likely (b)** | Moderate (10) | Moderate (14) | High (18) | Critical (21) | Critical (23) |
| | **Possible (c)** | Low (6) | Moderate (9) | Moderate (13) | High (17) | High (20) |
| | **Unlikely (d)** | Low (3) | Low (5) | Moderate (8) | Moderate (12) | High (10) |
| | **Rare (e)** | Low (1) | Low (2) | Low (4) | Moderate (7) | Moderate (11) |

Critical risk: immediate action required
High risk: senior management attention needed
Moderate risk: management responsibility must be specified
Low risk; manage by routine procedures

#### *6.5.1.2 Risk Assessment Outcomes*

A site risk assessment has been developed to identify and manage potential environmental risks associated during care and maintenance and closure. The risk assessment was based on an understanding of the existing environment through desktop assessments, technical reports and any concerns raised during discussions with relevant stakeholders. A summary of the risk assessment outcomes for each environmental factor (not including closure only risks) is provided in Table 6-8 and the full risk assessment is provided in Appendix 10.6.

**Table 6-8: Closure Risk Assessment Summary**

| Environmental Factor | Total Risks | Inherent Risk (pre-treatment) | | | | Residual Risk (post-treatment) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Low | Moderate | High | Critical | Low | Moderate | High | Critical |
| Biodiversity | 8 | 5 | 3 | 0 | 0 | 6 | 2 | 0 | 0 |
| Land and Soils | 4 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| Rehabilitation and Mine Closure | 3 | 2 | 1 | 0 | 0 | 3 | 0 | 0 | 0 |
| Social | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Water Resources | 13 | 10 | 3 | 0 | 0 | 13 | 0 | 0 | 0 |
| **Total** | **29** | **22** | **7** | **0** | **0** | **27** | **2** | **0** | **0** |

The priority risk rating from this analysis shows 7 activities with an inherent risk level of Moderate. With management, all residual risks are reduced to a Low level other than 2 Moderate (weeds and fire). This outcome is consistent with the nature and scale of the project, which includes factors such as:

1. The occurrence of weeds and fire are common in the region and require ongoing management including as part of the post mining pastoral land use;
2. The RRPA has been in Care and Maintenance for more than 20 years;
3. The majority of infrastructure has already been removed;
4. Mined material was mostly oxide (NAF, non-dispersive and low salinity);
5. The relatively small scale of disturbance; and
6. Potential impacts are most likely to have only a localised affect, usually confined to the mine boundary and can be readily controlled or remediated.

Table 6-9 summarises the identified key care and maintenance issues and associated risks for the RRPA.

**Table 6-9: Key Care and Maintenance Issues and Associated Risk**

| Issue | Associated Risk |
|---|---|
| **Water Quality** | Contamination of surface water from mine impacted areas. |
| **Erosion and Sediment** | Erosion of materials increasing sediment in natural drainage channels. |
| **Weeds** | Introduction and/or spread of weed species. |
| **Fire** | Uncontrolled fire. |
| **Flora and Fauna** | Fauna or Livestock illness, injury, or death due to inadequate barriers. |

## 6.6 Environmental Audits and Inspections

The Mount Bundey Pastoralist and Station Manager undertake a quarterly site inspection of the RRPA to identify any water, erosion, weed, fire, or fauna (or livestock) risks and any items requiring follow up action are reported to Primary Gold.

No significant issues were identified during the previous reporting period and inspections will continue during the next reporting period.

In addition to routine inspections, Primary Gold engaged consultants CDMS in 2019 to conduct assessments of the site surface water, groundwater, and geochemistry to address previous DPIR comments and better understand the RRPA environment. A site inspection was undertaken as part of this assessment and it was recommended as part of site erosion and sediment control that existing berms need to be maintained and repaired. This has been included in the MMP Work Program (Table 4-1).

## 6.7 Environmental Monitoring

### 6.7.1 Surface Water Monitoring Program

The key objective of the RRPA surface water monitoring program is to obtain quantitative information on the physical, chemical, and biological characteristics of surface water. Water quality data is used to determine whether additional site water management strategies are required to ensure that the beneficial use of surrounding surface water is protected.

Effective and targeted monitoring will ensure that an appropriate and timely response can address any issues at an early stage. The monitoring program forms part of the EMS to ensure that there are appropriate action and reporting protocols.

In late 2016 Primary Gold improved the accuracy and integrity of its surface water monitoring by ensuring that samples are collected in line with company procedures and industry best practice, utilising a reputable laboratory that is NATA accredited and applying appropriate QA/QC practices. Based on this, only data from 2016 onwards (other than reported historical data) has been considered in the MCP as this is the most robust and still includes any seasonal variations.

The RRPA surface water monitoring program is designed to assist in identifying changes over time. The RRPA surface water monitoring locations are described in Table 6-10 and shown in Figure 6-2. Analytes and sampling frequencies for the surface water monitoring program are provided in Table 6-11. The sites, analytes and frequencies have been updated based on the recommendations from the 2019 CDMS Groundwater Assessment (Appendix 10.2).

**Table 6-10: RRPA Surface Water Monitoring Locations**

| Site Code | Description | Position: Zone 52L | |
|---|---|---|---|
| | | Easting | Northing |
| **SW2** | Downstream of the Storm Water Pond | 771428 | 8569426 |
| **SW5** | Storm Water Pond | 771365 | 8569398 |
| **SW6** | Spillway of Annie's Dam | 770130 | 8570006 |
| **SW7** | Downstream of Annie's Dam Spillway | 769723 | 8570262 |
| **SW10** | ROM Drainage (before influence from Heap Leach) | 770919 | 8570094 |
| **SW11** | Downstream of SW10 in Heap Leach Pad Drain (at culvert) | 770920 | 8569935 |
| **SW12** | Northern Drainage of WRL | 770590 | 8571310 |
| **SW22** | Rustlers Roost Pit | 770933 | 8570702 |
| **SW23** | Downstream of the Stormwater Pond | 771900 | 8569190 |
| **SWQ2** | Mount Bundey Creek Crossing on RRPA Access Road (Downstream) (Reported in Quest 29 MMP) | 774154 | 8571092 |


**Figure 6-2: RRPA Surface and Groundwater Monitoring Sites**

**Table 6-11: RRPA Surface Water Monitoring Analytes and Frequency**

| Analytes | Frequency | Sites |
|---|---|---|
| Field Physical Parameters (pH, EC, DO, Redox and Turbidity) | M | SW2<br>SW5<br>SW6<br>SW7<br>SW10<br>SW11<br>SW12<br>SW22<br>SW23<br>SWQ2 |
| Major Cations (Ca, K, Na and Mg - Dissolved) and Anions ($SO_4$ – Filtered) | Q | |
| Total and Dissolved Metals (Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, U and Zn) | B | |
| Acidity, Alkalinity, Hardness (all as $CaCO_3$) and Total Suspended Solids (TSS) | B | |

**Table 6-12: RRPW Surface Water Monitoring Frequency Key**

| Frequency | |
|---|---|
| M | Monthly (when streams are flowing) |
| Q | Quarterly (i.e. January, April, July, October) |
| B | Biannual (first flow-October/November, and recessional flow-April/May) |

#### *6.7.1.1 Guideline Values*

The RRPA water quality guideline values (GVs) have been developed based on the ANZECC Guidelines and the 2018 CSIRO Review of Site-Specific Trigger Values (SSTV) for the TGPA (CSIRO, 2018 – provided in the MCP Appendix 10.4). Noting that it is proposed to discharge treated water into the Mount Bundey Creek from the TGPA. The Mount Bundey catchment is classified as 'tropical lowland rivers and streams' and aquatic ecosystem protection is the dominant environmental value.

The Mount Bundey catchment ecosystem condition is a highly disturbed environment. Modification of water quality is due to the long history of anthropogenic activities and typical tropical ecosystem characteristics, such as the wet-dry climate. The ANZECC 2000 Guidelines set varying GV levels of ecosystem protection derived from local reference data that should aim to:

- Maintain the existing ecosystem condition; and/or
- Enhance the modified ecosystem (by targeting the most appropriate condition level).

The 80% species protection GVs have historically been applied for highly disturbed systems. However Primary Gold strive for continuous improvement and aim for the RRPA passively discharged water quality to meet the 95% species protection GVs (outside of seasonal or natural fluctuations). Given the post mining pastoral land use, livestock drinking water guidelines (SWG) for cattle are also applicable.

ANZECC 2000 enables the consideration of the natural background concentrations of metals when setting GVs. If background concentrations cannot be measured at the site, measurement at an equivalent high-quality reference site that closely matches the geology, natural water quality etc is suggested. If the background concentration has been clearly established and it exceeds the GV, the 80$^{th}$ percentile of the background concentration can be accepted as the alternative and is called a SSTV.

In 2018, Primary Gold engaged CSIRO to undertake a Review of SSTVs for the TGPA for the proposed active discharge into the Mount Bundey Creek (CSIRO, 2018). This review was an update of similar

work undertaken by GHD in 2015. Wet season monitoring data from the reference site SWTG1A indicates that both iron and aluminium have high natural background concentrations and SSTVs for these metals have been calculated based on the 80$^{th}$ percentile.

While ANZECC 2000 states that the GVs "are not meant to be applied directly to recycled water quality, contaminant levels in discharges from industry, mixing zones, or stormwater quality". Primary Gold compares all surface water monitoring sites to the applicable SSTVs, 80%, 90% and 95% ecosystem protection GVs and SWG (Table 6-13). This provides a good understanding of the site surface water quality, seasonal variations and enables an assessment of potential environmental impacts in the event of discharge.

The RRPA GVs are used as an early warning mechanism to provide insight into potential adverse water quality changes and are not intended to assess compliance. The GVs are used to trigger water management actions if water quality sampling indicates on-going values outside of the GVs and/or the long-term site data range. Table 6-14 details a series of action levels in relation to water quality monitoring and the GVs and outlines the Primary Gold action and reporting process.

**Table 6-13: RRPA Water Quality Guideline Values**

| Parameters | Units | Applicable Guideline Values | | | | |
|---|---|---|---|---|---|---|
| | | SSTV | 95% | 90% | 80% | SWG |
| pH | pH | - | 6.0 - 8.0 | | | - |
| Electrical Conductivity (EC) | µS/cm | - | 20 - 250 | | | 5,970 |
| Turbidity | NTU | - | 2-15 | 2-15 | 2-15 | - |
| Dissolved Aluminium (Al) | mg/L | 0.295 (1) | 0.055 (2) | 0.080 (2) | 0.150 (2) | - |
| Total Aluminium (Al) | mg/L | - | - | - | - | 5 |
| Dissolved Arsenic (As) | mg/L | - | 0.013 | 0.042 | 0.14 | - |
| Total Arsenic (As) | mg/L | - | - | - | - | 0.5 |
| Dissolved Cadmium (Cd) | mg/L | - | 0.0002 (3) | 0.0004 (3) | 0.0008 (3) | - |
| Total Cadmium (Cd) | mg/L | - | - | - | - | 0.01 |
| Dissolved Chromium (Cr) | mg/L | - | 0.001 | 0.006 | 0.04 | - |
| Total Chromium (Cr) | mg/L | - | - | - | - | 1 |
| Total Cobalt (Co) | mg/L | - | - | - | - | 1 |
| Dissolved Copper (Cu) | mg/L | - | 0.0014 | 0.0018 | 0.0025 | - |
| Total Copper (Cu) | mg/L | - | - | - | - | 1 |
| Total Iron (Fe) | mg/L | 2.7 (1) | 0.7 (4) | 0.95 (4) | 1.4 (4) | - |
| Dissolved Manganese (Mn) | mg/L | - | 1.9 | 2.5 | 3.6 | - |
| Dissolved Nickel (Ni) | mg/L | - | 0.011 (3) | 0.013 (3) | 0.017 (3) | - |
| Total Nickel (Ni) | mg/L | - | - | - | - | 1 |
| Dissolved Lead (Pb) | mg/L | - | 0.003(3) | 0.006 (3) | 0.009 (3) | - |
| Total Lead (Pb) | mg/L | - | - | - | - | 0.1 |
| Total Uranium (U) | mg/L | - | - | - | - | 0.2 |
| Dissolved Zinc (Zn) | mg/L | - | 0.008 (3) | 0.015 (3) | 0.031 (3) | - |
| Total Zinc (Zn) | mg/L | - | - | - | - | 20 |
| Sulphate ($SO_4$) | mg/L | - | - | - | - | 1,000 |
| Calcium (Ca) | mg/L | - | - | - | - | 1,000 |

1. Derived from TGPA reference site SWTG1a to account for natural background levels (CSIRO, 2018).
2. GV should not be applied to samples with pH less than 6.5 (ANZECC, 2000).
3. Low hardness value (CSIRO, 2018).
4. New ANZECC/ARMCANZ GV for total Fe (under review) (CSIRO, 2018)

**Table 6-14: Water Quality Management Actions**

| Trigger Levels | Water Quality Results | Corrective Actions | Reporting Requirements |
|---|---|---|---|
| Level 1 - Focus | Sampling results meet GVs | Continue Routine Monitoring | Nil |
| Level 2 - Action | Sampling results outside of long-term range or above GVs on three consecutive sampling occasions | Resample within 48 hours of receipt of results Investigate following ANZECC 2000 Procedures | Internal Incident Report |
| Level 3 - Upper Limit | Sampling results above SWG | Resample within 48 hours of receipt of results Investigate following ANZECC 2000 Procedures | Internal Incident Report |

### 6.7.2 Groundwater Monitoring Program

The key objective of the RRPA groundwater monitoring program is to obtain quantitative information on the physical and chemical characteristics of groundwater. Water quality data is used to determine whether additional site water management strategies are required to ensure that the beneficial use of surrounding groundwater is protected.

The RRPA groundwater monitoring program is designed to assist in identifying changes over time. The RRPA groundwater monitoring locations are described in Table 6-15 and shown in Figure 6-2. Analytes and sampling frequencies for the groundwater monitoring program are provided in Table 6-16. The sites, analytes and frequencies have been updated based on the recommendations from the 2019 CDMS Groundwater Assessment (Appendix 10.2).

**Table 6-15: RRPA Groundwater Monitoring Locations**

| Site Code | Description | Position: Zone 52L | |
|---|---|---|---|
| | | Easting | Northing |
| **MB01** | Downgradient of the Heap Leach Pads | 771334 | 8569626 |
| | *Additional Monitoring Sites to be confirmed in 2021 | | |

**Table 6-16: RRPA Groundwater Monitoring Analytes and Frequency**

| Analytes | Frequency | Sites |
|---|---|---|
| Standing Water Level (SWL) | Monthly | MB01 |
| Field Physical Parameters (pH, EC, DO, Redox and Turbidity) | Monthly | |
| Major Cations (Ca, K, Na and Mg - Dissolved) and Anions ($SO_4$ – Filtered) | Quarterly | |
| Total and Dissolved Metals (Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, U and Zn) | Biannual | |
| Acidity, Alkalinity, Hardness (all as $CaCO_3$) and Total Suspended Solids (TSS) | Biannual | |

#### 6.7.2.1 Guideline Values

There are no current GVs for groundwater ecosystem protection, however ANZECC 2000 provides values for livestock drinking water (SWGs). It is also appropriate to consider the connectivity between groundwater and surface water ecosystems and so groundwater data is compared to the applicable 80% ecosystem protection GVs and SWGs (Table 6-13).

## 6.8 Environmental Performance

### 6.8.1 Objectives and Targets

The identified environmental objectives and targets for the RRPA are outlined in Table 6-17.

**Table 6-17: RRPA Environmental Objectives and Targets**

| Aspect | Objectives | Targets |
|---|---|---|
| Water | Water quality generally reflects the background levels and water use by stakeholders is not compromised. | Passively discharged surface water meets the applicable 95% species protection GVs, SSTV and SWGs (outside of seasonal or natural fluctuations).<br>Groundwater and the pit lake meet the applicable 80% ecosystem protection GVs, SSTV and SWGs (outside of seasonal or natural fluctuations). |
| Erosion and Sediment | Minimise areas of disturbance and implement appropriate erosion control measures in mine impacted areas. | All roads and tracks are inspected, and a maintenance and repair action plan is developed and implemented.<br>All constructed landforms maintain structural integrity and functionality.<br>All areas with erosion and sediment control issues are identified, documented and a maintenance and repair action plan is developed and implemented. |
| Weeds and Pests | Minimise adverse impacts to native flora and fauna and to manage weed growth to reduce the risk of uncontrolled wildfire impacts. | No increase in weed spatial distribution and no new weed species identified.<br>No increase in pest populations or species and no observed detrimental effects. |
| Fire | Effectively manage fuel loads in the RRPA and mitigate potential impacts from uncontrolled wildfires. | Fire breaks are installed and maintained.<br>Controlled burning completed in accordance with a Permit to Burn.<br>No incidents of vehicle ignited fires. |
| Flora and Fauna | Protect and appropriately manage threatened species that occur within the RRPA and prevent the disturbance of flora and fauna outside of the RRPA. | No incidents of adverse impact to flora and fauna of significance. |

### 6.8.2 Performance Reporting

#### 6.8.2.1 Surface Water Quality

Following is an assessment for each monitoring location (Table 6-18) and parameter (Table 6-19) of the available surface water quality monitoring data (2016-2020) against the GVs. Given that there is

limited data an assessment of long-term trends has not been undertaken. Summary water quality data is provided in Appendix 10.7.

**Table 6-18: RRPA Surface Water Monitoring Site Summary**

| Site | Total Samples | Parameters Analysed | % of Sample Analysis Meeting Guideline Values | | | | |
|---|---|---|---|---|---|---|---|
| | | | SSTV | 80%GV | 90%GV | 95%GV | SWG |
| SW2 | 5 | 124 | 98 | 96 | 93 | 90 | 100 |
| SW5 | 7 | 175 | 100 | 95 | 95 | 94 | 100 |
| SW6 | 4 | 100 | 100 | 94 | 92 | 92 | 100 |
| SW7 | 10 | 250 | 100 | 96 | 96 | 96 | 100 |
| SW10 | 3 | 75 | 99 | 95 | 93 | 93 | 100 |
| SW11 | 6 | 150 | 98 | 96 | 95 | 94 | 99 |
| SW12 | 3 | 75 | 100 | 88 | 88 | 88 | 100 |
| SW22 | 7 | 175 | 100 | 98 | 98 | 98 | 100 |
| SWQ2 | 7 | 174 | 99 | 96 | 96 | 94 | 99 |

**Table 6-19: RRPA Surface Water Monitoring Parameter Summary**

| Parameter | Total Samples | % of Sample Analysis Meeting Guideline Values | | | | |
|---|---|---|---|---|---|---|
| | | SSTV | 80%GV | 90%GV | 95%GV | SWG |
| pH | 52 | | 87 | | | |
| EC | 52 | | 71 | | | 100 |
| Turbidity | 51 | | 47 | | | |
| Calcium | 52 | | | | | 100 |
| Sulphate | 52 | | | | | 100 |
| Aluminium | 52 | 94 | | | | 98 |
| Arsenic | 52 | | 100 | 100 | 90 | 100 |
| Cadmium | 52 | | 100 | 100 | 100 | 100 |
| Chromium | 52 | | 100 | 100 | 96 | 100 |
| Cobalt | 52 | | | | | 100 |
| Copper | 52 | | 92 | 81 | 79 | 100 |
| Iron | 52 | 90 | | | | |
| Lead | 52 | | 100 | 100 | 100 | 100 |
| Manganese | 52 | | 100 | 100 | 100 | |
| Nickel | 52 | | 90 | 88 | 88 | 98 |
| Uranium | 52 | | | | | 100 |
| Zinc | 52 | | 96 | 92 | 87 | 100 |

*SW2 – Downstream of the Storm Water Pond*

Monitoring site SW2 is in a creek line downstream of the Leach Ponds. The water quality at the site is influenced by the Heap Leach Pads and the Leach/Storm Water Ponds if they overflow.

Measured water quality at SW2 indicates that the pH ranges from 6.4 to 7.4 and the EC is low, between 38-120µS/cm. Turbidity ranges from 11-40 NTU and is higher than the ANZECC Guidelines during the early wet season which is likely to be the effects of the seasonal “first flush” run-off. All total metal parameters are within the SWGs and SSTV.

Sampling indicates that some dissolved metals have on occasions been recorded above the ecosystem protection GVs or SSTV. Arsenic was above the 95% GVs in 2019 (and 2016), however recent sampling indicates levels are within the GVs. Chromium was above the 95% GV in 2016, however levels are now within the GVs. Copper remains higher than the 90% and 95% GVs. Nickel was above the GVs in 2016 and 2017, however recent sampling indicates levels are within the GVs. Zinc was above the 90% and 95% GVs in 2020 (and 2017) and Aluminium was above the SSTV in 2020 (and 2016). Additional data is required to determine whether these are seasonal effects or a sampling spike.

*SW5 – Storm Water Pond*

Monitoring site SW5 is the Storm Water Pond and monitoring results are influenced by the seasonal filling and drying cycle of the pond (evapo-concentration).

Measured water quality at SW5 indicates that the pH ranges from 6.3 to 7.8 and the EC is between 13-300µS/cm. Turbidity ranges from 7-720 NTU, the 720 appears to be an anomaly given that more recent samples range between 7-24 NTU.

All total metal parameters are within the SWGs and SSTV. Sampling indicates that some dissolved metals have on occasions been recorded above the ecosystem protection GVs. Arsenic was above the 95% GVs in 2019 (and 2016). Additional data is required to determine whether this is a seasonal effect or a sampling spike. Copper and Zinc were above the GVs in 2019, however sampling after these events indicate levels are within the GVs.

*SW6 – Spillway of Annie's Dam*

Monitoring site SW6 is at the spillway of Annie's Dam which is the pre-existing freshwater pastoral catchment dam. This dam does not form part of the RRPA however may be influenced by site run-off. The dam will remain at closure for ongoing use by the pastoralist.

Measured water quality at SW6 indicates that the pH ranges from 5.6 to 6 and the EC is low, between 10-25µS/cm. Turbidity ranges from 3.9-30 NTU. All total metal parameters are within the SWGs and SSTV.

Dissolved metal parameters are effectively within the ecosystem protection GVs and SSTV. While some single results for Copper and Nickel were higher than the GVs, sampling after these events indicate levels are within the GVs.

*SW7 – Downstream of Annie's Dam Spillway*

Monitoring site SW7 is downstream of the Annie's Dam Spillway. This site was added to the surface water monitoring program in March 2016 to monitor offsite drainage from the RRPA reporting to the Adelaide River Catchment.

Measured water quality at SW7 indicates that the pH ranges from 4.3 to 6.3. It is noted that the 4.3 was recorded in 2016 and more recent data indicates a pH range of 6.1 to 6.3. The EC is low, between 11-49µS/cm. Turbidity ranges from 2.2-28 NTU, with more recent data indicating a range of 2.4 to 5.5 which is within the GVs.

All total metal parameters are within the SWGs and SSTV. All dissolved metal parameters are within the ecosystem protection GVs and SSTV. One recorded value for Nickel in 2017 was above the GVs however more recent data indicates that this is now within the GVs.

*SW10 – ROM Drainage (before influence from Heap Leach)*

Monitoring site SW10 measures drainage from the rehabilitated Run-of-Mine (ROM) Pad prior to any influence from the Heap Leach Pads. Limited data is available as the site is high in the catchment is often dry at sampling times.

Measured water quality at SW10 indicates that the pH ranges from 6.1 to 7.1 and the EC is low, between 8-55µS/cm. Turbidity ranges from 44-860 NTU, however the 860 appears to be an anomaly given that more recent samples range between 44-73 NTU.

All total metal parameters are within the SWGs. Iron was higher than the SSTV in 2016, at 4.9mg/L which appears to be an anomaly given that more recent data ranges from 0.83-0.3mg/L. Dissolved metal parameters are effectively within the ecosystem protection GVs. While a single result for Copper (in 2017) was higher than the GVs, sampling after this event indicates that this is now within the GVs.

*SW11 – Downstream of SW10 in Heap Leach Pad Drain (at culvert)*

Monitoring site SW11 measures drainage from the Heap Leach Pads and is downstream of SW10. This site was added to the surface water monitoring program in October 2016 as SW10 is often dry. The Heap Leach Pads require rehabilitation.

Measured water quality at SW11 indicates that the pH ranges from 6.2 to 7.3 and the EC is low, between 21-82µS/cm. Turbidity ranges from 2.8-610 NTU, however more recent samples range between 2.8-11 NTU.

All total metal parameters are within the SWGs other than Nickel. In 2012, Nickel was 1.2mg/L which appears to be an anomaly given that more recent data is 0.001mg/L. Iron was higher than the SSTV on two occasions (2016 and 2017), more recent additional data is below the SSTV.

Sampling indicates that some dissolved metals have on occasions been recorded above the ecosystem protection GVs or SSTV. While some single results in 2016 for Arsenic, Chromium and Nickel were higher than the GVs, sampling after these events indicate levels within the GVs. Copper was above the 90% and 95% GVs in 2019 (and 2016). Additional data is required to determine whether this is a seasonal effect or a sampling spike. Aluminium was 0.51mg/L in 2016 which is higher than the SSTV, this appears to be an anomaly given that more recent data ranges from 0.01-0.08mg/L.

*SW12 – Northern Drainage of WRL*

Monitoring site SW12 measures drainage from the northern side of the WRL. While water naturally drains to the south in this area, the construction of the WRL prevents this and water pools in this location. This site was added to the surface water monitoring program in October 2016 however it most often dry. The WRL requires rehabilitation.

Measured water quality at SW12 indicates that the pH ranges from 5.4 to 6.1 and the EC is low, between 10-14µS/cm. Turbidity ranges from 24-47 NTU. All total metal parameters are within the SWGs and SSTV. Dissolved metal parameters are effectively within the ecosystem protection GVs and SSTV. While a single result for Nickel (in 2017) was higher than the GVs, additional data is required to determine whether this is a sampling spike or ongoing influence.

*SW22 – Rustlers Roost Pit*

Monitoring site SW22 measures the surface water quality of the Rustlers Roost Pit. Water stored in the pit is likely a combination of stormwater runoff, incident rainfall and (possibly) groundwater. The pit void acts as a terminal sink for a large portion of the catchment, including the WRL and previous mine infrastructure area.

Measured water quality at SW22 indicates that the pH ranges from 6.2 to 7.1 and the EC is low, between 21-27µS/cm. Turbidity ranges from 0.7-9.6 NTU. All total metal parameters are within the SWGs and SSTV. Dissolved metal parameters are within the ecosystem protection GVs and SSTV other than Zinc. Zinc was above the 90% and 95% GVs in 2019 and additional data is required to determine whether this is a sampling spike or ongoing influence.

*SWQ2 – Mount Bundey Creek Crossing on RRPA Access Road (Downstream)*

Monitoring site SWQ2 measures the offsite drainage from the RRPA (and Quest 29 Project Area) reporting to the Mary River Catchment. The site is located at the Mount Bundey Creek crossing on Rustlers Roost access road, downstream of the RRPA.

Measured water quality at SWQ2 indicates that the pH ranges from 6.3 to 7.3 and the EC is low, between 16-43µS/cm. Turbidity ranges from 9.1-1,500 NTU, the 1,500 appears to be an anomaly given that more recent samples range between 9.1-62 NTU.

Total metal parameters are within the SWGs other than Aluminium. In 2016, Aluminium was 6.9mg/L which appears to be an anomaly given that more recent data ranges from 0.31-0.84mg/L. Iron was higher than the SSTV on two occasions (2016 and 2020) and additional data is required to determine whether this is an ongoing influence or sampling spikes.

All dissolved metal parameters are effectively within the ecosystem protection GVs and SSTV. While a single result for Copper (in 2016) and two (2) results for Zinc (in 2016 and 2017) were higher than the GVs, sampling after these events indicate that these are now within the GVs.

*Site Summary by Parameter*

Following is a summary of the surface water sampling by parameter:

- pH (6.0 to 8.0) – 87% of samples meet the GV. Three (3) sites have samples below the GVs (slightly acidic).
    - SW6 (Spillway of Annie's Dam) range 5.6 to 6.
    - SW7 (Downstream of Annie's Dam Spillway) range 4.3 to 6.3 (more recently 6 to 6.3).
    - SW12 (Northern Drainage of WRL) range 5.4 to 6.1.
- EC (200-250µS/cm) – 71% of samples meet the GV. Six (6) sites have low salinity and one (1) has recorded levels above the GV.
    - SW5 (Storm Water Pond) range 13 to 300µS/cm (influenced by evapo-concentration).
    - SW6 (Spillway of Annie's Dam) range 10 to 25µS/cm.
    - SW7 (Downstream of Annie's Dam Spillway) range 11 to 49µS/cm.
    - SW10 (ROM Drainage) range 8 to 55µS/cm.
    - SW12 (Northern Drainage of WRL) range 10 to 14 µS/cm.
    - SWQ2 (Mount Bundey Creek) range 16 to 43µS/cm.

- Turbidity (2 – 15 NTU) – 47% of samples meet the GV. All sites have recorded levels above the GV. Further assessment is required to determine if this is associated with the early wet season “first flush” run-off or sediment from the erosion of landforms.
- Calcium (1,000mg/L) – 100% of samples meet the SWG.
- Sulphate (1,000mg/L) – 100% of samples meet the SWG.
- Aluminium
    - Dissolved (0.295mg/L) – 94% of samples meet the SSTV. Two (2) sites have samples above the GVs.
        - SW2 (Downstream of the Storm Water Pond) range 0.01 to 0.72mg/L.
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.01 to 0.51mg/L.
    - Total (5mg/L) – 98% of samples meet the SSTV. One (1) site has a sample above the GVs.
        - SWQ2 (Mount Bundey Creek) range 0.1 to 6.9mg/L (possible anomaly).
- Arsenic
    - Dissolved (80%, 90%, 95% - 0.14, 0.042, 0.013mg/L) – 100% of samples meet the 80% and 90%GVs and 90% of samples meet the 95%GV. Three (3) sites have samples above the 95%GV.
        - SW2 (Downstream of the Storm Water Pond) range 0.004 to 0.015mg/L.
        - SW5 (Storm Water Pond) range 0.002 to 0.035mg/L.
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.001 to 0.016mg/L.
    - Total (0.5mg/L) – 100% of samples meet the SWG.
- Cadmium
    - Dissolved (80%, 90%, 95% - 0.0008, 0.0004, 0.0002mg/L) – 100% of samples meet the GVs.
    - Total (0.01mg/L) – 100% of samples meet the SWG.
- Cobalt
    - Total (1mg/L) – 100% of samples meet the SWG.
- Chromium
    - Dissolved (80%, 90%, 95% - 0.04, 0.006, 0.001mg/L) – 100% of samples meet the 80% and 90%GVs and 96% of samples meet the 95%GV. Two (2) sites have recorded samples above the 90%GV (in 2016) however recent results are below the GV.
        - SW2 (Downstream of the Storm Water Pond) range 0.001 to 0.002mg/L.
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.001 to 0.002mg/L.
    - Total (1mg/L) – 100% of samples meet the SWG.

- Copper
    - Dissolved (80%, 90%, 95% - 0.0025, 0.000018, 0.0014mg/L) – 92% of samples meet the 80%GV, 81% meet the 90%GV and 79% of samples meet the 95%GV. Six (6) sites have recorded samples above the GVs.
        - SW2 (Downstream of the Storm Water Pond) range 0.001 to 0.004mg/L.
        - SW5 (Storm Water Pond) range 0.001 to 0.004mg/L.
        - SW6 (Spillway of Annie's Dam) range 0.001 to 0.002mg/L.
        - SW10 (ROM Drainage) range 0.001 to 0.002mg/L.
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.001 to 0.004mg/L.
        - SWQ2 (Mount Bundey Creek) range 0.001 to 0.002mg/L.
    - Total (1mg/L) – 100% of samples meet the SWG.
- Iron
    - Total (2.7mg/L) – 90% of samples meet the SSTV. Three (3) sites have recorded levels above the SSTV.
        - SW10 (ROM Drainage) range 0.03 to 4.9mg/L (possible anomaly).
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.06 to 6.6mg/L.
        - SWQ2 (Mount Bundey Creek) range 0.31 to 10mg/L (possible anomaly).
- Manganese
    - Dissolved (80%, 90%, 95% - 3.6, 2.5, 1.9mg/L) – 100% of samples meet the GVs.
- Lead
    - Dissolved (80%, 90%, 95% - 0.009, 0.006, 0.003mg/L) – 100% of samples meet the GVs.
    - Total (0.1mg/L) – 100% of samples meet the SWG.
- Nickel
    - Dissolved (80%, 90%, 95% - 0.017, 0.013, 0.011mg/L) – 90% of samples meet the 80%GV, 88% meet the 90%GV and 88% of samples meet the 95%GV. Five (5) sites have recorded samples above the GVs.
        - SW2 (Downstream of the Storm Water Pond) range 0.001 to 0.18mg/L.
        - SW6 (Spillway of Annie's Dam) range 0.001 to 0.015mg/L (possible anomaly).
        - SW7 (Downstream of Annie's Dam Spillway) range 0.001 to 0.094mg/L (possible anomaly).
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.001 to 0.055mg/L (possible anomaly).
        - SW12 (Northern Drainage of WRL) range 0.001 to 0.018mg/L.
    - Total (1mg/L) – 98% of samples meet the SWG. One (1) site has recorded levels above the GV.
        - SW11 (Downstream of SW10 in Heap Leach Pad Drain) range 0.001 to 1.2mg/L (possible anomaly).

- Uranium
    - Total (0.2mg/L) – 100% of samples meet the SWG.
- Zinc
    - Dissolved (80%, 90%, 95% - 0.031, 0.015, 0.008mg/L) – 96% of samples meet the 80%GV, 92% meet the 90%GV and 87% of samples meet the 95%GV. Four (4) sites have recorded samples above the GVs.
        - SW2 (Downstream of the Storm Water Pond) range 0.001 to 0.03mg/L (possible anomaly).
        - SW5 (Storm Water Pond) range 0.001 to 0.19mg/L (possible anomaly).
        - SW22 (Rustlers Roost Pit) range 0.001 to 0.027mg/L (possible anomaly).
        - SWQ2 (Mount Bundey Creek) range 0.001 to 0.01mg/L (possible anomaly).
    - Total (20mg/L) – 100% of samples meet the SWG.

#### *6.8.2.2 Groundwater Quality*

Following is an assessment of the available groundwater quality monitoring data (2016-2020) trends against the GVs. Given that there is limited data an assessment of long-term trends has not been undertaken. Summary water quality data is provided in Appendix 10.7.

*MB01 – Downgradient of the Heap Leach Pads*

Measured groundwater quality at MB01 indicates that the pH ranges from 5.9 to 6.2 which is less acidic than background values (4.9 to 5.5). The EC is low ranging between 110-140µS/cm. All total metal parameters are within the SWGs (and SSTV) which is consistent with the background data. Both Zinc and Nickel have recorded levels above the 80% GVs however additional data is required to determine whether this is a long-term trend or a sampling anomaly.

#### *6.8.2.3 Erosion and Sedimentation*

Erosion and sedimentation are management at the RRPA in accordance with the Landform, Erosion and Sediment Control EMP (Appendix 10.9).

In 2016, a site inspection was undertaken to assess if erosion is occurring at the site. The inspection identified that erosion of the Heap Leach Pad material is evident. The 2019 CDMS Surface Water Assessment (Appendix 10.1) included an inspection and review of the RRPA erosion and sediment controls. It was recommended that existing berms need to be maintained and repaired and this has been included in the MMP Work Program (Table 4-1).

#### *6.8.2.4 Weeds and Pests*

Weeds and Pests are management at the RRPA in accordance with the Weed and Pest EMP (Appendix 10.9). Primary Gold provides an assessment of performance against each objective and target with discussion and comment on non-conformance/corrective actions where applicable (Table 6-20).

**Table 6-20: Weed and Pest EMP Performance Assessment**

| Objective | Target | Performance Against Commitment | | Non-Conformance / Corrective Actions |
|---|---|---|---|---|
| | | Result | Discussion | |
| Minimise adverse impacts to native flora and fauna and to manage weed growth to reduce the risk of uncontrolled wildfire impacts. | No increase in weed spatial distribution and no new weed species identified. | Met | No significant change in spatial distribution or new weed species identified during inspections. | Nil |
| | No increase in pest populations or species and no observed detrimental effects. | Met | No increase in pest populations or detrimental impacts identified during inspections. | Nil |

Updated weed mapping was carried out at the RRPA in May 2017 and the results are outlined in Table 6-21 and Figure 6-3. A weed control program was implemented in early 2016 to target the observed isolated populations of Gamba Grass and Mimosa to attempt to limit their spread. A follow up to this program was conducted in 2017. Additional weed spraying is undertaken as required by the Pastoral Lease Holder (on behalf of Primary Gold).

Hyptis has been documented in multiple surveys as the most widespread and abundant weed within the mining lease.

Hyptis is not only widespread and abundant on this mining lease, but is widespread throughout the Top End of the Northern Territory and disturbed sites in particular.

Infestations of Hyptis along the access road range from sparse plants interspersed with native grasses to very dense monospecific infestations that clearly dominate the ground cover vegetation. Mission Grass is also widely distributed across the RRPA. These weeds are managed through a combination of cattle grazing and controlled burns conducted by the Pastoral Lease Holder (on behalf of Primary Gold).

**Table 6-21: 2017 RRPA Identified Declared Weeds and WONS**

| Common Name | Scientific Name | WM Act Declaration | WoNS | Mapping Waypoint |
|---|---|---|---|---|
| Hyptis | *Hyptis suaveolens* | Class B | No | 155-158, 160-171, 173-183, 185-187 |
| Mission Grass | *Cenchrus polystachios* | Class B | No | 155-157, 159, 161-170, 172-175, 177, 179-180, 183, 185-187 |
| Mimosa | *Mimosa pigra* | Class A/B | Yes | 154 |
| Flannel Weed | *Sida cordifolia* | Class B | No | Nil |
| Gamba Grass | *Andropogon gayanus* | Class A/B | Yes | 163, 183-184, 186 |
| Sicklepod | *Senna obtusifolia* | Class B | No | 175-177 |
| Olive Hymanechne | *Hymenachne amplexicaulis* | Class B | Yes | Nil |
| Snake Weeds | *Stachytarpheta spp.* | Class B | No | Nil |

| Common Name | Scientific Name | WM Act Declaration | WoNS | Mapping Waypoint |
|---|---|---|---|---|
| Spinyhead Sida | *Sida acuta* | Class B | No | 155-158, 160, 170-171, 175, 177-178 |

A specific feral animal control program is not required as the populations observed are consistent with that of surrounding pastoral lease. Populations will continue to be monitored as part of environmental inspections. Should a substantial increase in feral animal species be observed, a targeted control program will be developed and implemented for the site.

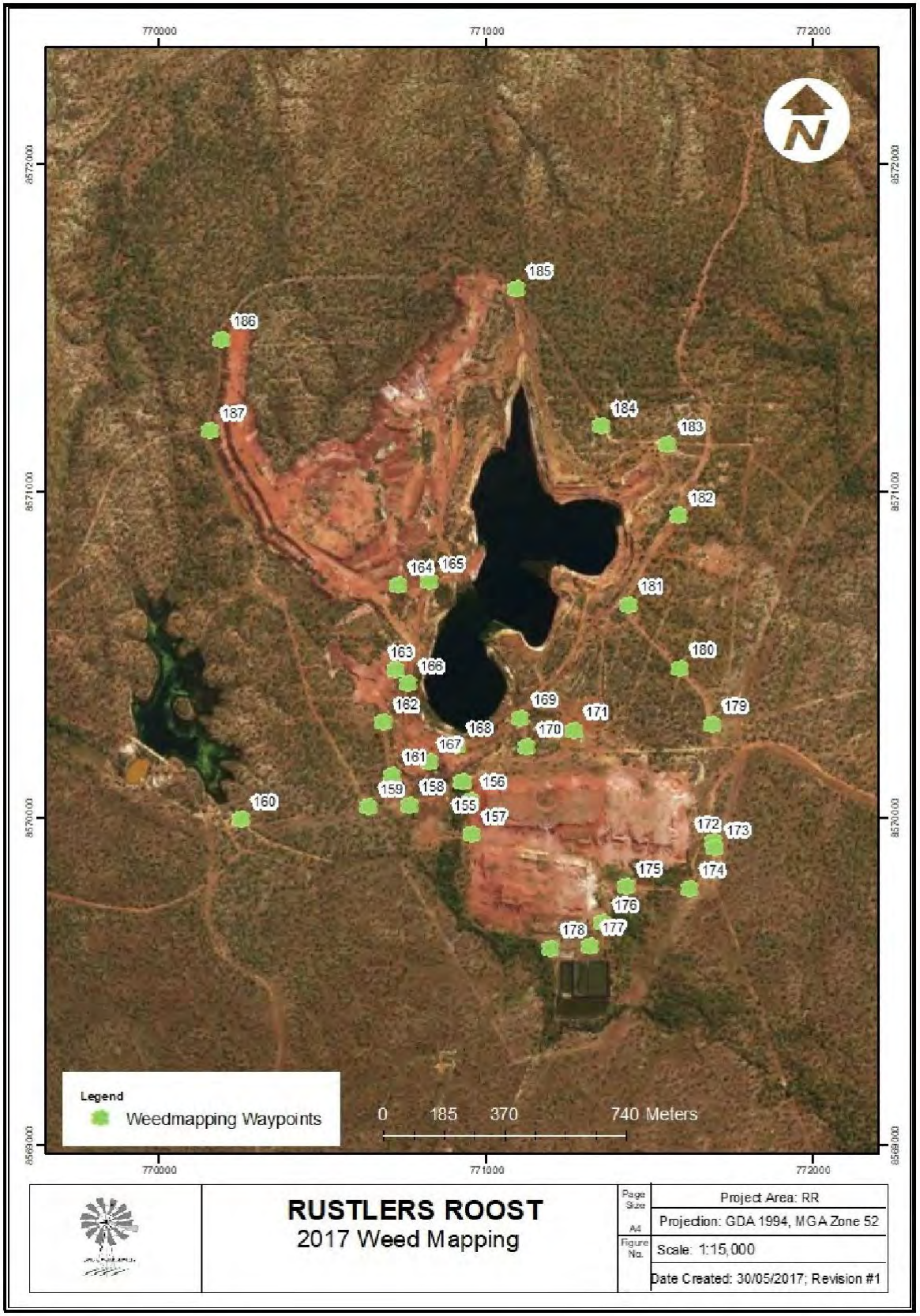



**Figure 6-3: 2017 RRPA Weed Mapping**

#### *6.8.2.5 Fire*

Fire is management at the RRPA in accordance with the Fire Prevention EMP (Appendix 10.9). Primary Gold provides an assessment of performance against each objective and target with discussion and comment on non-conformance/corrective actions where applicable (Table 6-22).

**Table 6-22: Fire EMP Performance Assessment**

| Objective | Target | Performance Against Commitment | | Non-Conformance / Corrective Actions |
|---|---|---|---|---|
| | | Result | Discussion | |
| Effectively manage fuel loads in the RRPA and mitigate potential impacts from uncontrolled wildfires. | Fire breaks are installed and maintained. | Met | Fire breaks were inspected and maintained. | Nil |
| | Controlled burning completed in accordance with a Permit to Burn. | Met | Controlled burns were undertaken as required. | Nil |
| | No incidents of vehicle ignited fires. | Met | Limited vehicle movements with no recorded incidents. | Nil |

No new fire breaks were created at the RRPA during the 2018-2019 reporting period. Existing fire breaks and fuel loads were maintained through a combination of cattle grazing, spraying and controlled burns conducted by the Pastoral Lease Holder (on behalf of Primary Gold). Fire scars in the RRPA in 2018 from the North Australia and Rangelands Fire Information (NAFI) are shown in Figure 6-4.

Cattle grazing will be intermittent during 2019-2020 and an assessment of the fuel loads will be made following the wet season. Where controlled burning is required, the relevant permits will be obtained, and Bushfires NT will be consulted. Surrounding landholders will also be advised prior to any controlled burns taking place.

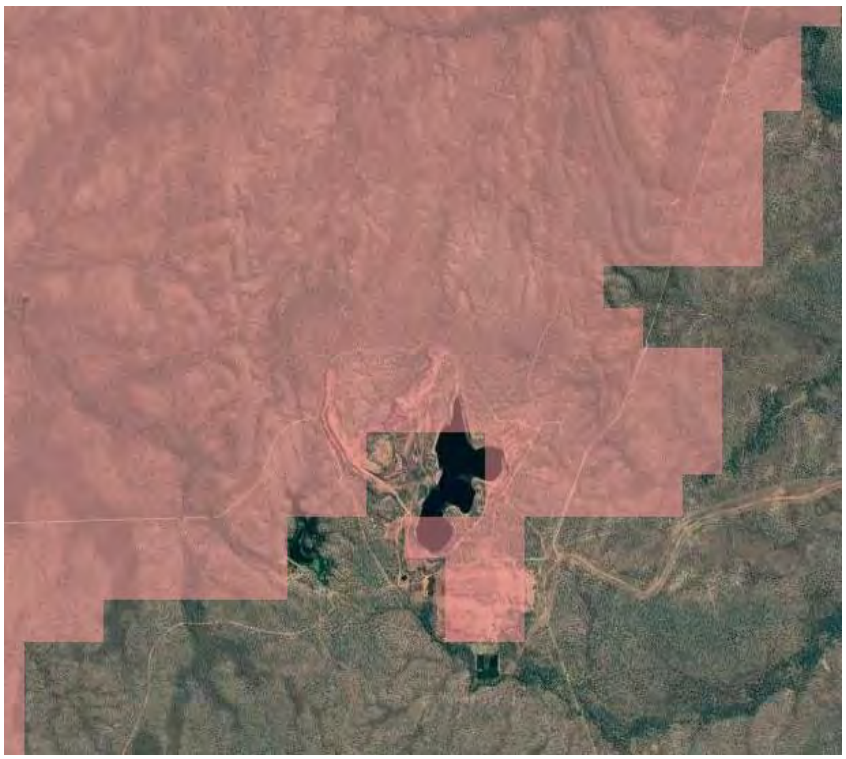


**Figure 6-4: 2018 RRPA Fire Scars (NAFI, 2020)**

#### 6.8.2.6 Flora and Fauna

Flora and fauna are management at the RRPA in accordance with the Flora and Fauna Prevention EMP (Appendix 10.9). Primary Gold provides an assessment of performance against each objective and target with discussion and comment on non-conformance/corrective actions where applicable (Table 6-23).

**Table 6-23: Flora and Fauna EMP Performance Assessment**

| Objective | Target | Performance Against Commitment | | Non-Conformance / Corrective Actions |
|---|---|---|---|---|
| | | Result | Discussion | |
| Protect and appropriately manage threatened species that occur within the RRPA and prevent the disturbance of flora and fauna outside of the RRPA. | Logging and review of site fauna sightings. | Met | No species of interest observed during inspections. | Nil |
| | No incidents of adverse impact to flora and fauna of significance. | Met | No incidents or adverse impacts identified during inspections. | Nil |

No threatened fauna species or incidents of adverse impacts were observed during site inspections.

## 6.9 Emergency Procedures and Incident Reporting

### 6.9.1 Emergency Procedures

Primary Gold considers that the environmental emergencies likely to occur at the RRPA in its current care and maintenance state are related to natural rainfall and wildfire events. High rainfall events have the capacity to destabilise landforms and potentially cause overtopping of water containment infrastructure. Whilst there is only minimal infrastructure onsite, wildfire has the potential to damage leach pad / pond linings and pumping equipment / infrastructure in place to mitigate overtopping.

Emergency response to environmental issues has been integrated within the Primary Gold emergency response procedures. In the first instance, the site contact (the Mount Bundey Pastoralist and/or Station Manager) would respond and contact Primary Gold to advise of the issue and decide on an appropriate level of response.

In summary the RRPA Emergency Response Plan (Appendix 10.8) includes:

- Critical incident management for those persons affected by the emergency event;
- Liaising with government authorities;
- Protecting the environment;
- Salvaging of damaged goods, plant, and equipment; and
- Wildfire management in conjunction with authorities.

All management personnel receive training in the emergency response procedures as an integral part of their site induction. Emergency communication mechanisms have been developed and documented. The Emergency Response Plan should be consulted for further detailed information regarding emergency response management, which will be addressed by the Emergency Response Team.

### 6.9.2 Environmental Incident Reporting

All Employees and Contractors must promptly report any emergency, incident, hazard, complaint, or non-compliance to Primary Gold as soon as reasonably practicable, or within 24 hours of any incident or occurrence. Reported events are investigated to identify and evaluate the immediate and contributory causes to enable prompt and effective corrective actions to be implemented.

As soon as practicable after becoming aware of the occurrence of an environmental incident or serious environmental incident at the RRPA, Primary Gold will notify the DPIR in accordance with the *Mining Management Act*. The Primary Gold internal procedure prescribes reporting within 12 hours and submission of a Section 29 report to the DPIR within 24 hours.

The occurrence of new declared weeds will be reported to the DENR (Weeds Management Branch), in accordance with the *Weed Management Act*. For any offsite environmental incidents, the DENR will be informed as soon as practicable (and in any case within 24 hours of becoming aware) in accordance with the *Waste Management and Pollution Control Act*.

## 6.10 Environmental Management Plans

Primary Gold manages significant environmental aspects of its operations through a series of EMPs, which are a compilation of the work required to:

- Meet the requirements of the Environmental Policy;
- Comply with all applicable regulatory requirements;
- Achieve objectives and targets; and
- Manage and reduce the impact of environmental aspects.

Each EMP sets key objectives, targets, and management and mitigation measures, which are aimed to prevent or minimise higher risk impacts, identified during the site risk assessments. The Primary Gold EMPs are provided in Appendix 10.9 and include:

- Landform, Erosion and Sediment Control;
- Weed and Pest;
- Fire;
- Flora and Fauna; and
- Water.

The EMPs have been reviewed and consolidated to reduce duplication. No significant changes to these EMPs have been identified based on the activities proposed for the next MMP reporting period.

# 7 Closure Plan

The NT Department of Primary Industry and Resources (DPIR) *Mining Management Plan Structure Guide for Care and Maintenance Operations* (DPIR, 2017) requires that the MCP is:

- Approved in conjunction with the MMP and demonstrates that agreement for an appropriate post mining land use has been reached with all relevant stakeholders;
- Updated whenever significant changes are made to the scope of the operation and no less than every three (3) years during the life of an operation. An updated MCP must be produced two (2) years prior to planned closure;
- Addressing both unplanned closure within the life of the MMP and planned closure at the end of the operational life of the project; and
- Compliant with the current NT *Mine Closure Guidelines* (under development) or in the interim the Western Australian *Guidelines for Preparing Mine Closure Plans*.

A MCP has been developed in accordance with the WA Department of Mines, Industry Regulation and Safety (DMIRS) *Statutory Guidelines for Mine Closure Plans* (DMIRS, 2020a). These Guidelines are effective from 3 March 2020 and supersede the WA *Guidelines for Preparing Mine Closure Plans* published in 2015.

The DPIR released *Draft Guidelines for Mine Closure Plans* in May and August 2016, however these guidelines have not progressed to an approved final version. This document has been developed in accordance with the WA Department of Mines, Industry Regulation and Safety (DMIRS) *Statutory Guidelines for Mine Closure Plans* (DMIRS, 2020a). These Guidelines are effective from 3 March 2020 and supersede the WA *Guidelines for Preparing Mine Closure Plans* published in 2015.

## 7.1 Life of Plan – Unplanned Closure

The RRPA was effectively placed into Care and Maintenance from July 1998 and remains in this status. A LOM Plan is currently being developed by Primary Gold to return the RPPA into operational status in the next 2-5 years. The development of the LOM Plan will help shape the long-term options for the RRPA, be that remaining on Care and Maintenance, returning to operational status, or transitioning to planned closure.

Until the RRPA mine plans have been finalised (and approvals granted) the site will remain in Care and Maintenance. If future mining does not occur and the RRPA transitions into planned closure, then the 2020 RRPA MCP will be implemented.

Progressive rehabilitation to date has focussed on the removal of site infrastructure (with some rehabilitation) and the monitoring and management of the permanent site landforms (i.e. Open Pit and WRL). All mobile infrastructure has been removed except for three (3) large tanks transported to the site in preparation for the commencement of Phase 2 mining, which never eventuated.

Perhaps the most significant limitation to the final rehabilitation of the RRPA is that there is an unmined gold resource (defined in 2019 as a Mineable Reserve ~19Mt at 0.93g/t for 578koz of gold). This is the primary reason that further site rehabilitation has not been undertaken since the cessation of mining in August 1997.

Given the strong Australian gold price and the large mineable resource of gold of 1.5 million oz at Rustlers Roost the Company's intention is to now seek approvals for the development of a large open cut gold mine, CIL plant and tailings dam with Quest 29 developed as a satellite operation to RRPA.

## 7.2 Costing of Closure Activities

The DPIR Security Cost Estimate online template was utilised to summarise and calculate closure costs for this MMP and the associated activities. The security estimate is consistent with third party costs and remediation requirements in the event of the closure at the end of the life of this plan i.e. rehabilitation costs for any previous disturbances carried out by Primary Gold. Post closure monitoring and maintenance costs are also included.

The current security held for the RRPA (Authorisation 0738-01) is $303,616. The RRPA Security Cost Estimate has been reviewed and a copy is provided in Appendix 10.7. No changes to the security are proposed as part of this MMP given that no additional disturbances are proposed or have occurred.

# 8 Glossary

| Term | Definition |
|---|---|
| **AAPA** | Aboriginal Areas Protection Authority. |
| **Activity** | Elements of the organisation's activities or products or services that can interact with the environment. These include routine and non-routine activities. |
| **AEP** | Annual Exceedance Probability. |
| **AG** | Australian Government. |
| **AGC** | AGC Woodward-Clyde Pty Ltd. |
| **AHD** | Australian Height Datum. |
| **ALARP** | As Low as Reasonably Practicable. Any measure which is practicable and the implementation cost (money, time, effort) is not grossly disproportionate to the benefit, the measure is considered "reasonably practicable" and implementation is expected. |
| **AMD** | Acid and Metalliferous Drainage. Mine drainage may consist of acid drainage and/or metalliferous drainage. AMD originates when sulphide material is exposed to air and water. Metalliferous drainage can occur when acid is neutralised, but concentrations of some metals remain elevated at near neutral or alkaline conditions. Potential sulphide-bearing material includes waste rock, pit wall rock and tailings. |
| **ANZECC** | Australian and New Zealand Environment and Conservation Council. |
| **ANZMEC** | Australian and New Zealand Minerals and Energy Council. |
| **ARI** | Annual Recurrence Interval. |
| **ARMCANZ** | Agriculture and Resource Management Council of Australia and New Zealand. |
| **BoM** | Bureau of Meteorology, Commonwealth. |
| **BUD** | Beneficial Use Declaration. |
| **Care and Maintenance** | Phase following temporary cessation of mining operations where infrastructure remains intact and the site continues to be managed. All mining operations suspended, site being maintained and monitored. |
| **CDMS** | CDM Smith Australia Pty Ltd. |
| **CEC** | Cation Exchange Capacity. |
| **CGAO** | Crocodile Gold Australian Operations. |
| **Closure** | A whole-of-mine-life process, that typically culminates in completion of all obligations under the *Mining Management Act*, government "sign- |

| Term | Definition |
|---|---|
| | off" and responsibility has been accepted by the next land user or manager. It includes decommissioning and rehabilitation. |
| **Community** | A group of people living in a particular area or region. In terms of mining activities, this refers to the inhabitants of immediate and surrounding areas who are affected by a mining activity. |
| **Community and Stakeholder Strategy** | The proposed course of action for community and stakeholder engagement. |
| **Consequence** | Outcome of an event affecting outcomes. |
| **Consultation** | A process that permits and promotes the two-way flow of ideas and information. Effective consultation is based on principles of openness, transparency, integrity, and mutual respect. |
| **Contaminated** | Contaminated, in relation to land, water or a site, means having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value. This definition may apply to the artificial concentration (localised accumulation) of natural substances or minerals which have the potential to present a risk of harm to human health, the environment or any environmental value through this accumulation, such as mineral processing sites or TSFs. |
| **CSIRO** | Commonwealth Scientific and Industrial Research Organisation. |
| **DENR** | Department of Environment and Natural Resources, NT. |
| **Disturbance Type** | A feature created during mining or exploration activity, e.g. WRLs, haul roads, access roads, ROM, plant site, TSF, borrow pits, drill pads, stockpiles, office blocks, accommodation village, etc. |
| **Disturbed** | Area where vegetation has been cleared and/or topsoil (surface cover) removed. |
| **DMIRS** | Department of Mines, Industry Regulation and Safety, WA. |
| **DoIR** | Department of Industry and Resources, WA (now known as DMIRS). |
| **DotEE** | Department of the Environment and Energy, Commonwealth. |
| **DPIR** | Department of Primary Industry and Resources, NT. |
| **DTSC** | Department of Tourism, Sport and Culture, NT. |
| **Earthworks** | Reshaping, landscaping, capping, water/wind erosion control, rock armouring, ripping. |
| **EC** | Electrical Conductivity. |
| **EcoFox** | EcoFox Enterprises Pty Ltd. |
| **Ecologically Sustainable** | Meeting the goal and principles of the National Strategy for Ecologically Sustainable Development, endorsed by all Australian jurisdictions in 1992, to ensure that development improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. |

| Term | Definition |
|---|---|
| **EIS** | Environmental Impact Statement. |
| **EMS** | Environmental Management System. A system of practices and procedures relating to the:<br>• identification and assessment of the risk of environmental harm occurring as a result of the carrying out of mining operations; and<br>• implementation of practicable measures to avoid or minimise the risk of such environmental harm occurring or reduce such environmental harm if it occurs. |
| **Engagement** | The process by which relevant parties work collaboratively to build ongoing, mutually beneficial relationships. |
| **Environment** | Living things, their physical, biological, and social surroundings, and interactions between all of these. |
| **Environmental Factor** | A part of the environment that may be impacted by an activity. |
| **Environmental Harm** | Environmental harm means adverse ecological effects on the environment. |
| **Environmental Impact** | Any change to the environment, whether adverse or beneficial, wholly, or partially resulting from a proponent's activities. |
| **Environmental Outcome** | Environmental outcome is the acceptable level of impact that must not be exceeded, or a level of protection/performance/result that must be achieved, for the mine site to be considered compliant. |
| **Environmental Value** | A beneficial use and/or an ecosystem health condition. |
| **EPA** | Environmental Protection Authority, NT. |
| **EPBC Act** | *Environment Protection and Biodiversity Conservation Act 1999.* |
| **ESP** | Exchangeable Sodium Percentage. |
| **ESS** | Environmental and Earth Sciences Pty Ltd. |
| **GBS** | GBS Gold Australia Pty Ltd. |
| **GCA** | Graeme Campbell and Associates Pty Ltd. |
| **GIS** | Geographical Information System. |
| **GV** | Guideline Values. |
| **HDPE** | High-density polyethylene. |
| **IBRA** | Interim Biogeographic Regionalisation for Australia classification system. |
| **ICMM** | Australian Mining Industry Council. |
| **IFD** | Intensity-Frequency-Duration. |
| **Interested Parties** | For the purposes of this document, the term 'interested parties' may be used in exchange with community and stakeholders. |

| Term | Definition |
|---|---|
| **JV** | Joint Venture. |
| **Key Stakeholders** | Refers to post-mining landowners/managers and relevant regulators. |
| **Kinhill** | Kinhill Engineers Pty Ltd. |
| **LES** | Low Ecological Services P/L. |
| **Level of Risk** | Magnitude or a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood. |
| **Likelihood** | Description of probability or frequency of an event occurring. |
| **LOM** | Life of Mine. Expected duration of mining and processing operations. |
| **Maintain** | To keep in existence or continuance; preserve; retain or to keep in a specified state, position, etc. |
| **MCA** | Minerals Council of Australia. |
| **MCMPR** | Ministerial Council on Mineral and Petroleum Resources |
| **MCP** | Mine Closure Plan. |
| **Mine Activity Reference** | Name given to a particular activity at the mine for ease of identification, for example “Western WRL” or “TSF1”. |
| **Mineral Processing Facilities** | Includes all processing facilities for ore treatment including crushing plants, grinding, vat leach, heap leach, dump leach and tailings disposal facilities. |
| **Minimise** | Limit the degree or magnitude of the adverse impact. |
| **Mining Disturbances** | Features created during mining activities e.g. WRL, haul roads, plant site, TSF, stockpiles, camp etc. |
| **MMP** | Mining Management Plan. A document required under section 40 of the *Mining Management Act* and containing the information required by relevant DPIR guidelines. |
| **MRF** | Mining Remediation Fund. |
| **NAF** | Non-Acid Forming. |
| **NAPP** | Net Acid Producing Potential. |
| **NOI** | Notice of Intent. |
| **NT** | Northern Territory. |
| **NTG** | Northern Territory Government. |
| **Operations** | The active pit, haul roads, workshops, administration; – the collective group of features that are needed to run an operation. |
| **PAF** | Potentially Acid Forming. |
| **PCK** | Pine Creek Bioregion. |

| Term | Definition |
|---|---|
| **PCK01** | Pine Creek Subregion. |
| **PCO** | Pine Creek Orogen. |
| **PER** | Preliminary Environmental Assessment. |
| **Pits** | All open excavations including active mineral rock, gravel, sand, clay, bauxite, and salt-pan extraction areas. |
| **Post-Mining Land Use** | Term used to describe a land use that occurs after the cessation of mining operations. |
| **Problematic Materials** | Materials that have the potential to detrimentally impact on humans and the environment and require careful and appropriate management (e.g. PAF materials, radioactive materials, asbestiform materials, dispersive materials, arsenic etc.). |
| **Project** | The total integrated mining operation in which the site(s) contribute to the overall operation to supply ore, processing facilities and disposal of waste products. |
| **Rehabilitation** | The return of disturbed land to a safe, stable, non-polluting/non-contaminating landform in an ecologically sustainable manner that is productive and/or self-sustaining consistent with the agreed post-mining land use. |
| **Residual Risk** | Risk remaining after risk treatment. |
| **Revegetation** | Establishment of self-sustaining vegetation cover after earthworks have been completed, consistent with the post-mining land use. |
| **Risk** | The chance of something happening that will have an impact on objectives. It is measured in terms of consequences and their likelihood of occurrence. |
| **Risk Analysis** | Process to comprehend the nature of risk and to determine the level of risk. |
| **Risk Assessment** | Overall process for risk identification, risk analysis and risk evaluation. |
| **Risk Identification** | Process of finding, recognising, and describing risks. |
| **Risk Management** | Coordinated activities to direct and control an organisation regarding risk. |
| **Risk Management Framework** | Set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management. |
| **Risk Pathway** | The causal mechanism through which a hazard or risk would be realised or occur. |
| **Risk Treatment** | Process to modify and reduce risk. |
| **ROM** | Run of Mine. |
| **RRMPL** | Rustlers Roost Mining Pty Ltd. |
| **RRPA** | Rustlers Roost Project Area. |

| Term | Definition |
|---|---|
| **Source of Risk** | Source of potential harm or situation with the potential to cause loss or adverse impact. These should also include sources which may only have potential unplanned interactions with the environment (i.e. accidents/incidents). |
| **Safe** | A condition where the risk of adverse effects to people, livestock, other fauna, and the environment in general has been reduced to a level acceptable to all stakeholders. |
| **SoCS** | Sites of Conservation Significance. |
| **SoBS** | Sites of Botanical Significance. |
| **SSTV** | Site Specific Trigger Value. |
| **Stable** | A condition where the rates of change of specified parameters meet agreed criteria. |
| **Stakeholder** | A person, group, or organisation with an interest in a decision, either as individuals or representing a group, with the potential to influence or be affected by the process of, or outcome of, mine closure. |
| **SWG** | Livestock Drinking Water Guidelines. |
| **SWL** | Standing Water Level. |
| **TDS** | Total Dissolved Solids. |
| **Tenement** | Land tenure granted under the *Mineral Titles Act*. |
| **TGPA** | Toms Gully Project Area. |
| **TPWC Act** | *Territory Parks and Wildlife Conservation Act*. |
| **TSF** | Tailings Storage Facility. An area used to store and consolidate tailings and may include one or more tailings storage features. |
| **Version** | An identifier that reflects a change to a MMP or MCP that occurs during assessment. If modification and resubmission of a document is required as part of the assessment, the version number must be updated prior to resubmission (e.g. 4.0 updated to 4.1). |
| **Void** | Surface excavations made as a result of mining operations which exceed five metres in depth from the surrounding levels (also referred to as Open Pits). |
| **Water Table** | The level below which the ground is saturated with water. |
| **WDL** | Waste Discharge Licence. |
| **WoNS** | Weeds of National Significance. |
| **WRL** | Waste Rock Landform. Areas associated with the storage of unprocessed waste material resulting from a mining operation. |

# 9 Bibliography

AGC Woodward-Clyde Pty Ltd (1994a) – *Rustlers Roost Gold Project Hydrological and Water Balance Study for the Heap Leach Facility*. Prepared for Valdora Minerals NL.

Australian Government (2008) – *Rangelands 2008 – Taking the Pulse: Pine Creek Bioregion*. Prepared by the National Land and Water Resources Audit.

Australian Government (2020) – *National Map*. Available: https://www.nationalmap.gov.au/. Accessed: April 2020

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) – *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1*. Prepared by ANZECC/ARMCANZ.

Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia (2000) – *Strategic Framework for Mine Closure*. Prepared by ANZMEC/MCA.

Bureau of Meteorology (2005) – *Climate Classification Maps*. Available: http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp Accessed: April 2020

Bureau of Meteorology (2006) – *Australian Climate Variability and Change – Average Maps: Pan Evaporation*. Available: http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp. Prepared by BoM. Accessed: April 2020

Bureau of Meteorology (2020a) – Climate Statistics for Australian Locations – Middle Point Rangers Weather Station. Available: http://www.bom.gov.au/climate/averages/tables/cw_014090_All.shtml. Accessed: April 2020

Bureau of Meteorology (2020b) – *Northern Australia Cyclone Frequency By Month*. Available: http://www.bom.gov.au/cyclone/images/nt/Frequency-By-Month-Category_1964-2015.jpg. Accessed: April 2020

Bureau of Meteorology (2020c) – *Design Rainfall Data System 2016*. Available: http://www.bom.gov.au/water/designRainfalls/revised-ifd/. Accessed: April 2020

CDM Smith (2019a) – *Rustlers Roost Project – Desktop and Limited Field Geochemical Assessment.* Prepared for Hanking Australia.

CDM Smith (2019b) – *Rustlers Roost Project – Surface Water Assessment.* Prepared for Primary Gold.

CDM Smith (2019c) – *Rustlers Roost Project – Desktop Groundwater Assessment.* Prepared for Primary Gold.

CSIRO (2018) – *Review of Site-Specific Trigger Values for the Toms Gully Mine, NT.* Prepared for Primary Gold.

Department of Environment and Natural Resources (2019) – *Declared Weeds in the Northern Territory*. Prepared by NT DENR.

Department of the Environment and Energy (2012) – *Interim Biogeographic Regionalisation for Australia Version 7 Map*. Prepared by the Commonwealth of Australia.

Department of the Environment and Energy (2020) – *Protected Matters Search Tool*. Available: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf. Accessed: May 2020

Department of Mines, Industry Regulation and Safety (2020a) – *Statutory Guidelines for Mine Closure Plans*. Prepared by WA DMIRS.

Department of Primary, Industry and Resources (2016) – *Security Calculation Procedure (Version 1.0)*. Prepared by NT DPIR.

Department of Primary, Industry and Resources (2017) – *Mining Management Plan Structure Guide for Care and Maintenance Operations*. Prepared by NT DPIR.

Department of Primary, Industry and Resources (2020) – *Variation of Authorisation 0738-01*. Prepared by NT DPIR.

EcoFox Enterprises Pty Ltd (2004) – *Mining Management Plan Rustlers Roost Ornamental Rock Extraction*. Prepared for the NT DPIR.

Environmental and Earth Sciences Pty Ltd (1993) – *Preliminary Groundwater Investigation of the Proposed Rustlers Roost Gold Mine.* Prepared for Valdora Minerals NL.

Environmental and Earth Sciences Pty Ltd (1994) – *Waste and Ore Characterisation Study of the Proposed Rustlers Roost Gold Mine.* Prepared for Valdora Minerals NL.

Golder Associates Pty Ltd (1994) – *Geotechnical Assessment Rustlers Roost Project.* Prepared for Valdora Minerals NL.

Graeme Campbell and Associates Pty Ltd (1996) – *Rustlers Roost Gold Mine Acid Formation Potential and Multi-Element Composition of Primary Ore and Transition Ore Tailings.* Prepared for Rustlers Roost Mining Pty Ltd.

Graeme Campbell and Associates Pty Ltd (1997) – *Rustlers Roost Gold Mine Acid Formation Potential and Multi-Element Composition of Waste Rock and Ore Samples.* Prepared for Rustlers Roost Mining Pty Ltd.

Kinhill Engineers Pty Ltd (1993a) – *Proposed Rustlers Roost Gold Mine: Fauna, Flora and Soils Study.* Prepared for Valdora Minerals NL.

Kinhill Engineers Pty Ltd (1993b) – *Archaeological Investigations of the Proposed Rustlers Roost Gold Mine.* Prepared for Valdora Minerals NL.

Low Ecological Services P/L (2016) – *Toms Gully, Rustlers Roost and Quest 29 Flora and Fauna Report.* Prepared for Primary Gold.

National Native Title Tribunal (2020a) – *Native Title Applications, Registration Decisions and Determinations Search. Available: http://www.nntt.gov.au/searchRegApps/NativeTitleClaims/Pages/default.aspx* Accessed: April 2020

National Native Title Tribunal (2020b) – *Northern Territory Native Title Claimant Applications and Determination Areas Map (As per the Federal Court 31 December 20119).* Prepared by the NNTT.

North Australia and Rangelands Fire Information (2020) – *North Australia and Rangelands Fire Information website. Available:* https://www.firenorth.org.au/nafi3/ Accessed: May 2020

Northern Territory Government (1999) – *Declaration of Beneficial Uses and Objectives of Water – Mount Bundey Creek Map.* Prepared by the Department of Lands, Planning and Environment (now DENR).

Northern Territory Government (2002a) – *Government Gazette No G6 13 February 2002.* Prepared by the NTG.

Northern Territory Government (2002b) – *Declaration of Beneficial Uses and Objectives of Water – Mary River Surface Water Map.* Prepared by the Department of Infrastructure, Planning and Environment (now DENR).

Northern Territory Government (2002c) – *Declaration of Beneficial Uses and Objectives of Water – Mary River Groundwater Map.* Prepared by the Department of Infrastructure, Planning and Environment (now DENR).

Northern Territory Government (2020a) – *Strike: Tenure and Geoscience Information (DPIR) Search – Available:* http://strike.nt.gov.au/wss.html. Accessed April 2020.

Northern Territory Government (2020b) – *Natural Resource (NR) Maps (DENR) Search – Available:* https://nrmaps.nt.gov.au/nrmaps.html. Accessed April 2020.

Northern Territory Government (2020c) – *Heritage Register Search – Available:* http://www.ntlis.nt.gov.au/heritageregister/. Accessed April 2020.

Primary Gold Ltd (2016a) – *Mining Closure Plan – Rustlers Roost Project Area*. Prepared by Primary Gold.

Primary Gold Ltd (2016b) – *Care and Maintenance Mining Management Plan – Rustlers Roost Project Area 2015-2016*. Prepared by Primary Gold.

Primary Gold Ltd (2018) – *Care and Maintenance Mining Management Plan – Rustlers Roost Project Area 2016-2017 (Resubmission)*. Prepared by Primary Gold.

Primary Gold Ltd (2019) – *Care and Maintenance Mining Management Plan – Rustlers Roost Project Area 2018-2019*. Prepared by Primary Gold.

Rustlers Roost Mining Pty Ltd (1997) – *Draft Environmental Impact Statement – Stage 2 Mining.* Prepared by NUYTSIA WA Pty Ltd.

Valdora Minerals NL (1994) – *Rustlers Roost Gold Mine – Preliminary Environmental Report*. Prepared by Valdora Minerals NL.

# 10Appendices

## 10.1 Surface Water Assessment

Primary Gold Pty Ltd

# Rustler's Roost Project – Surface Water Assessment

15 May 2019

CDM Smith

listen. think. deliver.

# Table of Contents



# Figures



# Tables

# Appendices

# Document history & status

| Revision | Date issued | Reviewed by | Approved by | Date approved | Revision type |
|---|---|---|---|---|---|
| 1 | 29/03/2019 | PD | PD | 29/03/2019 | Draft |
| 0 | 15/05/19 | PD | PD | 15/05/19 | Final |
| | | | | | |
| | | | | | |

# Distribution of copies

| Version | Date issued | Quantity | Electronic | Issued to |
|---|---|---|---|---|
| Rev-A | 04/04/2019 | 1 | Pdf | Hanking |
| Rev-0 | 16/05/2019 | 1 | Pdf | Hanking |
| | | | | |
| | | | | |

| | |
|---|---|
| **Last Saved:** | 15 May 2019 |
| **File Name:** | PGO-1000338-RPT-SW-001-Rev0.docx |
| **Author:** | Evan O'Brien |
| **Project Manager:** | Paul Davey |
| **Client:** | Primary Gold Pty Ltd |
| **Document Title:** | **Rustler's Roost Project – Surface Water Assessment** |
| **Document Version:** | Rev-0 |
| **Project Number:** | 1000338 |

# Section 1 Introduction

## 1.1 Purpose

The purpose of this report is to document the work undertaken in addressing the surface water aspects of the Rustler's Roost Project site (Figure 1-1), to support Primary Gold Ltd (PGO) in addressing queries raised by the Northern Territory Department of Primary Industries and Resources (DPIR) as they relate to the site's Mining and Management Plan (MMP). Specifically, this report addresses the following comments raised by DPIR in relation to water management issues:

- **Water Account.** A site water balance has been developed to assess the likely long-term condition of the pit lake.
- **Previous MMP – Surface Water.** 2D hydrodynamic flood models have been developed to assess the flood immunity of critical site infrastructure.
- **Erosion and Sediment Control.** The existing erosion and sediment issues have been assessed in developing mitigation concepts and design drawings.

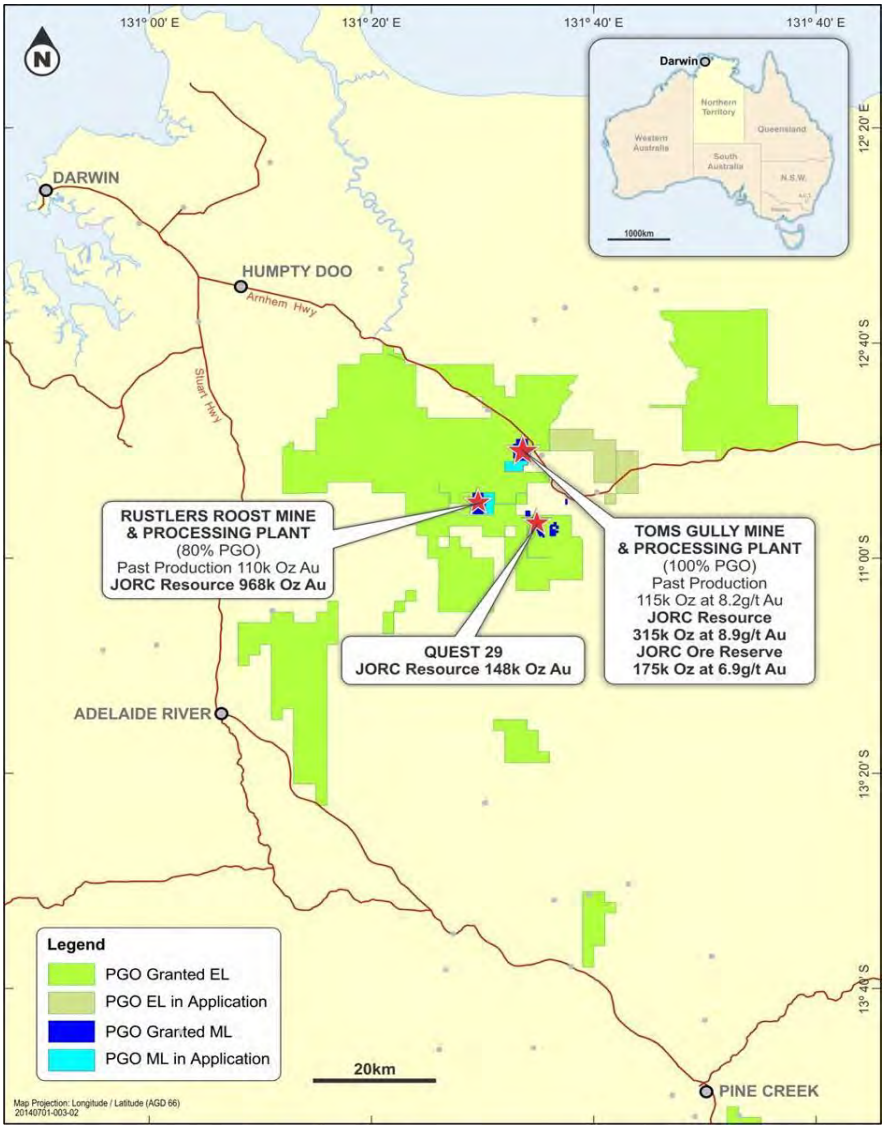



**Figure 1-1 Project Locality Plan**

## 1.2 Previous Studies

- TSF water balance model (Rustler's Roost Mining Pty Ltd Draft EIS Statement 1997)
- Basic flood study, steady state flow analysis in 1D, suitable at the time, but now outdated.
- No current pit water balance
- New work uses more sophisticated modelling technique and higher accuracy rainfall and terrain data

## 1.3 Catchment Description

The mine site straddles a catchment divide, with the eastern portion of the site draining to the Mary River catchment via Bundey Creek, and the western portion of the site draining into the Adelaide River via an unnamed tributary. As such, the mine site itself has only a small external catchment area, measured at about 2.2 km$^2$. This means that the site is unlikely to be affected by riverine flooding (ie. flooding generated from further upstream), and that the dominant flooding mechanism is expected to be the rapid generation of overland flow in response to local catchment rainfall.

## 1.4 Climate

Annual rainfall totals in the region are in the order of 1330 mm. Daily rainfall totals from Mt Ringwood Station (BOM gauge 014177), approximately 27 km south-west of the site, have been observed since 1968. Monthly statistics from this gauge are presented below in Figure 1-2. The presence of the two dominant seasons is obvious in the data, with the majority of rainfall occurring during the monsoonal months of November through April. The small differences between the mean and average monthly values suggests that the average is not skewed upwards by relatively few larger storms, indicating that the rainfall conditions not highly variable within any one month.

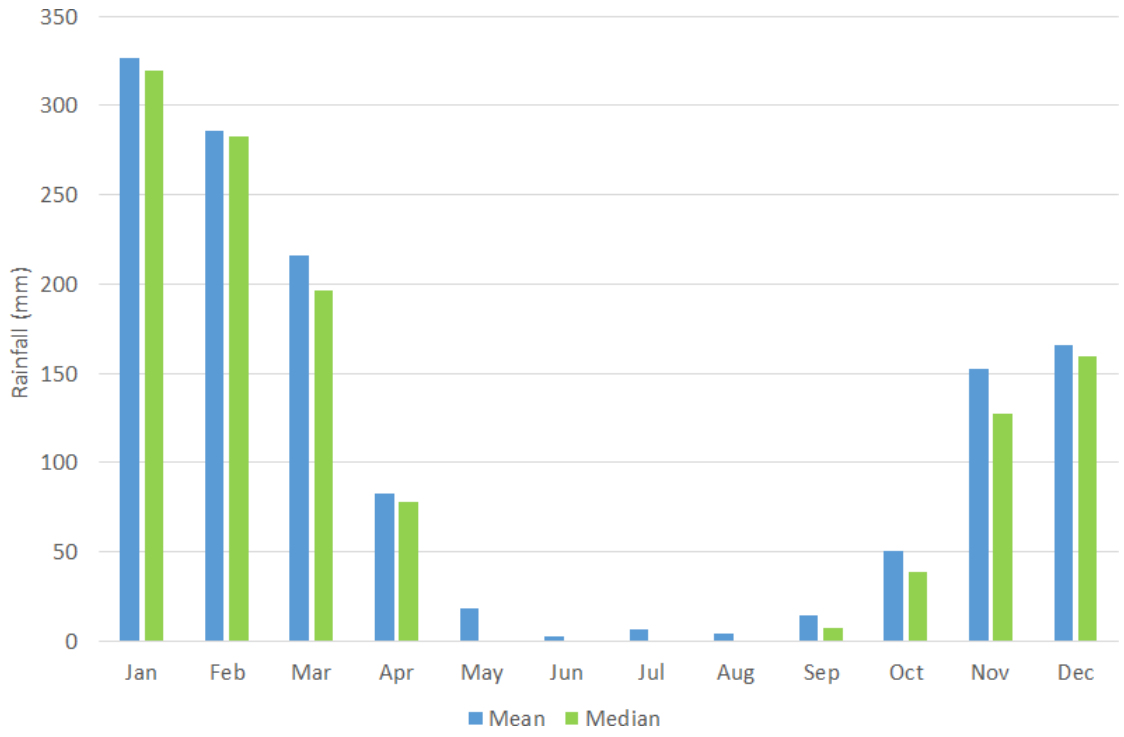



**Figure 1-2 Monthly Rainfall Statistics, Mount Ringwood**

# Section 2 Flood Modelling

## 2.1 Model Schematisation

### Hydraulic Model Software

The hydrodynamic model HEC-RAS v5.0.5 (US Army Corps of Engineers, 2018) was used to model the hydraulic characteristics of the surface drainage features within the site, via the direct application of rainfall to the model domain (ie. “rain on grid”). The model was set up as a 2D semi-structured mesh with a default cell size of 5 m. This resolution would typically be considered too coarse for river channel modelling in a traditional gridded model. However, HEC-RAS utilises a sub-grid sampling routine (in which the characteristics of the underlying 1 m LiDAR grid are incorporated into the cell and face hydraulic properties) that allows for detailed hydraulic characteristics to be captured on a relatively large grid.

Key hydraulic controls (such as tops of banks, embankments, channel constrictions) were captured by the addition of breaklines, which serve to align cell faces along the control, ensuring that hydraulic effects are adequately represented in the model. Additionally, so-called “refinement regions” were used to set finer or coarser cell sizes, giving greater resolution in areas where additional model detail was desired, such as at hydraulic controls (2 m), or less resolution where grid size was unimportant, such as standing water bodies.

### Model Domain

Hydraulic model extents were chosen with regard to the nature of the site. As the site sits across a major catchment divide, two separate model domains were developed; an eastern model, covering the majority of the previously disturbed area (pit, waste rock dump, heap leach pads, ponds), and a western model centred on Annie’s Dam and the upstream catchment to it. Model extents are shown on Figure 2-1.

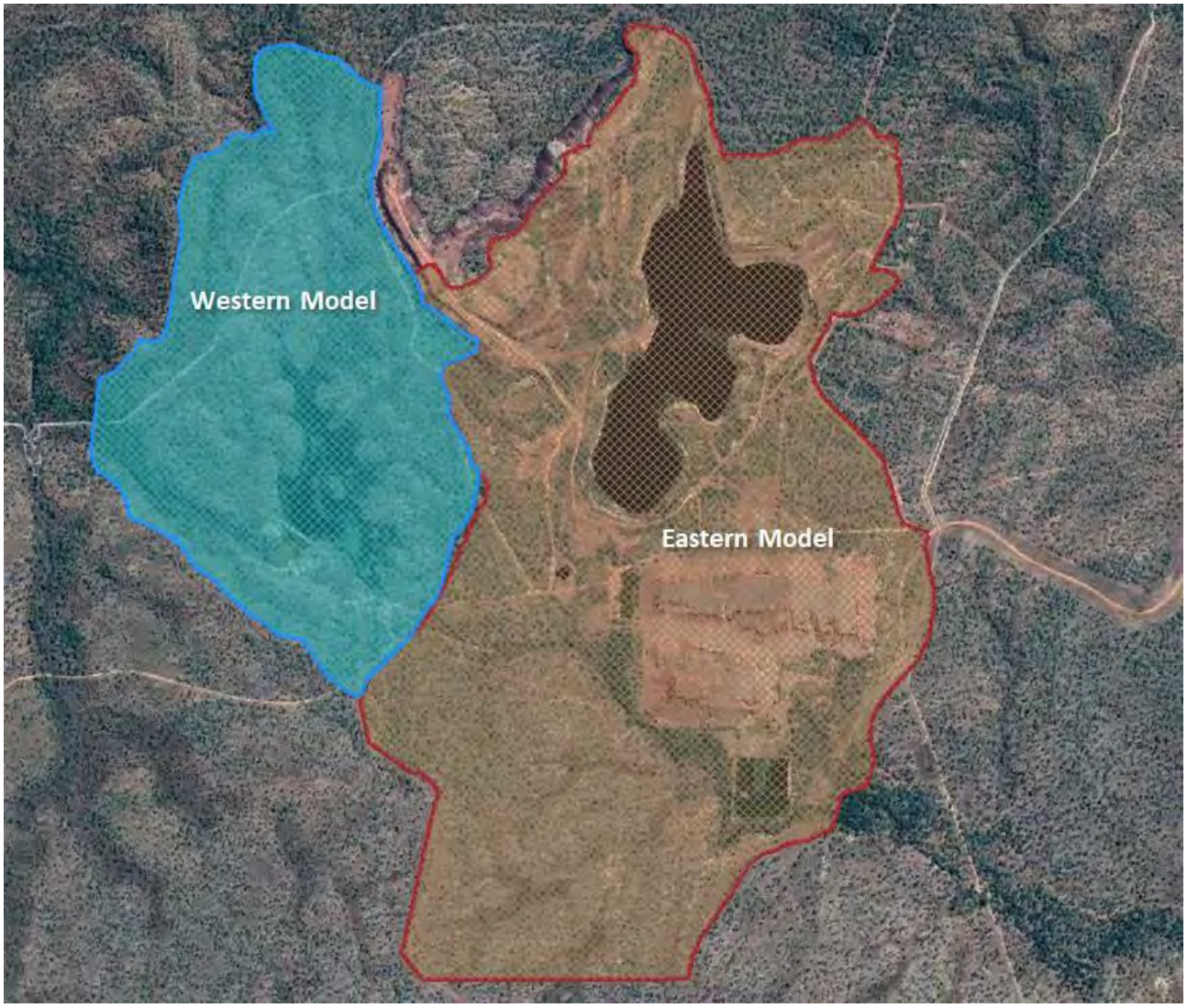



**Figure 2-1 Hydraulic Model Extents**

## 2.2 Model Data

### 2.2.1 Digital Elevation Models

A digital elevation model was developed to form the spatial basis for the HEC-RAS model, utilising an aerial survey dataset of the site provided by PGO in the form of 1km by 1km LiDAR grids at a resolution of 1m. This dataset suggested that at the time of survey, the mine pit contained water to a level of about 60 m AHD. The grids were mosaicked together and exported for use in the HEC-RAS model.

### 2.2.2 Rainfall Data

Design rainfall depths were calculated using the online intensity-frequency-duration (IFD) tool hosted at the Bureau of Meteorology website. IFD curves for three Annual Exceedance Probabilities (AEPs) are reproduced below in Figure 2-2.

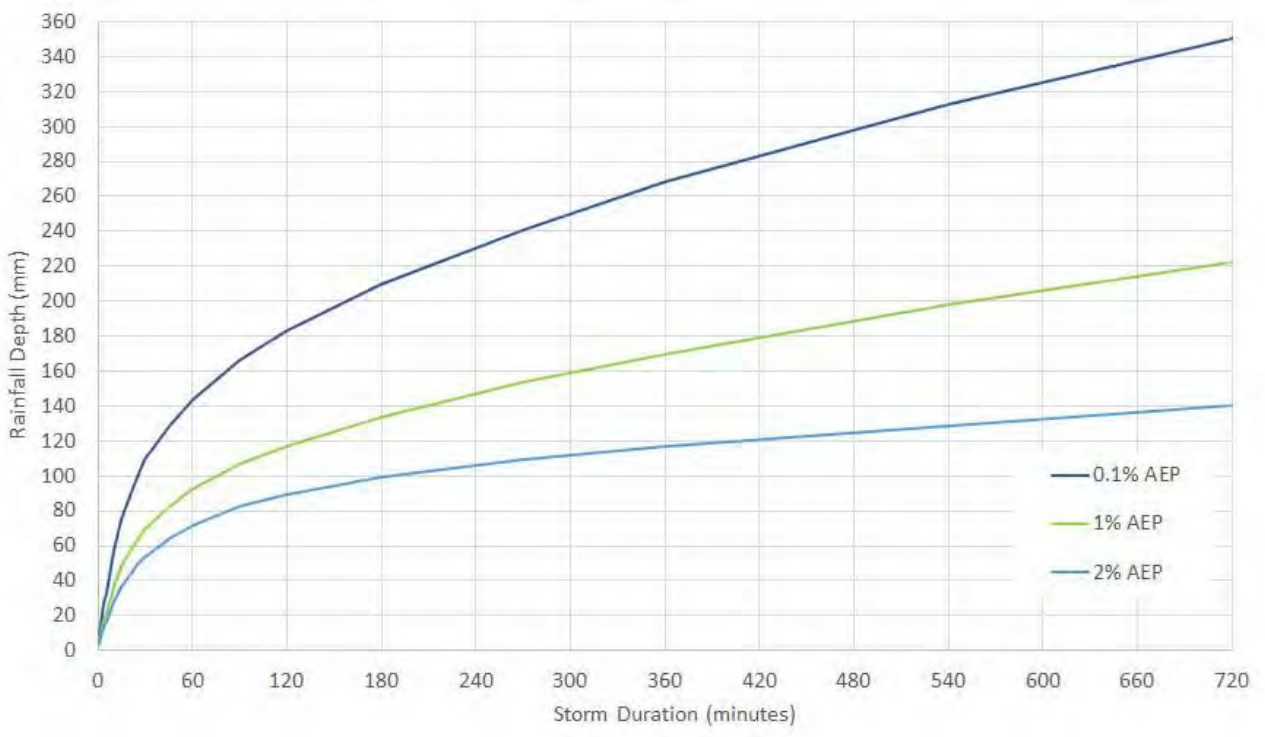



**Figure 2-2 Intensity-Frequency-Duration Data for selected AEPs**

The IFD curve shows the total rainfall depth for a storm of a given duration and magnitude. Within the storm, the time distribution of the total design rainfall depth is disaggregated through the use of a design temporal pattern. The current industry guidance document, Australian Rainfall and Runoff 2016 (ARR16), provides a suite of ten temporal patterns to be tested for each storm duration and geographic region, whereas the previous document, Australian Rainfall and Runoff 1987 (ARR87), provided just a single pattern per duration and zone. A comparison between the two sets of data (on an accumulated rainfall percentage basis) is presented below in Figure 2-3.

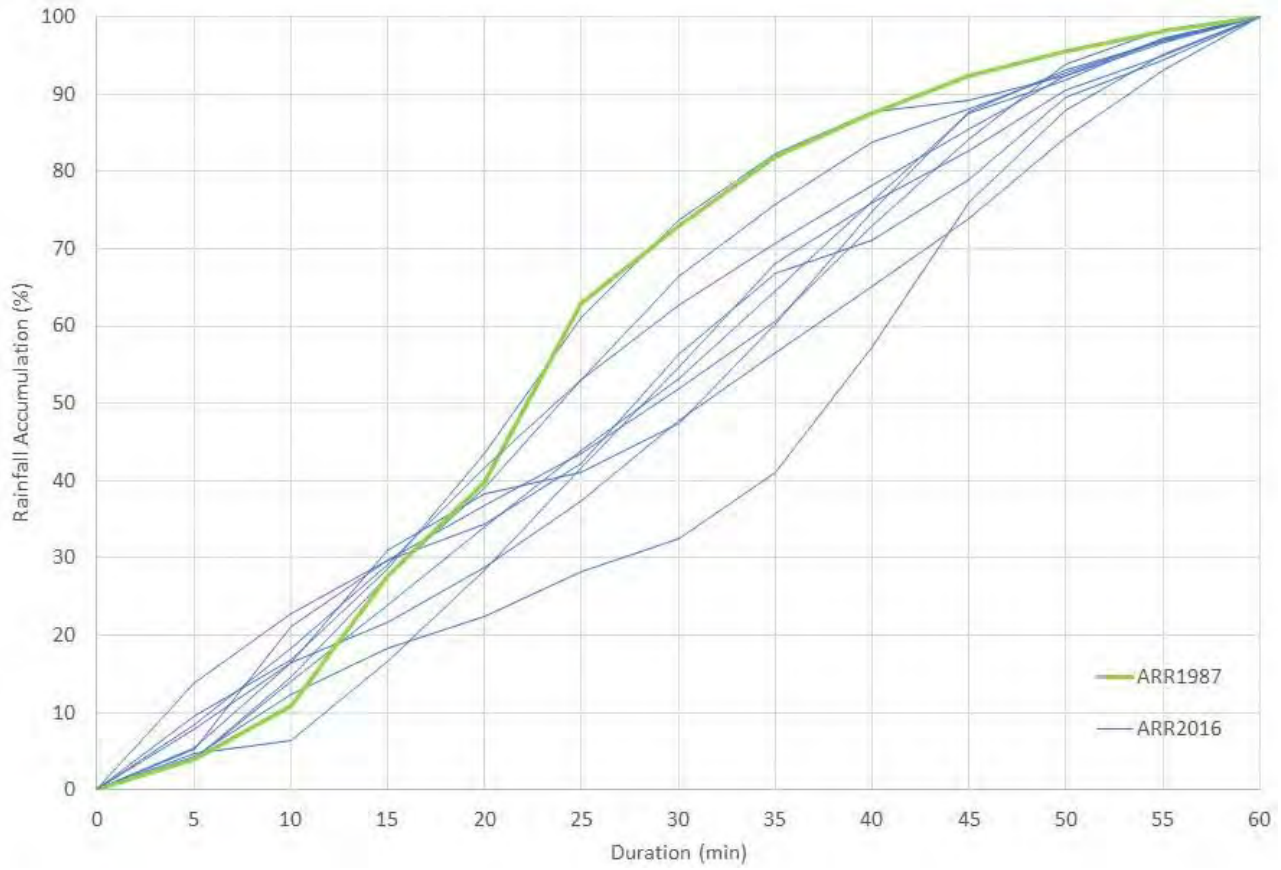



**Figure 2-3 Comparison of Temporal Patterns, 60 minute storm**

The ARR16 patterns are generally more uniform than the single ARR87 pattern, as can be seen for the 60 minute duration event, where the none of the ARR16 curves are steeper at any point than the ARR87 curve. In essence, the ARR87 curve delivers the majority of the rainfall (60%) in a 20 minute period from minute 10 to minute 30 of the storm. The implication for runoff modelling, especially for small sites such as this mine site, is that the new curves are likely to produce lower peak runoff estimates, and thus lower flood level predictions. Given that the purpose of this assessment is to provide a high-level characterisation of surface water features on the site, it is felt that some conservatism is warranted, and therefore, for the purposes of this assessment the ARR1987 design temporal patterns has been adopted for use in the hydraulic model.

Similarly, conservatism is applied to the consideration of design rainfall losses, which have been set to zero for this assessment. The choice of zero losses is somewhat offset by the use of the rain-on-grid methodology, in that a portion of the incident rainfall will always be trapped in the small non-draining depressions that are always present in a LiDAR terrain dataset.

### 2.2.3 Land Use Data

Satellite imagery was used to assess land use types. Three broad classifications were observed:

- **Bare earth.** Confined to the heap leach pads, parts of the waste rock dump, and previous mine infrastructure areas, bare earth was assigned a Manning's roughness value of n = 0.03
- **Vegetation.** The majority of the mine site and surrounds is vegetated. Without any fine-grained detail on the type and density of plants, vegetated areas were assigned a representative average roughness value of n = 0.06
- **Open water.** Two open water features exist on site – Annie's Dam, and the Mine Pit Lake. As these are storage features as opposed to conveyance features (eg. a river channel), the bed resistance is not particularly important. However for the sake of consistency open water was assigned a roughness value of n = 0.03.

### 2.2.4 Hydraulic Structures

Numerous access roads traverse the site. Where these roads cross gullies or, it is likely that cross-drainage structures were installed to prevent nuisance flooding. However, no data were available to confirm the existence, size, and geometry of any such culverts or bridges. In the absence of this information, professional judgement was used in reviewing the LiDAR to identify likely cross-drainage locations. At such spots, the terrain model was manually edited to "cut" a small channel through the road to preserve free-drainage.

## 2.3 Results and Analysis

### 2.3.1 Model Calibration and Sensitivity Testing

#### Assessment of Critical Duration Storm

Five design storm durations, ranging from 45 minutes to 3 hours, were tested in each model to identify the storm that produced the highest peak water levels. In the eastern model, levels were assessed in the gully to the south of the stormwater pond, whilst in the western model the analysis was conducted in the creek bed about 600 m downstream from Annie's Dam. Time series results of water elevation are presented below in Figure 2-4 and Figure 2-5:

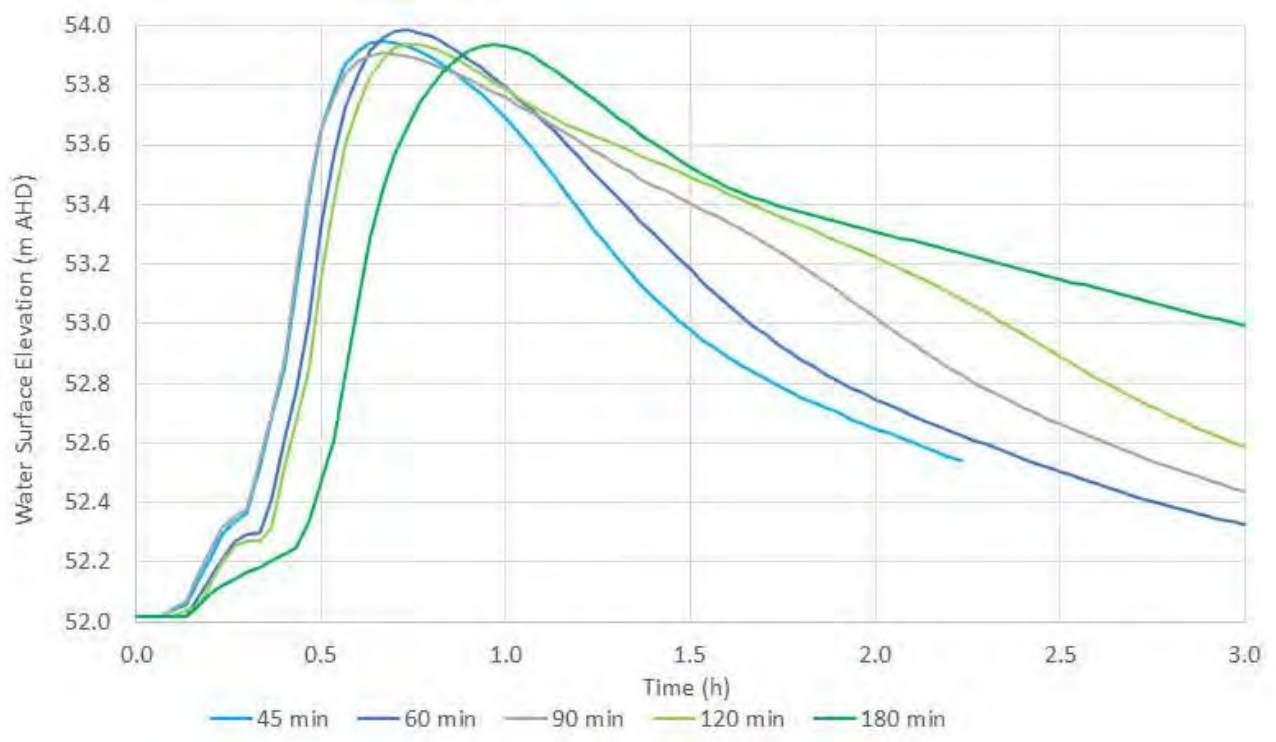



**Figure 2-4 Comparison of Peak Water Levels by Storm Duration – Eastern Model**

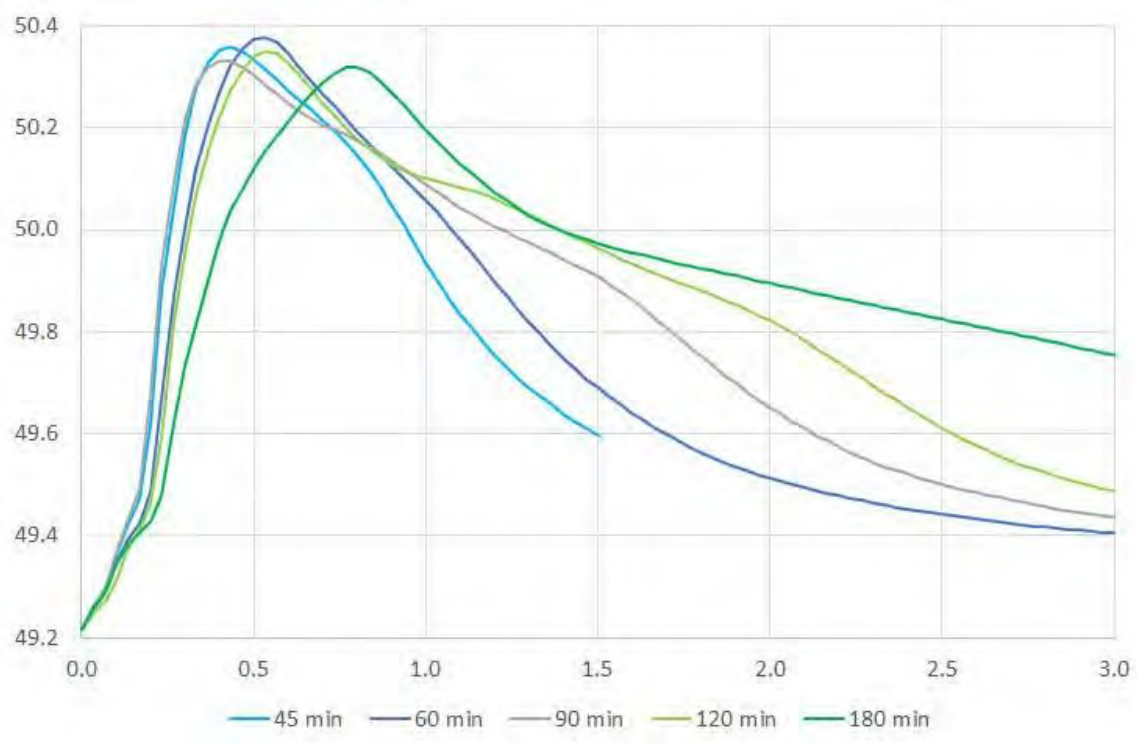



**Figure 2-5 Comparison of Peak Water Levels by Storm Duration, Western Model**

In both cases, the 60 minute storm was identified as producing the highest peak water levels, albeit without a great deal of difference to the surrounding durations. This storm was therefore adopted as the reference event for flood modelling.

### Comparison to Regional Flood Frequency Estimate

Although the local catchment is ungauged, the sensibility of the HEC-RAS runoff estimates can be checked by comparing peak discharges against the Engineers Australia's online regional flood frequency estimation (RFFE) model. The model uses catchment data (size, location of centroid, location of outlet) and regression techniques to estimate design peak discharges, using flood frequency results from similar gauged catchments nearby. Using the free-draining areas of the site only (ie. excluding the terminal catchment to the pit lake, as well as the catchment above Annie's Dam) and carrying out the comparison at the respective HEC-RAS downstream model boundaries, the following results were achieved:

**Table 2-1 Comparison of HEC-RAS Peak Discharge to RFFE**

| Flood Event | Peak Discharge ($m^3/s$) | | | |
|---|---|---|---|---|
| | HEC-RAS 60 minute design storm | Regional Flood Frequency Estimate | | |
| | | Lower Confidence Limit ^ | Calculated Value | Upper Confidence Limit + |
| *Eastern Model (Catchment Area = 2.05 $km^2$)* | | | | |
| 10 % AEP | **37** | 15 | **31** | 66 |
| 1% AEP | **49** | 24 | **77** | 236 |
| *Western Model (Catchment Area = 0.5 $km^2$)* | | | | |
| 10 % AEP | **16** | 4.4 | **10** | 21 |
| 1% AEP | **20** | 7.4 | **23** | 69 |

^ 5th percentile; + 95th percentile

The results of the RFFE agree somewhat with the peak discharge estimates calculated by HEC-RAS. In all cases the HEC-RAS estimate sits within the upper and lower confidence limits of the RFFE. This is a fair result, particularly considering that the RFFE is conceptual in nature and assumes a naturally draining catchment, whereas the HEC-RAS model explicitly routes the rainfall runoff in the hydraulic domain, through highly modified terrain. Overall, the results give some confidence that the estimates of inundation produced by the HEC-RAS model are broadly representative of the likely flood behaviour that could occur on the site.

### 2.3.2 Site Flood Immunity

Peak flood depth maps for the 10%, 1% and 0.1% AEP design flood events are presented in Appendix A. In general, the following observations are made:

- The highly disturbed nature of the catchment, particularly in the Eastern model, leads to numerous areas of shallow (ie. less than 0.2 m) ponding. This is particularly evident around the many small stockpiles at the waste rock dump. In reality, incident rainfall would be likely to pond here for a short time before either seeping into the shallow subsoil, or evaporating away.
- There is reasonable separation between disturbed and undisturbed areas of the site. The pit void acts as a terminal sink for a large portion of the catchment, including the waste rock dump and previous mine infrastructure area. Meanwhile, the gullies to the west of the heap leach pad and ponds drain freely to the outlet (ie. site boundary), separated from the disturbed areas by bunds. Further discussion on specific measures to improve separation is given in Section 4.
- Annie's Dam is not overtopped by the 0.1% AEP 60 minute duration flood event. Although this is not a dam safety analysis, the fact that the dam does not overtop during a large event (particularly given that no consideration was given to bathymetry or to possible spillway discharges) is of some comfort. A longitudinal section of water levels through the dam is shown in Figure 2-6. Nonetheless, this result should not preclude the appropriate dam safety studies from being carried out, as a more detailed analysis may yield different insights.
- The processing ponds and stormwater pond are not overtopped by the 0.1% AEP 60 minute duration flood event. Separation between the ponded volume and adjacent creek flows is maintained. It should be noted that without bathymetric detail no comment can made as to the ponds' adequacy to retain volumes arising from any particular storm event (such as any reference event (eg. 10% AEP 24 hour duration) nominated under the relevant regulations.

Overall it would seem that the site is unlikely to be adversely affected by flooding – the undisturbed sections are largely free draining, and the disturbed sections drain mostly to the pit.

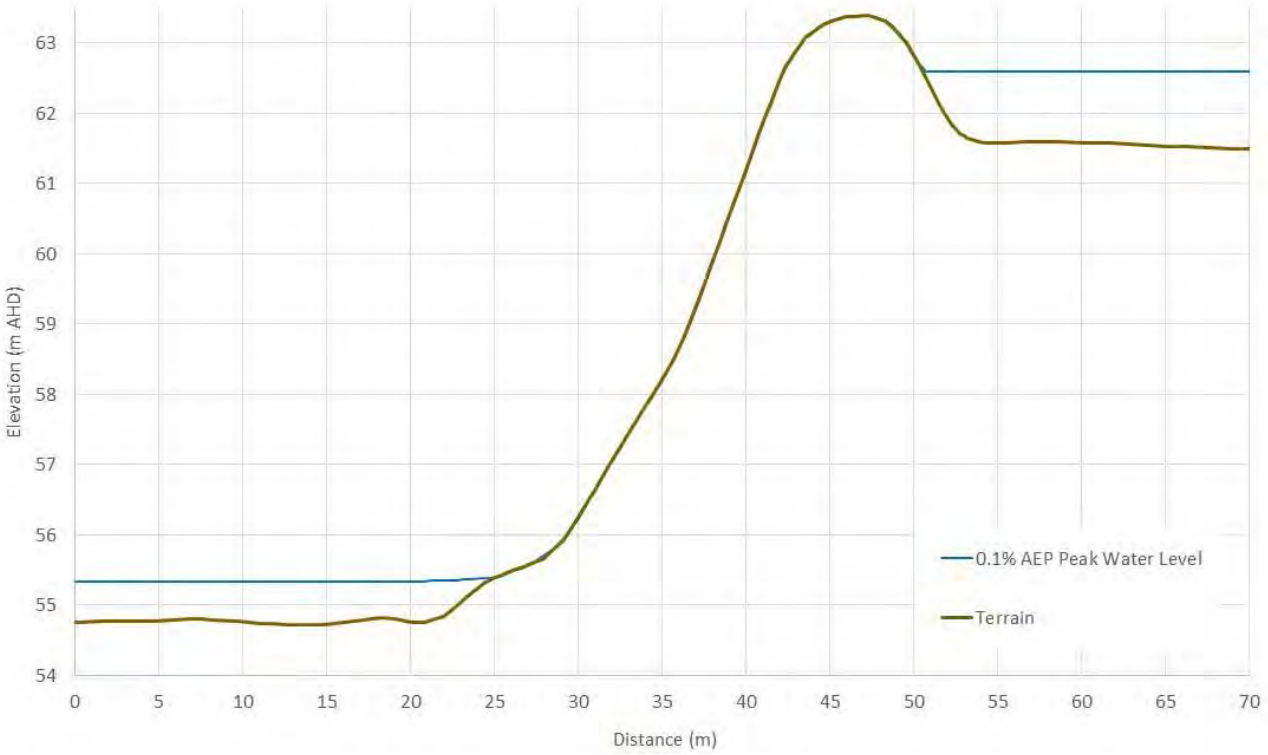



**Figure 2-6 Longitudinal Section of Peak Water Levels through Annie's Dam**

# Section 3 Water Balance

## 3.1 Model Schematisation

A daily timestep water balance model was created in Excel to characterise the dynamics of the mine pit lake. The changes in lake water level is a function of a number of variables, which can broadly be grouped into the categories of geometry, catchment, and sub-surface:

Geometry parameters include the following:

- Volume-height curve. The quantity of water stored at any given elevation;
- Surface area-height curve. The water surface area for any given elevation;
- Dam crest level. Defines the Full Supply Level, and thus maximum storage volume, and partly influences how often the storage is likely to be full or empty.

Of these, the volume-height and area-height relationships are implicit to the pit and cannot be changed except through earthworks (eg. excavating or widening), leaving selection of crest level as the key design parameter available to influence the water balance, should this be necessary.

Catchment variables typically include:

- Catchment runoff. The main surface water contributor to stored volume, runoff is direct function of rainfall depth and contributing area. For this water balance, a simplified depth x area relationship was used to estimate runoff volume.
- Direct rainfall. A minor contributor to stored volume, applied to account for the contribution of local rainfall (ie. that rain which falls directly onto the ponded surface).
- Evaporation. In arid and highly seasonal climates it can be a major contributor to losses from the water balance.
- Seepage. In an unlined storage, some amount of water will be lost to the soil, according to the characteristics of the soil type

Subsurface variables include the relationship of the surrounding water table level to the pit, and the direction and quantum of regional groundwater flow. These variables are considered in detail in CDM Smith's accompanying Desktop Groundwater Assessment Report. The report identifies that groundwater processes are unlikely to play a significant role in influencing the long term water level of the pit, and therefore for the purpose of this water balance, the net seepage flux (ie. loss to or gain from the ground to the stored pit volume) has been set to zero.

## 3.2 Model Data

### Pit Storage and Area Curves

A survey of the pit shell was carried out in 1997, at the cessation of mining. A CAD file of the surveyed levels was provided to CDM Smith, and used as the basis for developing the geometric parameters of the water balance. Based on these data, a pit storage curve (volume as a function of elevation) and pit area curve (surface area as a function of elevation) were developed, as shown below in Figure 3-1 and Figure 3-2.

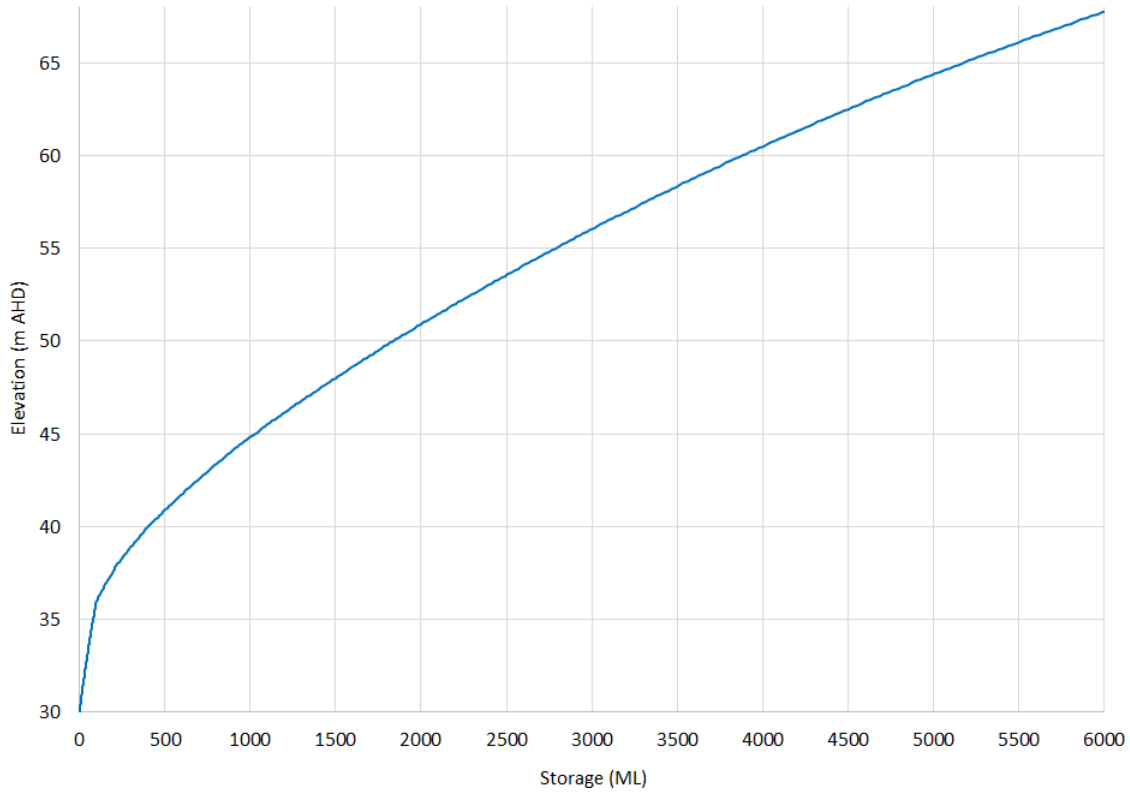



**Figure 3-1 Pit Storage Curve**

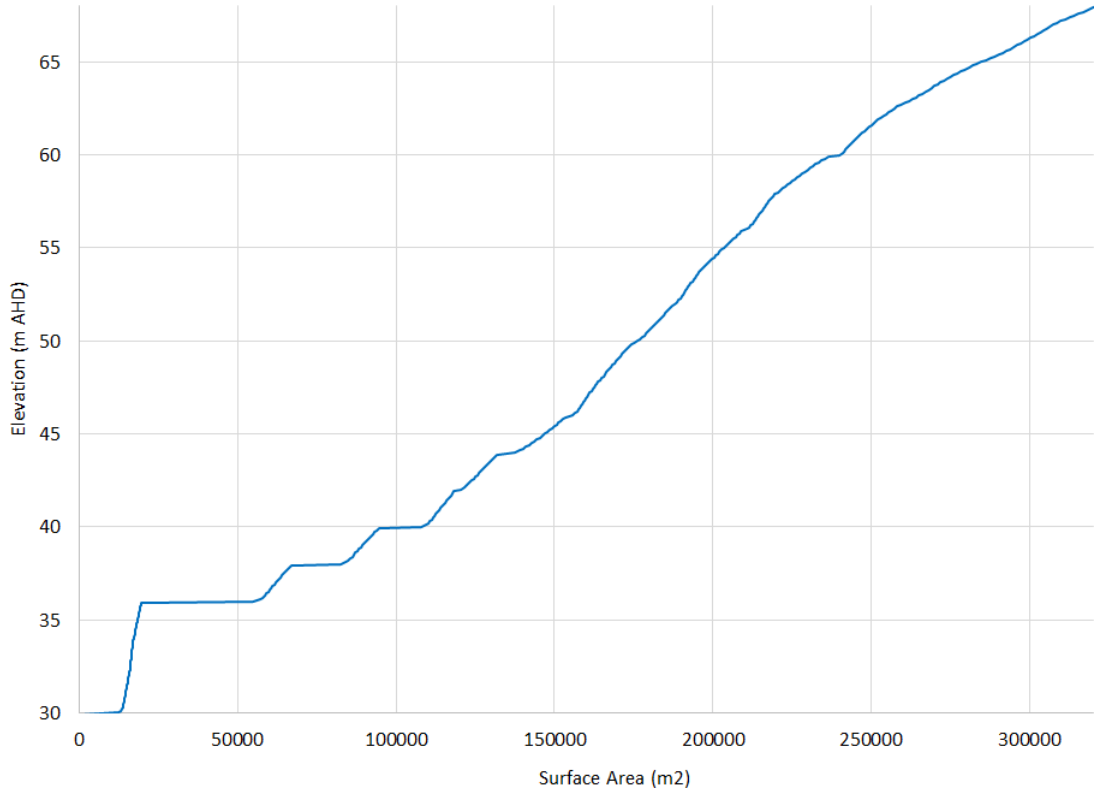



**Figure 3-2 Pit Surface Area Curve**

### Long Term Climate Series

Gridded climate data were obtained from the Bureau of Meteorology's SILO website. This service uses historic rain gauge data and applies an interpolation function to enable long term climate series to be extracted at an area of interest within Australia. The data series obtained included rainfall and evaporation at a daily timestep.

## 3.3 Results and Analysis

The dynamic performance of the weirs can be seen by plotting a time-series of water levels, per Figure 3-3.

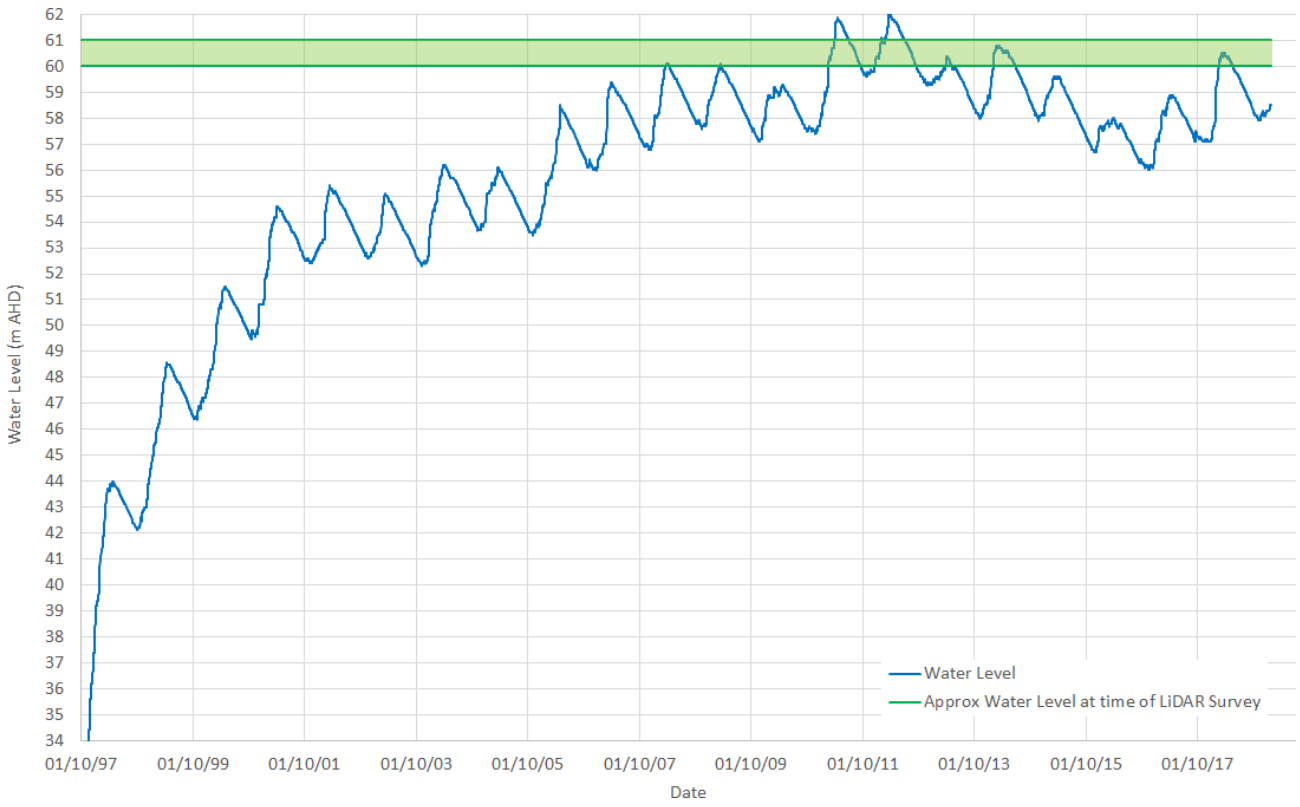



**Figure 3-3 Pit Water Balance from Time of Mine Closure**

The time series begins in 1997, at the time of pit closure. Initially empty, the average pit water level rises approximately 15 m over the subsequent three years. At these low elevations evaporation is constrained by the relatively small free surface area but as time progresses the surface area increases rapidly, allowing for evaporation to increase, bringing the pit water level towards a dynamic equilibrium in the range of 56 m AHD to 62 m AHD. This is *below* the approximate pit crest level (ie. the lowest elevation at which water could spill to a downstream gully) of 67 m AHD.

Also shown on Figure 3-3 is the inferred water level at the time of the LiDAR survey (the exact date of which is not known). It can be seen that this sits close to the equilibrium range, giving confidence that the system dynamics are appropriately represented.

# Section 4 Erosion and Sediment Control

## 4.1 General Principles

An erosion and sediment control plan has been developed using the following guiding principles:

- **Separation of clean runoff from dirty runoff**. In this context, clean runoff is that which originates from undisturbed, naturally vegetated areas. Dirty runoff is any runoff source that can be traced to rain that was incident upon a disturbed area of the site, such as (but not limited to) the waste rock dump and heap leach pads.
- **Maintenance of existing berms**. Separation appears to have been reasonably well catered for by the construction of berms during or at the cessation of mining, and many remain in good condition. Regular maintenance should be carried out to ensure their condition and effectiveness is maintained.
- **Remediation of deficient control measures**. It is clear from the LiDAR that some berms have suffered from erosion, may no longer be performing their intended function, and should be remediated to their original condition.
- **Provision of new control measures**. Concurrently with the preceding point, new control measures may need to be constructed, per the outcome of desktop review and on-site observations.
- **Maintenance of Annie's Dam**. Although this dam has a height of about 9m and is therefore unlikely to be a referrable dam it is still a significant storage, and care should be taken to maintain it in a safe condition.

## 4.2 Site Specific Control Measures

In conjunction with the general principles outlined above, the following data sources were utilised in developing specific control measures for the site:

- Aerial Imagery
- LiDAR-derived contours
- Observations from a site visit carried out by CDM Smith staff on 8 March 2019

A concept sketch of erosion and sediment control measures is provided in Appendix B.

# Appendix A Flood Depth Maps

131°30'0"E

12°5'0"S

12°5'0"S

**Depth (m)**

- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1

131°30'0"E

| R | Details | Date |
|---|---|---|
| 1 | DRAFT | 29/03/19 |
| 0 | FINAL | 16/05/19 |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |



| | | | |
|---|---|---|---|
| DESIGNED | EOB | CHECKED | PD |
| DRAWN | EOB | CHECKED | PD |
| APPROVED | PD | DATE | 29/03/19 |

NOTES: FOR INFORMATION ONLY

Scale @ A3 - 1:9,000

MGA1994 Zone 55

DISCLAIMER

CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DESIGNER

CDM Smith
cdmsmith.com

CLIENT

PRIMARY GOLD

# FIGURE A-1

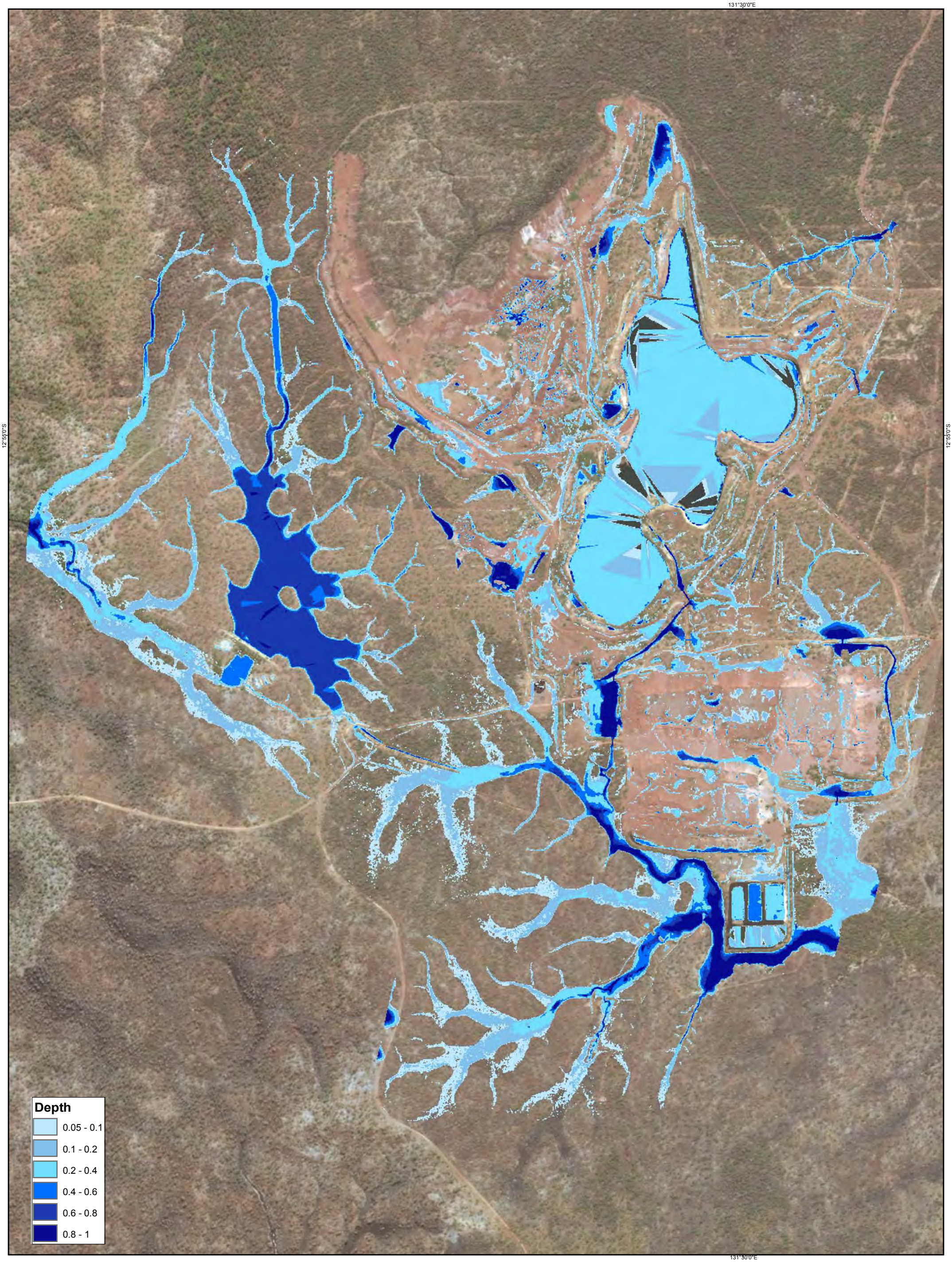
RUSTLER'S ROOST MINE
10% AEP PEAK FLOOD DEPTHS

DRG Ref: Fig A-1_010_060_depth

D:\ArcGIS\38_Rustlers Roost\GIS\Raster\HEC Outputs\03_report figures\Fig A-1_010_060_depth.mxd

131°30'0"E

12°5'0"S




| R | Details | Date |
|---|---|---|
| 1 | DRAFT | 29/03/19 |
| 0 | FINAL | 16/05/19 |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |



| | | | |
|---|---|---|---|
| DESIGNED | EOB | CHECKED | PD |
| DRAWN | EOB | CHECKED | PD |
| APPROVED | PD | DATE | 29/03/19 |

NOTES: FOR INFORMATION ONLY

Scale @ A3 - 1:9,000

MGA1994 Zone 55

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DESIGNER
CDM Smith
cdmsmith.com

CLIENT
PRIMARY GOLD

FIGURE A-2

RUSTLER'S ROOST MINE
1% AEP PEAK FLOOD DEPTHS

DRG Ref: Fig A-2_100_060_depth

D:\ArcGIS\38_Rustlers Roost\GIS\Raster\HEC Outputs\03_report figures\Fig A-2_100_060_depth.mxd

131°30'0"E

12°5'0"S

12°5'0"S

**Depth (m)**

- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1

131°30'0"E

| R | Details | Date |
|---|---|---|
| 1 | DRAFT | 29/03/19 |
| 0 | FINAL | 16/05/19 |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |



| | | | |
|---|---|---|---|
| DESIGNED | EOB | CHECKED | PD |
| DRAWN | EOB | CHECKED | PD |
| APPROVED | PD | DATE | 29/03/19 |

NOTES: FOR INFORMATION ONLY

Scale @ A3 - 1:9,000

MGA1994 Zone 55



DESIGNER

CDM Smith
cdmsmith.com

CLIENT

PRIMARY GOLD

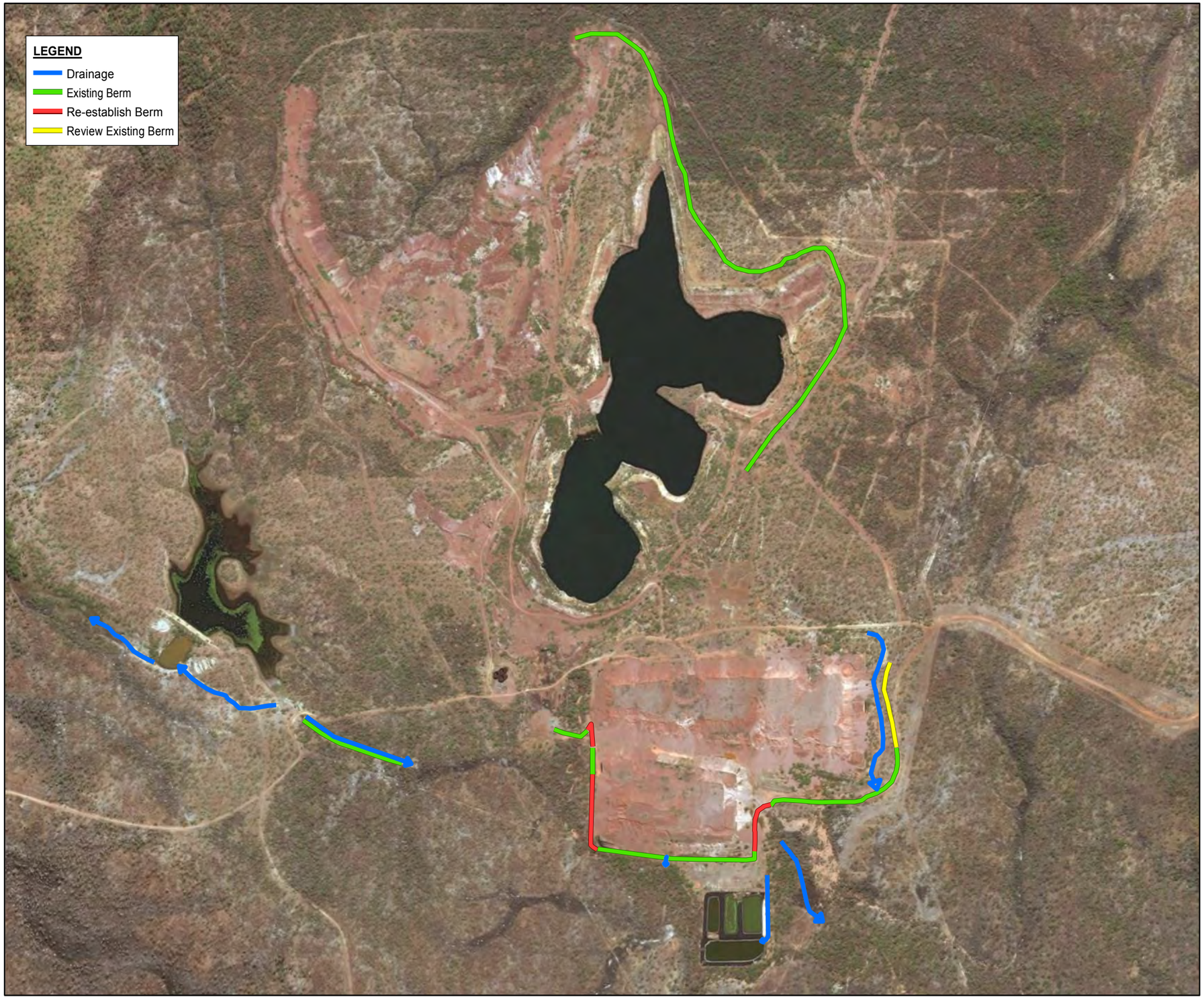
# FIGURE A-3

RUSTLER'S ROOST MINE
0.1% AEP PEAK FLOOD DEPTHS

DRG Ref: Fig A-3_1000_060_depth

D:\ArcGIS\38_Rustlers Roost\GIS\Raster\HEC Outputs\03_report figures\Fig A-3_1000_060_depth.mxd

# Appendix B Erosion and Sediment Control Plan




**GENERAL NOTES:**

1. ALL WORK SHALL BE COMPLETED IN ACCORDANCE WITH ANY AND ALL DEVELOPMENT APPROVALS AND LANDOWNER AND CLIENT REQUIREMENTS.
2. THE MOST RECENT VERSION OF THESE DRAWINGS SHALL BE KEPT ON SITE AND DISTRIBUTED TO SUPERVISORS AND MANAGERS INVOLVED IN SITE EROSION AND SEDIMENT CONTROL.
3. ALL DIMENSIONS SHOWN ON THESE PLANS ARE IN METRES UNLESS OTHERWISE NOTED.
4. THESE PLANS SHOULD BE READ IN CONJUNCTION WITH THE PRIMARY EROSION AND SEDIMENT CONTROL PLAN ENV-ESCP-001 PREPARED BY CDM SMITH DATED 3 MARCH 2019.
5. ALL LINE WORK DENOTING THE LOCATION OF SITE FOOTPRINTS, BOUNDARIES, EXISTING AND PROPOSED ROADS, SLOPES AND DRAINAGE LINES IS APPROXIMATED AND IS BASED ON MAPS PROVIDED BY OTHERS. CDM SMITH ACCEPTS NO RESPONSIBILITIES IN INACCURACIES IN DATA PROVIDED BY OTHERS.
6. THESE PLANS HAVE BEEN PREPARED WITH REFERENCE TO THE IECA BEST PRACTICE GUIDELINES (2008).
7. PRIMARY GOLD AND CONTRACTORS SHALL TAKE ALL NECESSARY MEASURES TO MINIMISE EROSION ON SITE AND PREVENT SEDIMENT LADEN RUNOFF FROM SITE FROM ENTERING WATERWAYS. THIS INCLUDES ADJUSTMENTS AND MODIFICATIONS TO THESE PLANS IN THE FIELD AS REQUIRED TO ACHIEVE THAT PURPOSE.

**EARTHWORKS**

8. PRIMARY GOLD AND CONTRACTORS SHALL DO ALL THAT IS PRACTICABLE TO MINIMISE EROSION DURING OPERATIONS.
9. PRIMARY GOLD AND CONTRACTORS SHALL BE RESPONSIBLE FOR LOCATING ALL EXISTING UTILITIES PRIOR TO COMMENCING EARTHWORKS.
10. PRIMARY GOLD AND CONTRACTORS SHALL BE RESPONSIBLE FOR THE PROTECTION AND REINSTATEMENT OF ANY AND ALL EXISTING SERVICES WHICH MAY BE DAMAGED AND/OR DISTURBED DURING OPERATIONS.
11. CDM SMITH ACCEPTS NO RESPONSIBILITY FOR DAMAGE TO UTILITIES DURING OPERATIONS.

**EROSION AND SEDIMENT CONTROL**

12. DISTURBED AREAS WITHIN THE EXCLUSION ZONES SHALL BE TREATED WITH A NON REWETTABLE SOIL STABILISING POLYMER (SUCH AS VITAL BON MATT STONEWALL) WITHIN EITHER:
    - TWO WEEKS OF DISTURBANCE; OR
    - PRIOR TO ANY FORECASTED RAINFALL
13. POLYMER SHALL BE DILUTED AND APPLIED ACCORDING TO MANUFACTURER RECOMMENDATIONS .
14. ALL TEMPORARY DRAINAGE STRUCTURES AND ESC CONTROLS SUCH AS DIVERSION BERMS AND SEDIMENT TRAPS SHALL BE INSTALLED IN ACCORDANCE WITH IECA STANDARD DRAWINGS OR AS OTHERWISE SPECIFIED IN ESCP ENV-ESCP-001.
15. SEDIMENT SHALL BE CAPTURED AND RETAINED ON SITE AS CLOSE AS POSSIBLE TO THE SOURCE AND MAINTAINED WITHIN EXCLUSION ZONE BOUNDARIES AS FAR AS PRACTICABLE.
16. FLOC BLOCS INCORPORATED INTO CHECK DAMS TO BE PLACED IN MAJOR DRAINAGE LINES AT MAXIMUM 80M INTERVALS TO ASSIST IN FLOCCULATION OF EXCLUSION ZONE WATER.
17. SEDIMENT FENCING (OR ALRTERNATIVE GRAVEL FILTER BUND) IS TO BE PROVIDED DOWNSLOPE OF ANY DISTURBED AREA THAT DOES NOT DRAIN TO AN ALTERNATIVE SEDIMENT CONTROL AT THE DISCRETION OF THE SITE SUPERVISOR OR ENVIRONMENTAL MANAGER.
18. SEDIMENT FENCES MUST BE FIRMLY ANCHORED INTO THE GROUND FOR THE ENTIRE LENGTH. SEDIMENT FENCES (AND GRAVEL FILTER BUNDS) MUST INCLUDE SMAL 'RETURNS' TO MINIMISE THE RISK OF WATER FLOWING ALONG RATHER THAN THROUGH THE FENCE AS PER THE MAXIMUM INTERVALS SPECIFIED ON IECA SD SF-01.
19. THE EROSION HAZARD AT THE SITE WILL BE MINIMISED TO AS LOW AS PRACTICABLE BY MINIMISNG LAND DISTURBANCE.

**DUST SUPPRESSION**

20. DUST SUPPRESSION SHALL BE CARRIED OUT WHENEVER NECESSARY TO MININSE SEDIMENT BECOMING AIRBORNE DUE TO WIND EROSION.
21. ENSURE A RELIABLE WATER SOURCE AND/OR DUST SUPRESSION MANAGEMENT SYSTEM IS AVAILABLE ON SITE PRIOR TO COMMENCING ANY GROUND DISTURBING WORKS.

**STABILISATION**

22. UNDERTAKE PROGRESSIVE STABILISATION OF SURFACES AS THEY ARE COMPLETED.
23. ACCESS TRACKS AND HAUL ROADS ARE TO BE STABILISED WITH ROAD BASE, CRUSHED ROCK, POLYMER OR EQUIVALENT AFTER THE COMPLETION OF FORMATION.
24. PRODUCTS THAT CAN ACHIEVE TEMPORARY SITE LOCK DOWN ARE VITAL BON MATT STONEWALL, VITAL P47, GEOTEXTILE FABRIC, HYDROMULCH, COARSE MULCH, GLUON OR EQUIVALENT.

**SLOPE LENGTHS / BATTER GRADIENTS**

25. SLOPE LENGTHS ARE TO BE MAINTAINED AT MAXIMUM 80 METRE INTERVALS ACROSS ALL DISTURBED LAND DURING RAINFALL.
26. DIVERSION BUNDS, EARTH BANKS, SANDBAGS OR EQUIVALENT SHOULD BE IN PLACE PRIOR TO RAINFALL TO ACHIEVE THIS.

**SITE INSPECTIONS, MONITORING AND MAINTENANCE**

27. INSPECTIONS MUST BE CARRIED OUT IN ACCORDANCE WITH A SITE INSPECTION PROGRAM AT LEAST WEEKLY; WITHIN 24 HRS OF EXPECTED RAINFALL AND WITHIN 24 HOURS FOLLOWING RAINFALL THAT CAUSES RUNOFF.
28. A SITE INSPECTION CHECKLIST SHALL BE EMPLOYED AT THE SITE.
29. DURING INSPECTIONS, PARTICULAR ATTENTION MUST BE PAID TO: THE STABILITY OF SEDIMENT CONTROLS IN DRAINAGE LINES, COMPACTED EARTH BUNDS, SEDIMENT FENCES; MAINTAINING ESC IN A FUNCTIONAL CONDITION; REMOVING TRAPPED SEDIMENT FROM CONTROLS AS REQUIRED TO MAINTAIN CAPACITY.
30. ADDITIONAL SEDIMENT AND EROSION CONTROLS MUST BE INSTALLED OR CONSTRUCTED AS NECESSARY TO ENSURE THE DESIRED WATER CONTROL IS ACHIEVED.
31. AN APPOPRIATE WASH DOWN BAY MUST BE AVAILABLE FOR USE ON SITE.
32. SAFE STORAGE AREAS FOR FUELS AND CHEMICALS MUST BE PROVIDED.
33. ANY SEDIMENT ACCUMULATED IN TRAPPING DEVICES IS TO BE REMOVED AND DEPOSITED IN A LOCATION WHERE IT IS ADEQUATELY CONTAINED.
34. ESCS IN THIS PLAN MAY VARY DEPENDING ON SITE CONDITIONS AND CONSTRAINTS. PROGRESSIVE ESCPS ARE TO BE PRODCUED AS REQUIRED TO REFLECT ANY CHANGES.

| R | Details | Date |
|---|---|---|
| A | DRAFT | 26/02/19 |
| 0 | FINAL | 03/04/19 |
| - | - | |
| - | - | |
| - | - | |
| - | - | |
| - | - | |



| | | | |
|---|---|---|---|
| DESIGNED | RDM | CHECKED | |
| DRAWN | MG | CHECKED | |
| APPROVED | | DATE | 03/04/19 |

Notes:

0 50 100 200 Metres

Scale @ A3 - 1:10,000
GCS GDA 1994 MGA Zone 52

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL
CPESC®
Russell D. Merz
No. 2493

DESIGNER
CDM Smith
cdmsmith.com

CLIENT
Primary Gold

FIGURE 1

RUSTLERS ROOST PRELIMINARY EROSION AND SEDIMENT CONTROL PLAN

DRG Ref: **1000338-001-EEVA.RR-ENV-ESCP-001_10_4**

\\brbsvr1\DARPRO\Project\1000338 - Rustlers Roost Water Assessments\7Work\3GIS_backup\1000338-001-EEVA.RR-ENV-ESCP-001_10_4.mxd

## 10.2 Groundwater Assessment

Primary Gold Ltd

# Rustler's Roost Project – desktop groundwater assessment

15 May 2019

CDM Smith

listen. think. deliver.

# Table of Contents



# Figures



# Tables

# Tables

# Document history & status

| Revision | Date issued | Reviewed by | Approved by | Date approved | Revision type |
|---|---|---|---|---|---|
| Rev-A | 05/04/2019 | P. Davey | P. Davey | 05/04/2019 | Draft |
| Rev-0 | 15/05/2019 | P. Davey | P. Davey | 15/05/2019 | Final |
| | | | | | |
| | | | | | |

# Distribution of copies

| Version | Date issued | Quantity | Electronic | Issued to |
|---|---|---|---|---|
| Rev-A | 05/04/2019 | 1 | Pdf | HangKing Australia |
| Rev-0 | 15/05/2019 | 1 | Pdf | HangKing Australia |
| | | | | |
| | | | | |

| | |
|---|---|
| **Printed:** | 15 May 2019 |
| **Last Saved:** | 15 May 2019 |
| **File Name:** | PGO-1000338-RPT-GW-001-Rev0.docx |
| **Author:** | P. Howe |
| **Project Manager:** | P. Davey |
| **Client:** | Primary Gold Ltd |
| **Document Title:** | **Rustler's Roost Project – desktop groundwater assessment** |
| **Document Version:** | Rev-0 |
| **Project Number:** | 1000338 |

# Section 1 Introduction

## 1.1 Background

Primary Gold Ltd (PGO) has engaged CDM Smith Australia Pty Ltd (CDM Smith) to undertake a desktop review of hydrogeological information available for the Rustlers Roost Project (Figure 1). The review is required to identify data and information gaps relating to the understanding of effects that historic mining and processing related activities may have had or be having on water resources. On the basis of the review outcomes, recommendations are made regarding a works program designed to address the identified data and information gaps.

## 1.2 Approach

The overall approach to undertaking the review allows a measured assessment of the possible groundwater-related issues at the Rustlers Roost site (the Site) to assist in communicating outcomes to PGO and other stakeholders (e.g. Northern Territory Department of Primary Industry and Resources) prior to moving ahead with any works recommended to address possible knowledge gaps. The hydrogeological review adopts the general methodology outlined in the mining risk framework developed by the National Water Commission, as part of the National Water Initiative (Howe 2011). This is a risk-based framework developed to promote a rigorous, transparent and consistent approach to assessing and managing potential impacts of mining activities on groundwater resources and the receptors that rely partially or totally on those resources.

The framework consists of several steps (see Figure 2) to guide groundwater impact assessments in a logical, structured and defendable manner, the first, third and fourth steps being of relevance to this report:

- **Step 1 Context Setting** places the Site into a regional context, focusing on hydrogeology but also providing a brief overview of hydrology and geology. The development of a conceptual hydrogeological model based on the available data is a key component of this stage of the assessment.
- **Step 3 Groundwater Effects Assessment** considers mining-related activities that have the potential to alter the groundwater regime (see Table 6). The effects are described in the context of changes to the quantity and quality of groundwater, surface water - groundwater interaction and physical disruption of aquifers.
- **Step 4 Receptor Exposure Assessment** considers the possible exposure pathways between potentially sensitive groundwater receptors (i.e. groundwater users) and direct effects associated with mining and processing.

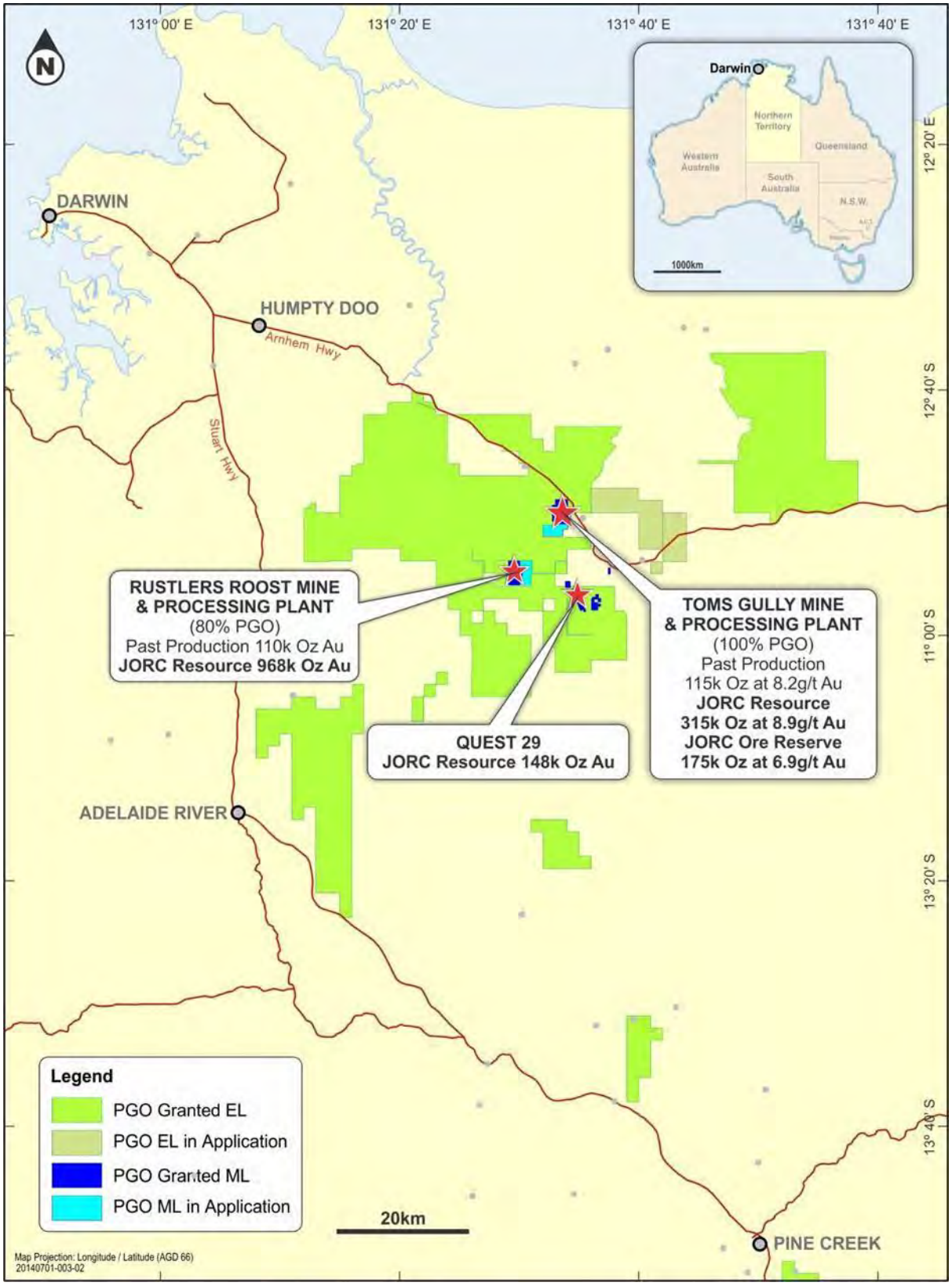



**Figure 1** **Project locality plan** (source: PGO)

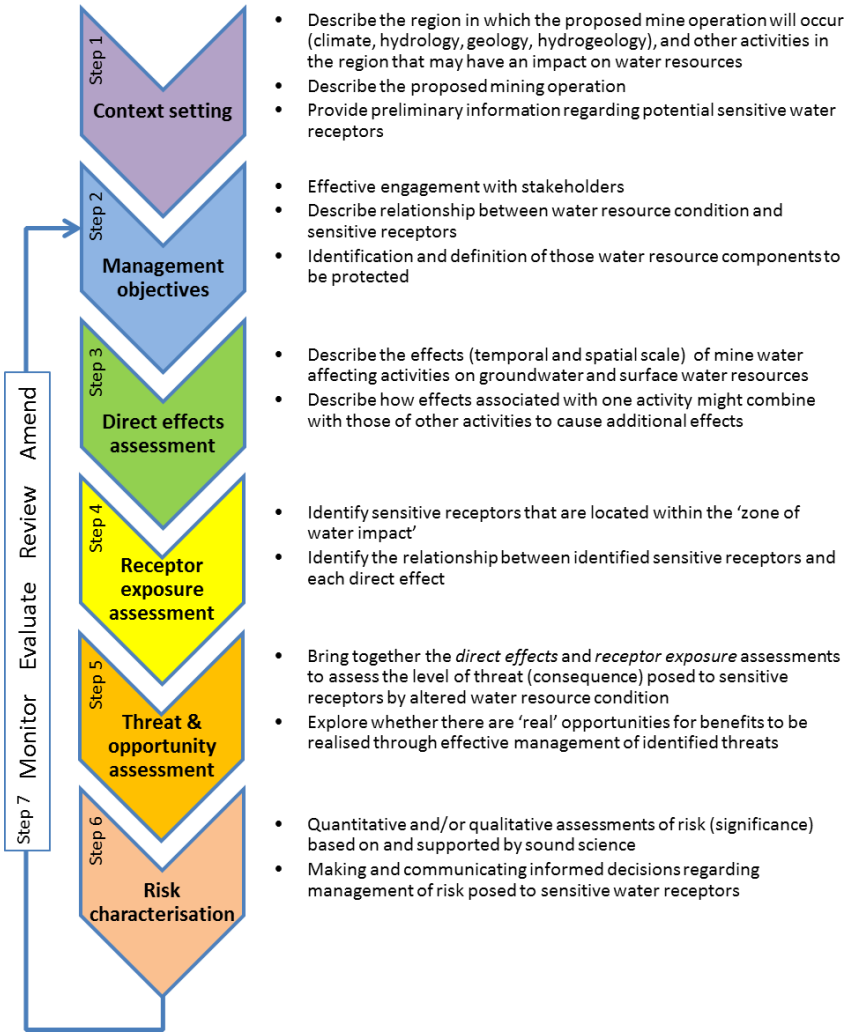



**Figure 2** **NWC risk assessment framework for cumulative effects assessment of mining on groundwater and connected systems** (after Fuentes et al. 2014)

**Table 1** **Key water affecting activities of relevance to the hydrogeological review**

| Water affecting activity | Description |
|---|---|
| Abandoned mine pits (voids) | Where the base of pit voids occur below the pre-mine water table, groundwater will discharge into the void until a quasi-equilibrium is reached between inflow (groundwater and incident rainfall) and evaporative discharge. Where there is PAF material in pit walls, the potential for AMD generation exists, which has the potential to impact pit lake water quality (dissolved metals and pH). If these PAF materials can be or are inundated, the potential for AMD generation can be expected to diminish.<br>Where pit voids are allowed to fill (partially or completely) with surface water (rainfall runoff and incident rainfall) the potential for the water bodies to recharge groundwater exists.<br>Pit water bodies that are allowed to overtop (offsite or to other onsite water bodies) have the potential to impact on the downstream receiving environment water quality. |

**Table 1 Key water affecting activities of relevance to the hydrogeological review** (cont.)

| Water affecting activity | Description |
|---|---|
| Waste rock dumps | Waste rock landforms are usually above ground and near to operating mine pits and underground developments. In some cases, they may be formed within abandoned pits and workings.<br>During development, waste rock storages may have recharge potential beyond that of native land surfaces and so could result in local water table mounding and possible water discharge from the landform toes. Following rehabilitation, the reduced potential for enhanced recharge to occur should be managed as a closure outcome.<br>Any PAF materials stored with the landforms (above ground or in backfilled pits) have the potential to generate AMD, which could then be mobilised as seepage to groundwater. |
| Heap leach pad | Heap leach pads are typically operated to maintain high levels of saturation to assist in leaching of minerals from mined materials, and are formed above ground. Depending on whether the facilities are lined (e.g. with clay or high density polyethylene (HDPE), the degree of seepage of leachate from the facilities will vary. Where seepage occurs, local water table mounding and possible water logging of the shallow soil profile around the facilities may occur.<br>Leachate from these facilities can comprise a range of solutes having the potential to be of environmental concern (e.g. metals, salts, and additives used in the process).<br>Above ground facilities will drain to some extent, depending on seasonal influences and rehabilitation design, after closure but the generation of leachate will likely occur for some time. |

# Section 2 Data and information sources

## 2.1 Overview

A listing of sources of data and information accessed as part of the review presented in this report is provided in this section. Much of the data and information have been provided by PGO but additional publicly available references have also been accessed, including:

- Fuentes R., Howe P.J and Glue S. 2014. Assessing and communicating the effects of mining on sensitive water receptors within a social licence to operate context. Water in Mining 2014 Conference. Gecamin, Santiago de Chile.
- Howe, P. 2011. Framework for assessing potential local and cumulative effects of mining on groundwater – project summary report, Waterlines report, National Water Commission, Canberra.
- Northern Territory Government. 2019. Water data portal. Accessed 11 February 2019.
- Tickell S.J. 2013. 1:2 000 000 hydrogeological map sheet of the Northern Territory. Water Resources Division. Dept. Land Resource Management. Darwin.

## 2.2 Rustlers Roost

- Exploremin. 2005. Annual report Y/E 20/06/05 EL 9154 Rustler's Roost North, Northern Territory, Australia. Vol. 1. Prepared for Rustler's Roost Mininig Pty Ltd by Exploremin Pty Ltd.
- PGO. 2017. Mining management plan - Rustlers Roost project area 2016-2017 care and maintenance tenements MLN 1083. Primary Gold Ltd, July 2017.
- Valdora. 1994. Rustler's Roost Gold Mine Preliminary Environmental Report. Prepared by Valdora Minerals N.L., January 1994.
- William. 1997. Annual report Mineral Claims N26710N2683 Rustler's East. Prepared by William Australia N.L.

## 2.3 Tom's Gully

- GHD. 2018. Toms Gully EIS – Baseline studies groundwater assessment & modelling. Prepared by GHD for Primary Gold Ltd, March 2018.
- GHD. 2018. Toms Gully Gold Project – Site water balance. Prepared by GHD for Primary Gold Ltd, July 2018.

# Section 3 Data and information review

## 3.1 Hydrology

### 3.1.1 Catchment description

The Site is situated near a catchment divide at the headwaters of Mount Bundey Creek, which drains to the east. The Mount Bundy Creek catchment has a total area of approximately 150 km$^2$ and is a tributary catchment of Mary River. The confluence of Mount Bundy Creek and Mary River is located near the Arnhem Highway crossing of Mount Bundey Creek (Figure 1). Like most creeks in the Top End, Mount Bundy Creek is ephemeral and typically only flows for four to six months of the year during the wet season (November to April inclusive).

The local catchment comprises a series of ridges and dissected hills that are drained by small steep rivulets, which converge into two main creek channel, flowing to the west from Annie's Dam and to the east from near the former ROM pad (Figure 3). The catchment upstream of Rustler's Roost operations covers around 2.2 km$^2$ and is characterised by outcropping rock. Runoff from the catchment is expected to occur rapidly following rainfall events.

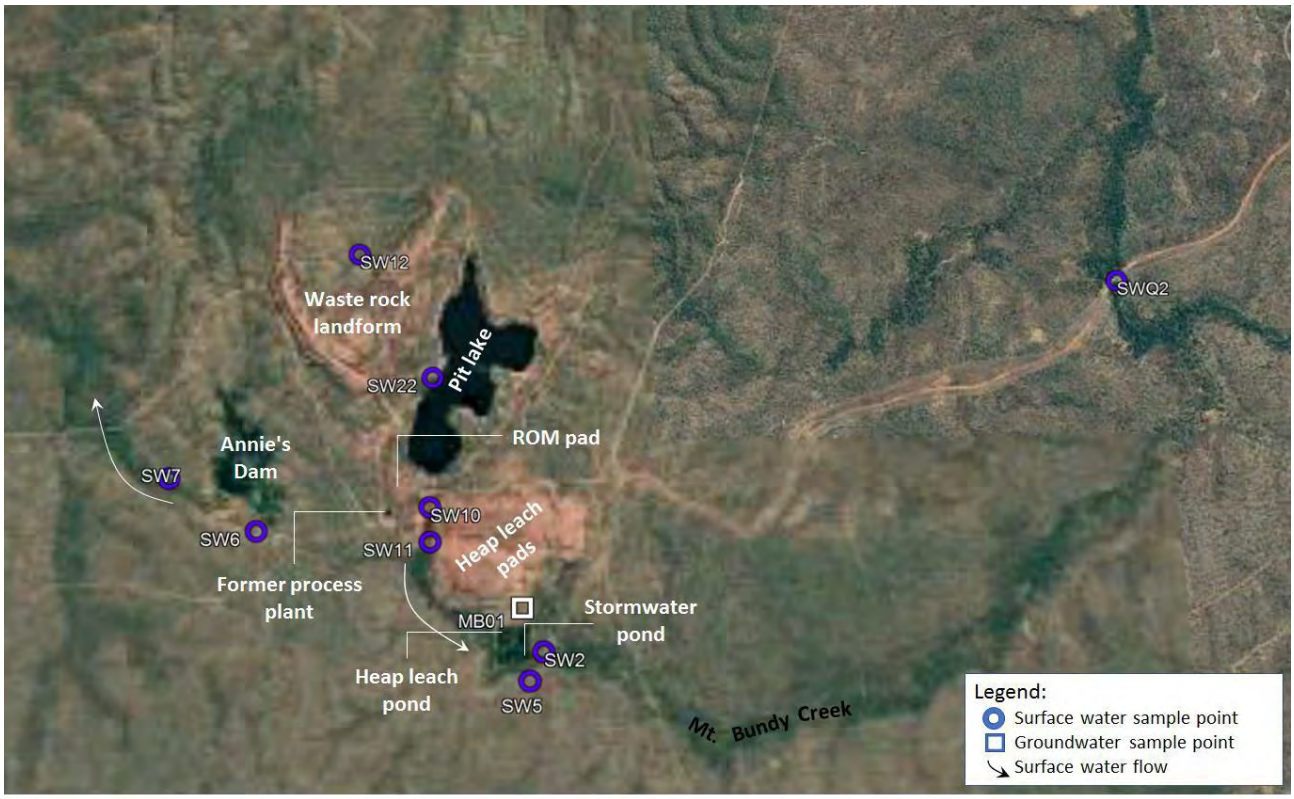



**Figure 3** **Site locality plan**

The landscape has been altered due to prior mining and processing operations at the Site. Today, there are two permanent water bodies located on the Site – the pit lake and Annie's Dam. Water stored in the pit is likely a combination of stormwater runoff, incident rainfall and (possibly) groundwater (assuming the pit lake surface lies below the pre-mine water table), whilst Annie's Dam is likely a combination of just stormwater runoff and incident rainfall.

There are no flow data available for Mount Bundey Creek. However, average annual runoff for most small to medium-sized ephemeral creeks in the Top End usually accounts for between 10 and 30 % of incident rainfall. Based on the

available flow records held by the Power and Water Authority (PAWA), the average annual runoff in the Mary River catchment approximated 23 % of the mean annual rainfall (310 mm).

### 3.1.2 Surface water quality

## 3.2 There are nine surface water quality monitoring locations around the Site, these locations are shown on Figure 3. Hydrogeology

### 3.2.1 General

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2013). The Site is situated near the northern flank of the Pine Creek Geosyncline. Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments, and are recharged by direct infiltration of rainfall and stream run-off. A single monitoring well (MB01) is located on the Rustler's Roost site, immediately downstream of the heap leach pad (Figure 3). Table 4 presents details of the groundwater monitoring and Table 5 presents reported results of field measurements and laboratory analyses. The results show:

- The water table likely occurs within basement rocks, and in Cainozoic sediments formed in topographic lows, where they occur
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons
- Groundwater quality is similar to end of dry season surface water quality, potentially indicating a degree of groundwater and surface water connectivity

Table 4Table 2 presents details of the surface water monitoring and Table 3 presents reported results of field measurements and laboratory analyses undertaken on water collected at the end of the dry and wet seasons. The results show:

- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons
- Surface water is fresh and acidic to neutral, with the most acidic samples collected from and downstream of Annie's Dam and on the northern side of the waste rock landform
- Many of the dissolved metals are reported at lower concentrations at the end of the wet season, with the exception of Al
- Elevated concentrations of Fe are typical in surface water samples
- Mn concentrations are elevated below Annie's Dam
- Al concentrations are elevated on the northern side of the waste rock landform
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons
- With the exception of Al, many of the dissolved metals may display freshening trend associated with wet season recharge
- Pit water quality is distinctly different to all of surface water features, particularly in terms of As, Fe and Zn concentrations

The available data are considered suitable for setting site specific surface water triggers and to assist in developing a water monitoring plan for the Site.

## 3.3 Geology

### 3.3.1 Regional

The Site is located within the Pine Creek Geosyncline, which consists of an extensive but poorly exposed sequence of low to medium metamorphic grade, early Proterozoic sediments (pellites and psammites) deposited in a shallow intra-cratonic geosyncline that overlies a late Archean granitic basement. The sediments have been intruded and overlain by late to early Proterozoic felsic volcanics and by middle Proterozoic platform sequences.

The dominant rock type beneath the Site belong to the Mt Bonnie Formation rocks of the South Alligator Group (Figure 4). These rocks largely comprise shallow marine, Fe-rich tuffaceous sediments that vary from open to tightly folded about a gently south plunging axes, with metamorphism accompanying this deformation. The group includes the Koolpin Formation, Gerowie Tuff and Mount Bonnie Formation, which is a transitional unit comprising interbedded units of the older Koolpin Formation and younger Burrell Creek Formation (Exploremin, 2005), a Proterozoic marine turbidite. The Koolpin Formation and Gerowie Tuff units are exposed to the immediate north of the lease (Figure 4).

Local to the Site, the sequence of metamorphosed sediments has been intruded and further altered by the Mount Bundey Granite and dolerite dykes.

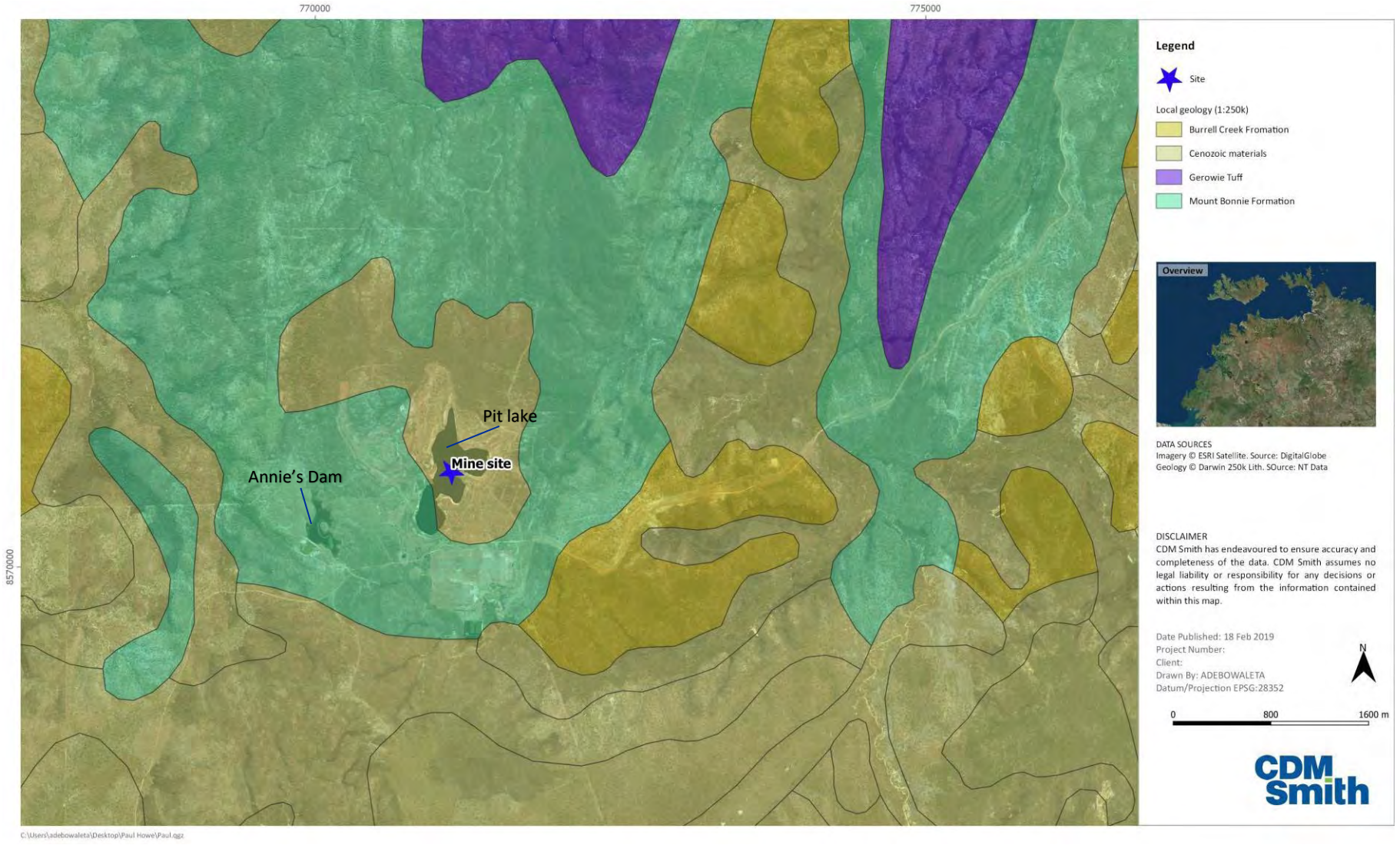



**Figure 4** **Surface geology**

**Table 2 Surface water monitoring program**

| Well no. | Sample location | Co-ordinate (m AMG; WGS84) | | | Analysis type [8] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Easting | Northing | 0 ^ | 1 ^ | 2 ^ | 3 ^ | 4 ^ |
| SWQ2 | Mt Bundy Creek crossing on Rustlers Roost access road, downstream | 52L | 774 154 | 8 571 092 | | M | M | M | M |
| SW2 | Downstream of the storm water pond | | 771 428 | 8 569 426 | | M | M | M | M |
| SW5 | Storm water pond | | 771 365 | 8 569 398 | | Q | Q | Q | Q |
| SW6 | Spillway of Annie's Dam. | | 770 130 | 8 570 006 | | Q | Q | Q | Q |
| SW7 | Downstream of Annie's Dam Spillway | | 769 723 | 8 570 262 | | Q | Q | Q | Q |
| SW10 | RoM drainage before influence from heap leach | | 770 919 | 8 570 094 | | Q | Q | Q | Q |
| SW22 | Rustlers Roost pit | | 770 933 | 8 570 702 | | Q | Q | Q | Q |
| SW11 | D/S of SW10 in drain around heap leach pad, at culvert | | 770 920 | 8 569 935 | | M | M | M | M |
| SW12 | Northern Drainage of WRD. | | 770 590 | 8 571 310 | | M | M | M | M |

Notes: ^ 0 -standing water level
1 – field parameters (pH, EC, temp. flow)
2 – total and filtered metals (Al, As, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, U, Zn
3. Major ions (Ca, K, Na, Mg, SO4)
4 – titratable acidity, alkalinity, hardness (CaCO3), total suspended solids
^^ Frequency of sampling
M is monthly (wet season), Q is quarterly (Jan/Apr/Jul/Oct), B is biannual (first flow Oct/Nov, recessional flow Apr/May

**Table 3 Surface water sampling results for monitoring well MB01**

| Date | Physico-chemical | | Dissolved metals [1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | EC [2] | Al | As | Cd | Co | Cr | Cu | Fe | Pb | Mn | Ni | U | Zn |
| ***Sample location SWQ2 (Mt Bundy Creek on Access road)*** | | | | | | | | | | | | | | |
| 28/11/16 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 26/3/18 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***Sample location SW2 (below Stormwater pond)*** | | | | | | | | | | | | | | |
| 28/11/16 | 6.4 | 38 | 160 | 7 | ND | ND | ND | ND | 250 | ND | 12 | ND | ND | 2 |
| 26/3/18 | 7.4 | 83 | ND | 4 | ND | ND | ND | ND | 50 | ND | ND | ND | ND | ND |
| ***Sample location SW5 (Stormwater pond)*** | | | | | | | | | | | | | | |
| 4/11/16 | 7.6 | 220 | 10 | 35 | | 1 | | | 400 | | 120 | 1 | | 1 |
| 26/3/18 | 6.4 | 13 | 30 | 2 | | | | | 80 | | | | | 1 |
| ***Sample location SW6 (Annie's Dam spillway)*** | | | | | | | | | | | | | | |
| 4/11/16 | 5.6 | 20 | | | | | | | 320 | | 33 | | | 1 |
| 26/3/18 | 5.6 | 10 | 50 | | | | | | 190 | | 15 | | | |
| ***Sample location SW7 (Below Annie's Dam spillway)*** | | | | | | | | | | | | | | |

| Date | Physico-chemical | | Dissolved metals [1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | EC [2] | Al | As | Cd | Co | Cr | Cu | Fe | Pb | Mn | Ni | U | Zn |
| 4/11/16 | 5.8 | 21 | 10 | | | | | | 210 | | 590 | | | 8 |
| 26/3/18 | 6 | 13 | 90 | | | | | | 220 | | 94 | | | |

**Table 3 Surface water sampling results for monitoring well MB01** (cont.)

| Date | Physico-chemical | | Dissolved metals [1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | EC [2] | Al | As | Cd | Co | Cr | Cu | Fe | Pb | Mn | Ni | U | Zn |
| ***Sample location SW10 (ROM pad up-gradient of heap leach pads)*** | | | | | | | | | | | | | | |
| 20/12/16 | 7.1 | 55 | 20 | 8 | ND | ND | ND | ND | 50 | ND | ND | ND | ND | ND |
| 26/3/18 | 6.1 | 8 | 40 | ND | ND | ND | ND | ND | 60 | ND | ND | ND | ND | 1 |
| ***Sample location SW11 (Below heap leach pad)*** | | | | | | | | | | | | | | |
| 28/11/16 | 7.3 | 82 | 20 | 14 | | | | 2 | 60 | | 24 | | | |
| 26/3/18 | 6.3 | 21 | 30 | 1 | | | | | 180 | | | | | |
| ***Sample location SW12 (Below Waste Rock Landform, north)*** | | | | | | | | | | | | | | |
| 30/12/16 | 5.4 | 13 | 70 | | | | | 1 | 50 | | 18 | | | 2 |
| 26/3/18 | 5.6 | 10 | 140 | 1 | | | | | 150 | | 18 | | | |
| ***Sample location SW22 (Pit lake)*** | | | | | | | | | | | | | | |
| 4/11/16 | 6.2 | 25 | 65 | 2 | 1 | 1 | 1 | 5 | 28 | ND | 38 | 2 | ND | 32 |
| 26/3/18 | 6.9 | 21 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Notes: 1. As $\mu$g/L (rounded to nearest 1 mg/L)
2. As $\mu$S/cm
- not measured
ND non-detect or below LoR

The Early Proterozoic metasediments in the vicinity of the lease have undergone one major phase of folding resulting in tight folds in the South Alligator and Finniss River groups, and tight to isoclinal folds in the underlying Mount Partridge Group fluvial sediments. Fold axes in all groups are sub-horizontal to shallow, plunge south and trend 180 to 200 degrees.

Cenozoic sediments drape these rocks to variable thicknesses.

### 3.3.2 Local

The Site is predominantly underlain by folded greywacke and mudstone units, with greywacke units varying between 20 and 50 metres thick within individual beds and having upward fining sequences ranging from 0.5 to 10 m. Individual beds are usually massive, weakly jointed, relatively soft and erode preferentially to form drainage features parallel to the bedding. There is no evidence of major faulting at Rustlers Roost.

Gold mineralisation at Rustler's Roost is related to varying forms of silicification occurring within a structurally prepared environment. The gold is hosted by weakly sulfidic banded chert mudstone sequences with varying quantities of thin quartz veining.

Geochemistry aspects of the local geology, particularly in relation to acidic metalliferous drainage (AMD), are not addressed in this report in any detail. However, PGO (2017) states that AMD is not likely to be an issue as former mining operations focused on non-acid forming (NAF) oxidised materials, and the water quality data for the pit lake

and other surface water sample points supports this conclusion. It is anticipated, though, that materials transitioning from weathered to fresh, and fresh basement may be potentially acid forming (PAF).

## 3.4 Hydrogeology

### 3.4.1 General

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2013). The Site is situated near the northern flank of the Pine Creek Geosyncline. Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments, and are recharged by direct infiltration of rainfall and stream run-off. A single monitoring well (MB01) is located on the Rustler's Roost site, immediately downstream of the heap leach pad (Figure 3). Table 4 presents details of the groundwater monitoring and Table 5 presents reported results of field measurements and laboratory analyses. The results show:

- The water table likely occurs within basement rocks, and in Cainozoic sediments formed in topographic lows, where they occur
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons
- Groundwater quality is similar to end of dry season surface water quality, potentially indicating a degree of groundwater and surface water connectivity

**Table 4 Groundwater monitoring program**

| Well no. | Sample location | Co-ordinate (m AMG; WGS84) | | | Analysis type [8] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Easting | Northing | 0 ^ | 1 ^ | 2 ^ | 3 ^ | 4 ^ |
| MB01 | Down gradient of heap leach pad A | 52L | 770 933 | 8 570 702 | | Q | Q | Q | Q |

Notes: ^ 0 -standing water level
1 – field parameters (pH, EC, temp. flow)
2 – total and filtered metals (Al, As, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, U, Zn
3. Major ions (Ca, K, Na, Mg, SO4)
4 – titratable acidity, alkalinity, hardness (CaCO3), total suspended solids
^^ Frequency of sampling
M is monthly (wet season), Q is quarterly (Jan/Apr/Jul/Oct), B is biannual (first flow Oct/Nov, recessional flow Apr/May

**Table 5 Groundwater sampling results for monitoring well MB01**

| Date | Physico-chemical | | Dissolved metals [1] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | EC [2] | Al | As | Cd | Co | Cr | Cu | Fe | Mn | Ni | U | Zn |
| 11/5/16 | 7.6 | 296 | 26.9 | 10 | 0.1 | 8.5 | 0.2 | 1.8 | 326 | 77 | 2.3 | ND | 30.6 |
| 11/1/17 | 6.5 | 160 | 90 | 4 | ND | 7 | ND | ND | 190 | 16 | 1 | ND | 7 |
| 11/1/17 | - | - | 90 | 4 | ND | 7 | ND | ND | 190 | 16 | ND | ND | 6 |
| 26/3/18 | 6.2 | 140 | 110 | 6 | ND | 5 | ND | ND | 320 | 31 | 1 | ND | 5 |
| 25/6/17 | 6 | 130 | 30 | 6 | 0.2 | 10 | ND | 2 | 1300 | 120 | 5 | ND | 43 |

Notes: 1. As $\mu$g/L (rounded to nearest 0.1 mg/L)
2. As $\mu$S/cm
- not measured
ND non-detect or below LoR

The available data are not considered suitable for setting site specific groundwater triggers (principally on basis of lack of monitoring locations) but can assist in developing a water monitoring plan for the Site.

### 3.4.2 Groundwater flow system

Limited aquifer testing has been undertaken at the Site, but the data that are available suggest:

- Aquifer transmissivity ranging between 80 and 110 $m^2/d$
- Aquifer storativity ranging between $10^{-5}$ and $2x10^{-3}$
- Dewatering requirements for the mine (as per the 1997 mine plan) might be in the order of 9 ML/d.

MB01 groundwater levels (heads) have not be gauged / reported and, so, there are no wet and dry seasonal groundwater level / head data by which to assess seasonal fluctuations in the water table. However, Power and Water Authority (PAWA) records indicate that late-wet season water tables are up to 8 m higher than end of dry season water tables, suggesting recharge rates are relatively high or aquifer storativity is low, or a combination of both.

Standing water levels have been measured in uncased and undeveloped exploration holes. Although the integrity of the holes for this purpose is uncertain, the gaugings indicate a fairly steep hydraulic gradient beneath the site, and this is consistent with observed topographic relief. "Backhoe" pumping tests were conducted in the 1990s and indicated the fractured rock aquifer has a high secondary permeability.

Groundwater flow beneath the site is likely to be structurally controlled, with a regional-scale flow path toward Mary River (approximately 20 km) to the east/northeast of the Site. However, at the Site level it is considered probable that local groundwater flow systems exist, with recharge occurring in elevated areas and discharging to small creek lines.

Observations of water inflows during mineral exploration activities (drillhole RNRC010; Exploremin, 2005) indicate there may be significant secondary porosity beneath the Site and ‘strong water inflow’ associated with intervals of chert and quartz veining, although the details presented in Exploremin (2005) are not clear in this regard.

## 3.5 Beneficial use categorisation

Records of registered bores held by PAWA indicate there are two stock/ domestic bores (RN 5912 and RN 27956) located within a 12-kilometre radius of Rustler's Roost. Based on the 1:2 000 000 hydrogeological map sheet (Tickell, 2013) and position in the landscape there is unlikely to be any springs in the immediate project area.

The available groundwater quality data for the Site indicates groundwater is suitable for most beneficial uses, although some treatment may be required where used for potable purposes. Potentially sensitive groundwater receptors in the area of the Rustler’s Roost site include:

- Commercial and social - Domestic water users, livestock, agricultural enterprises
- Environmental - aquatic ecosystems in baseflow maintained pools or watercourses, riparian vegetation

# Section 4 Conceptual hydrogeology

There is limited available data from which to develop a detailed conceptual hydrogeological model. Based on the results of the data and information review presented in Section 3, Figure 5 presents a preliminary conceptualisation schematic.

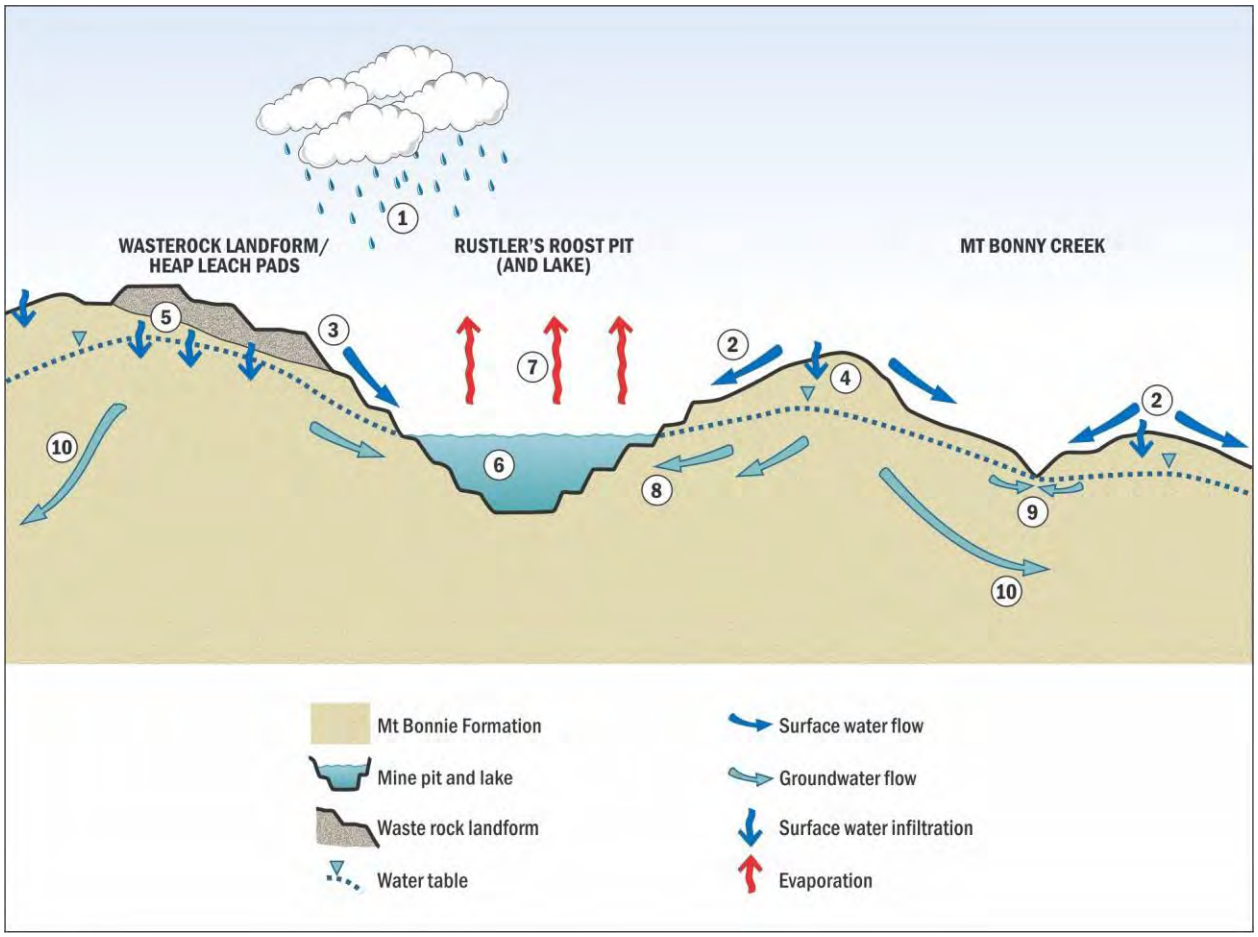



**Figure 5 Conceptual hydrogeological model for the Rustler's Roost site**

The following describes the essential elements of the preliminary conceptualisation:

❶ Wet season rainfall generates surface water runoff (sheet and stream flow) and groundwater recharge

❷ Runoff to local catchments, the Rustler's Roost pit lake and Annie's Dam[1]

❸ Seasonal runoff from waste rock[2] (to northern creek and mine pit) and heap leach pads[3] (to Mt Bonny Creek)

❹ Rainfall infiltration and recharge

❺ Infiltration of water from waste materials and leach pads to underlying groundwater system

❻ Pit lake formed from groundwater discharge to former mine pit, incident rainfall and seasonal runoff, it is unknown whether the pit overflows during extreme rainfall events or whether it is essentially a flow-through system (water quality data does not indicate the pit lake is a terminal water body)

[1] Annie's Dam is located in a separate catchment (Marakai Creek) to the pit lake and Mt Bonny Creek
[2] Northern side of waste rock landform drains to separate catchment
[3] Waste rock landform and heap leach pads are not integrated as shown on schematic, refer to Figure 3 for locations

❼ Evaporative losses from pit lake maintain a dynamic steady state pit lake level (seasonal fluctuations)

❽ Groundwater discharge to pit lake

❾ Possible seasonal groundwater discharge to creeks (reliant on water table rise due to seasonal recharge)

❿ Deep regional groundwater flow toward Mary River (Rustler's Roost catchment) and the catchment to the northeast of the Site (Marakai Creek)

# Section 5 Conclusions and recommendations

## 5.1 Conclusions

The available groundwater quality data, which is very limited, suggests the potential for groundwater contamination due to prior mining and processing activities is low. Engineering design (lining of leach pads and ponds), operational practices and disturbance of NAF materials are all likely to have contributed to this outcome. Table 6 presents a summary assessment of mine- and process-related water affecting activities at the Rustler's Roost site and the likely associated direct effects (changes to groundwater quantity and quality, changes to groundwater and surface water interaction, and aquifer disruption). The table also provides an assessment of whether there is sufficient information available to assess risks (knowledge gaps) and a risk ranking based on knowledge gaps.

**Table 6 Summary preliminary groundwater effects assessment**

| Direct effect | Present | Description | Gap | Risk rating |
|---|---|---|---|---|
| ***Groundwater affecting activity –MINE PIT(S)*** | | | | |
| Groundwater quantity | Yes | Any proposed future operation will require dewatering of the orebody to allow safe access. The rate of dewatering will need to be calculated based on the future mine plan to assist in demonstrating whether there will be a water excess or deficit for the mine and process.<br><br>After closure, the pit lake will act as a groundwater sink or groundwater recharge source. Based on existing water quality data, the latter is more probable but needs to be confirmed.<br><br>In any future mining scenario, the potential to impact on existing users (see ) as a result of dewatering will need to be considered. | Yes<br><br>Yes<br><br>Yes | High<br><br>High<br><br>High |
| Groundwater quality | Potential | The historic operation did not involve mining and processing of PAF materials, but this will unlikely be the case for any future operation. Interactions between groundwater and PAF materials, and the potential for generation of AMD will need to be considered for the operation and closure.<br><br>If pit lake acts as a groundwater sink, evaporative concentration of salts will occur in the pit. Overflow during extreme rainfall events may impact on environmental receptors, depending on release rates. However, this potential is not evidenced by available water salinity data, but needs to be considered in terms of the future mine plan. | Yes<br><br>Yes | Moderate<br><br>Moderate |

**Table 6 Summary preliminary groundwater effects assessment** (cont.)

| Direct effect | Present | Description | Gap | Risk rating |
|---|---|---|---|---|
| ***Groundwater affecting activity –MINE PIT(S)*** | | | | |
| Groundwater quality (cont.) | Potential | If pit lake is a source of groundwater recharge, or is a throughflow feature, the potential exists for pit water quality to impact on groundwater quality in any future closure period due to possible exposure of PAF materials in pit walls. | Yes | High |
| Groundwater & surface water interactions | Potential | Baseline interactions between groundwater and surface water are unknown and will need to be understood to place dewatering and closure strategies into perspective.<br>If pit lake is a groundwater sink, there is potential reduction in baseflow to local watercourses / riparian zones in any future closure period.<br>However, if pit lake is a source of groundwater recharge, or is a throughflow feature long-term effects on baseflow and riparian zones might be minimal. Recovery period is an important consideration though. | Yes<br>Yes<br>Yes | High<br>High<br>High |
| Aquifer disruption | Yes | If pit lake is a permanent groundwater sink, reduced discharge of groundwater down gradient of site can be expected. The effect of this outcome is mitigated by the fact the site is located within the headwaters of the Mt Bundy Creek tributary catchment of Mary River. | Yes | Low |
| ***Groundwater affecting activity – WASTE ROCK LANDFORM & HEAP LEACH PAD*** | | | | |
| Groundwater quantity | Potential | Drainage of leachate from waste rock landform and heap leach pad could give rise to local mounding of the water table and water logging, which could impact on vegetation (including riparian) surrounding the facilities. | Yes | High |
| Groundwater quality | Potential | The potential for water draining through waste rock landform and heap leach pad to encounter PAF and other material is unlikely. However, this may not be the case for a future operation, and there is no monitoring infrastructure in place to confirm. | Yes | High |
| Groundwater & surface water interactions | Potential | Water table mounding beneath these facilities could also give rise to increased rates of groundwater discharge to local surface water features (creeks). | Yes | Moderate |
| Aquifer disruption | No | - | n/a | n/a |

## 5.2 Recommendations

On the basis of the data and information review (Section 3) and the effects assessment (Table 6), the following recommended works are proposed to assess the groundwater-related knowledge gaps for the Rustlers Roost site. In summary:

- The surface water monitoring network appears adequate for monitoring potential effects on surface water quantity and quality due to past mining and processing activities and infrastructure, with perhaps the exception of a flow gauging site, but the sampling and analytical program needs to be refined to better assist in understanding these potential effects (temporal and scale), as well as groundwater - surface water interactions
- The groundwater monitoring network is considered inadequate for the purpose of monitoring potential effects on groundwater quantity and quality, and groundwater – surface water interaction due to past mining and processing activities and infrastructure

Table 7 presents details of proposed improvements that can be made to address deficiencies. Figure 6 presents a locality plan for proposed additional groundwater monitoring infrastructure. It is noted that several historical bores remain on site and it is recommended that these are assessed for serviceability prior to planning for additional bore installation.

**Table 7 Recommended monitoring infrastructure and works to address knowledge gaps**

| Infrastructure | Status | Description | Purpose |
|---|---|---|---|
| ***Surface water*** | | | |
| SWQ2, SW2, SW5, SW6, SW7, SW10, SW11, SW12, SW22 | Existing | Surface water sampling points<br>Analytical program to include:<br>• *Field measured*<br>EC, pH, DO, Redox (monthly)<br>• *Laboratory*<br>- Major ions (quarterly)<br>- Full metal suite; total and dissolved (biannual [1])<br>- Acidity, alkalinity, hardness, TSS (biannual [1]) | • Characterisation of possible groundwater recharge sources<br>• Characterisation of groundwater – surface water interactions |
| SW23 | Proposed | Surface water sampling point<br>Analytical program to include:<br>• *Field measured*<br>EC, pH, DO, Redox (monthly)<br>• *Laboratory*<br>- Major ions (quarterly)<br>- Full metal suite; total and dissolved (biannual [1])<br>- Acidity, alkalinity, hardness, TSS (biannual [1])<br>Stream gauging monitoring point if location is feasible (continuous [2]) | • Characterisation of groundwater – surface water interactions |
| ***Groundwater*** | | | |
| MB01 | Existing | Groundwater sampling point<br>Analytical program to include:<br>• *Field measured*<br>EC, pH, DO, Redox (monthly)<br>• *Laboratory*<br>- Major ions (quarterly)<br>- Full metal suite; total and dissolved (biannual [1])<br>- Acidity, alkalinity, hardness, TSS (biannual [1])<br>Gauging of standing water level (monthly) | • Characterisation of possible groundwater recharge sources<br>• Characterisation of groundwater quality (baseline and trends)<br>• Characterisation of groundwater – surface water interactions |

**Table 7 Recommended monitoring infrastructure and works to address knowledge gaps** (cont.)

| Infrastructure | Status | Description | Purpose |
|---|---|---|---|
| ***Groundwater*** *(cont.)* | | | |
| MB02, MB03, MB04, MB05, MB06, MB07 | Proposed | Surface water sampling point:<br>• MB02 – downstream stormwater pond & heap leach<br>• MB03 – downstream of ROM, upstream of heap leach<br>• MB04 – Western shore of pit lake, downstream of WRL<br>• MB05 – Downstream of WRL, western side<br>• MB06 – Off site groundwater baseline<br>• MB07 – Eastern shore of pit lake<br>Analytical program to include:<br>• *Field measured*<br>EC, pH, DO, Redox (quarterly)<br>• *Laboratory*<br>- Major ions (quarterly)<br>- Full metal suite; total and dissolved (biannual [1])<br>- Acidity, alkalinity, hardness, TSS (biannual [1])<br>Gauging of standing water level (monthly) | • Characterisation of possible groundwater recharge sources<br>• Characterisation of groundwater quality (baseline and trends)<br>• Characterisation of groundwater – surface water interactions |

Notes: 1. End of dry / first flow (October / November), and recessional flow (April / May)
2. Using loggers

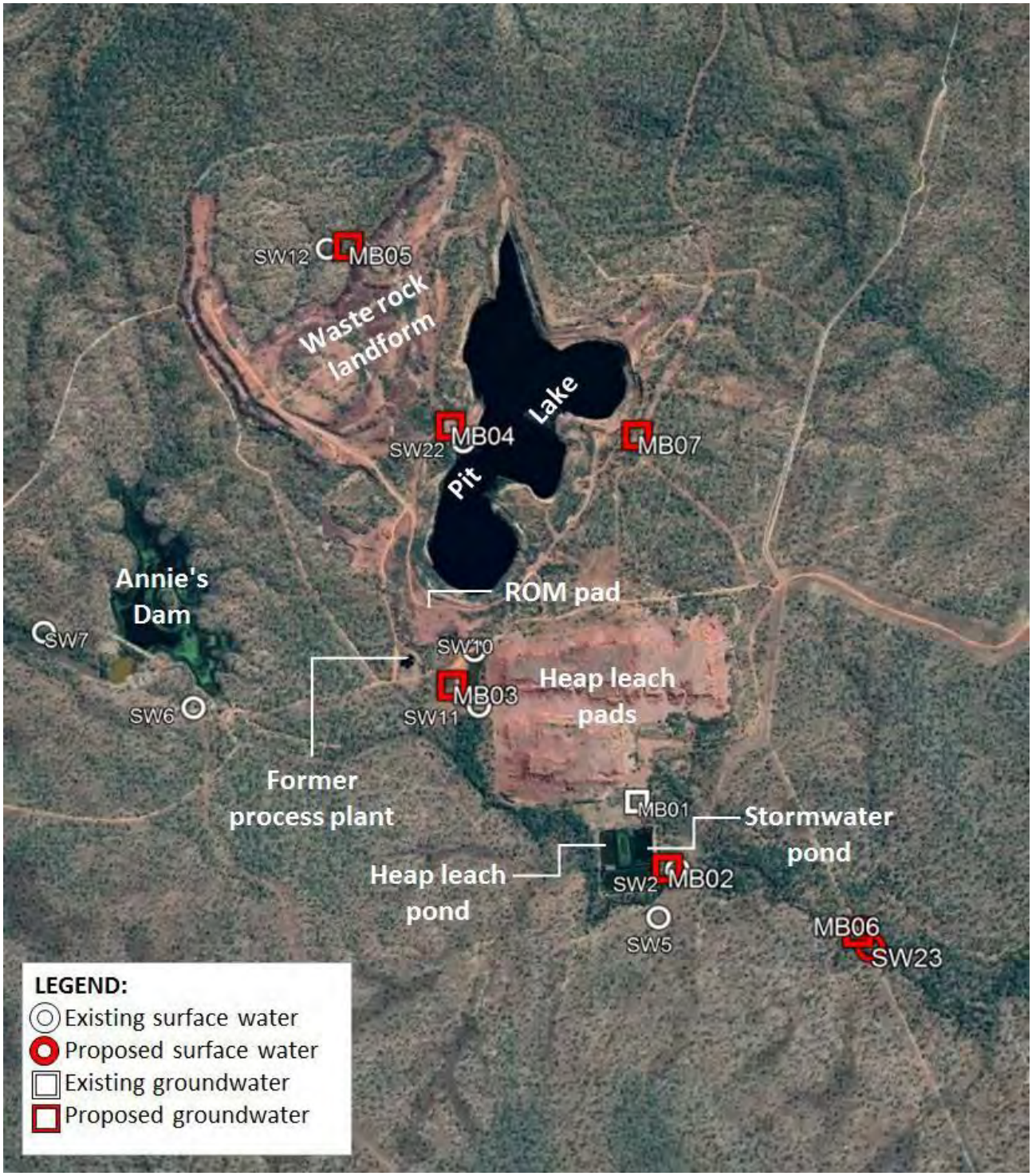



**Figure 6** **Existing and recommended (additional) groundwater monitoring infrastructure locations**

# Section 6 Groundwater knowledge status

Table 8 presents a summary of the status of groundwater knowledge for the Rustler's Roost site (based on the assessment outcomes presented in Section 4 and Section 5 of this report) in relation to issues raised by the Northern Territory Department of Primary Industries and Resources (DPIR) in correspondence with PGO.

**Table 8 DPIR issues and groundwater knowledge status**

| Issue | DPIR comment | Knowledge status |
|---|---|---|
| Issue 3<br>Water quality | PGO should consider if there is sufficient data to develop site specific water triggers to help guide the water monitoring program.<br>PGO has identified that hydrogeological characterisation is a data gap that will be addressed……. Provide firm commitments for resolution of this data gap. | ▪ Data and information gap analysis prepared (Section 5.1, Table 6)<br>▪ Recommendations made for upgrading existing monitoring network, analytical program and schedule (Section 0, Figure 6) |
| Issue 5<br>Previous MMP | PGO must provide the results of a groundwater review along with the next MMP, which will include outcomes and commitments. | ▪ Groundwater review completed (Section 3.4)<br>▪ Data and information gap analysis prepared (Section 5.1, Table 6) – available groundwater head and quality data is limited to a single location (MB01; Figure 3)<br>▪ Groundwater quality baseline presented (Section 3.4.1, Table 5) – requires additional work (Section 0, Figure 6)<br>▪ Preliminary assessment of groundwater system response to mine infrastructure completed (Section 3.4)<br>▪ Preliminary conceptualisation developed (Section 4, Figure 5) |
| Issue 6<br>Environment | In addition to maintaining groundwater and surface water quality to achieve good environmental outcomes, PGO needs to also consider other aspects of the water system requiring management such as groundwater baseflow to streams, ground water heads. | ▪ Groundwater review completed (Section 3.4)<br>▪ Based on available information, threat assessment and gap analysis completed (Section 5.1), and recommendation made to address data and information gaps (Section 0) |
| Issue 8<br>Identification of environmental aspects and impacts | Agree that groundwater impacts pose a risk to the environment……. include within the Aspects and Impacts Register | ▪ Groundwater review completed (Section 3.4)<br>▪ Based on available information, threat assessment and gap analysis completed (Section 5.1)<br>▪ Aspects and Impacts Register to be updated |
| Issue 9<br>Risk assessment | Risk assessment requires review to address issues of saline and neutral drainage potential from waste rock dump and leach pad.<br>Mitigation measures do not consider overtopping risk…. Must be addressed for future MMPs and included in a site-wide water balance. | ▪ Data and information gap analysis prepared (Section 5.1, Table 6) |

**Table 7 DPIR issues and groundwater knowledge status** (cont.)

| Issue | DPIR comment | Knowledge status |
|---|---|---|
| Issue 11<br>Information and knowledge gaps | A detailed plan of how knowledge gaps are to be addressed is required, along with an implementation schedule. | ▪ Recommendations for addressing knowledge gaps prepared, along with an implementation schedule (Section 0) |
| Issue 12<br>Groundwater monitoring program | Gauging of groundwater heads is required for the groundwater monitoring program. | ▪ Recommendations for addressing knowledge gaps prepared, including groundwater gauging (Section 0) |
| Issue 13<br>Develop completion criteria | Provide additional details as to guidelines used for assessing post-closure water quality, including development and justification of specific criteria. | ▪ Recommendations for addressing knowledge gaps prepared, once implemented additional work can be undertaken to assist with assessing post-closure water quality criteria (Section 0)<br>▪ This work remains outstanding |

## 10.3 Geochemical Assessment

HangKing Australia

# Rustler's Roost Project – desktop and limited field geochemical assessment

15 May 2019

CDM Smith

listen. think. deliver.

# Table of Contents

# Figures

# Tables

# Document history & status

| Revision | Date issued | Reviewed by | Approved by | Date approved | Revision type |
|---|---|---|---|---|---|
| Rev-A | 24/04/2019 | P. Davey | P. Davey | 26/04/2019 | Draft |
| Rev-0 | 15/05/2019 | P. Davey | P. Davey | 15/05/2019 | Final |
| | | | | | |
| | | | | | |

# Distribution of copies

| Version | Date issued | Quantity | Electronic | Issued to |
|---|---|---|---|---|
| Rev-A | 26/04/2019 | 1 | Pdf | HanKing Australia |
| Rev-0 | 15/05/2019 | 1 | Pdf | HanKing Australia |
| | | | | |
| | | | | |

| | |
|---|---|
| **Last Saved:** | 15 May 2019 |
| **File Name:** | PGO-1000338-RPT-Geochem-001-Rev0.docx |
| **Author:** | Karen Mackenzie |
| **Project Manager:** | Paul Davey |
| **Client:** | HangKing Australia |
| **Document Title:** | **Rustler's Roost Project – desktop and limited field geochemical assessment** |
| **Document Version:** | Rev-0 |
| **Project Number:** | 1000338 |

# Executive Summary

CDM Smith Australia Pty Ltd (CDM Smith) conducted a desktop and limited field geochemical assessment for the Rustlers Roost Project to assess the spatial distribution and quantities of the various mine wastes on site and to provide advice on the likelihood of acid or neutral metalliferous drainage to be released from site. The field assessment was conducted on the 8th March 2019. Data and information gaps relating to the understanding of effects that historic mining and processing related activities may have (or have had) on water quality were also reported.

**Assessment of Acid and Neutral Mine Drainage Risk**

Upon review of historical data, the total number of samples collected to date is not considered sufficient to fully characterise the ore and wastes that have been mined and are likely to be mined. An assessment of the leachability conducted on the oxide waste samples is required to establish a better understanding of the potential for the materials currently stored on site to pose a risk to water quality.

Despite this limitation, the high level assessment suggests that for the waste materials currently stored on the sites surface, the potential to leach a significant dissolved chemical load to surface or groundwater is low. However, if mining were to progress and materials from deeper within the geological profile were disturbed either by being raised to the surface or dewatered, leaching from newly exposed materials may impact groundwater and surface water quality.

The assessment of low risk is based on multiple lines of evidence including historical geological and mining depth data, recent field observations, surface and groundwater quality data and targeted surface rock geochemical data. It has been demonstrated that the total sulfide content of all weathered materials sampled is low. All samples collected in the current study are classified as NAF, this is consistent with previous geochemical assessments of the weathered materials within the geological profile.

Runoff from the catchment and potentially the Waste Rock Dum (WRD) may be acidic to circum-neutral and run off will likely contain elevated concentrations of Al, Fe and Mn compared to all other metals, and phosphorus (P) may also be present.

The Heap Lech Pad (HLP) materials have the highest propensity to deliver dissolved constituents to surface and or groundwater, this is as would be expected as these materials have the highest surface area per unit mass and have been chemically leached.

Any impacts to water quality from the waste landforms is likely to be in the form of increased salinity and increased concentrations of Al, As, Fe, Mn, Se and Zn.

Given the local geological profile, which is reported to host increasing levels of sulfide minerals with depth, the pit lake may be stratified. The water quality at the surface of the lake may represent surface run off, whereas deeper within the lake the water quality may be influenced by groundwater that may have a neutral mine drainage signature.

**Recommendations**

To increase confidence in the source, pathway receptor model and management of risks associated with acid and neutral mine drainage the following is recommended:

Additional sampling and analysis of the geological materials (ore and waste) at site should include:

- Mineralogical assessment of the materials;
- Static testing on waste and ore
    - Acid Base accounting on all samples collected.
    - Include sulfur speciation

    - Include total carbon analysis;

- Kinetic testing of waste and ore - Given the likelihood that the deeper geologies are more sulfidic than the materials raised to date, it is recommended that a kinetic test program is initiated as soon as practicable to inform the rate of oxidation of the materials and composition of leachates; and
- Sampling of sediments in streams down gradient from and at the base of the decant ponds.

The data from the kinetic column work can be used to inform the groundwater and surface water monitoring suite of analytes.

Based on the conclusions of the geochemical assessment presented above, it is recommended that the water quality suite adopted for the site monitoring should include the following as a minimum:

- Physical parameters: pH, temperature, EC and redox.
- Major ions (Ca, Mg, Na, K, Cl, total alkalinity)
- Metals and metalloids:
    - Total – Al and Fe (speciated)
    - Dissolved: Al, As, Cd, Cu, Fe, Mn, Pb, Se, Sn and Zn.
- Nutrients: total N, nitrate and ammonia, and total P

# Section 1 Introduction

## 1.1 Background

Primary Gold Ltd (PGO) engaged CDM Smith Australia Pty Ltd (CDM Smith) to undertake a geochemical assessment for the Rustlers Roost Project (Figure 1-2-2, location plan, Figure 1-3 associated tenements). This review is required to assess the spatial distribution and quantities of the various mine wastes on site and to provide advice on the likelihood of acid or neutral metalliferous drainage to be released from site. Further, the purpose of the desktop review is also to identify data and information gaps relating to the understanding of effects that historic mining and processing related activities may have (or have had) on water quality.

## 1.2 Scope of work

CDM Smith were engaged to undertake a desktop review of the geochemical analysis conducted to date and provide:

- advice regarding knowledge gaps;
- a sampling and analysis plan for opportunistic sampling of key landforms;
- opportunistic sampling of key landforms;
- a report on the findings; and
- recommendations for future work.

## 1.3 Approach

In general accordance with the guidance provided by the Northern Territory Environment Protection Authority, the data review focussed on the following information:

Publicly available geological mapping;

- Geological mapping/cross sections of the deposit provided by the client where the water table and base of oxidation is noted;
- Ore formation (mineralogy), and historical mining reports;
- Geochemical reports completed for the site;
- Estimated/calculated volumes of waste and ore; and
- Site observations.

The desktop review provides a summary of the geochemical nature of a range of materials at the site including sulfide content, sulfide types, presence or absence of carbonates and presence of other potential contaminants such as processing chemicals.

The data gathered in the desktop review is combined to develop a conceptual site model (CSM) of potential release, transport, and fate of any chemicals of interest from the mine site identifying source, pathway, receptor linkages.

The results of the sampling and analysis are compared to previous results and are discussed in the context of whether the materials stored in the current landforms may pose a risk to surface and or groundwater quality.

Our approach is summarised in Figure 1-1.

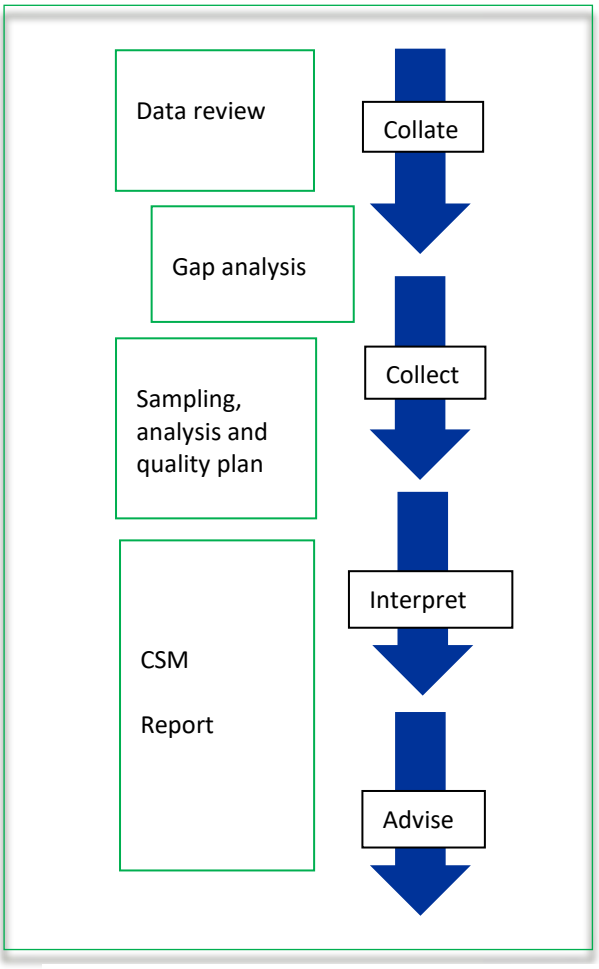



**Figure 1-1 Overall approach to desktop assessment**

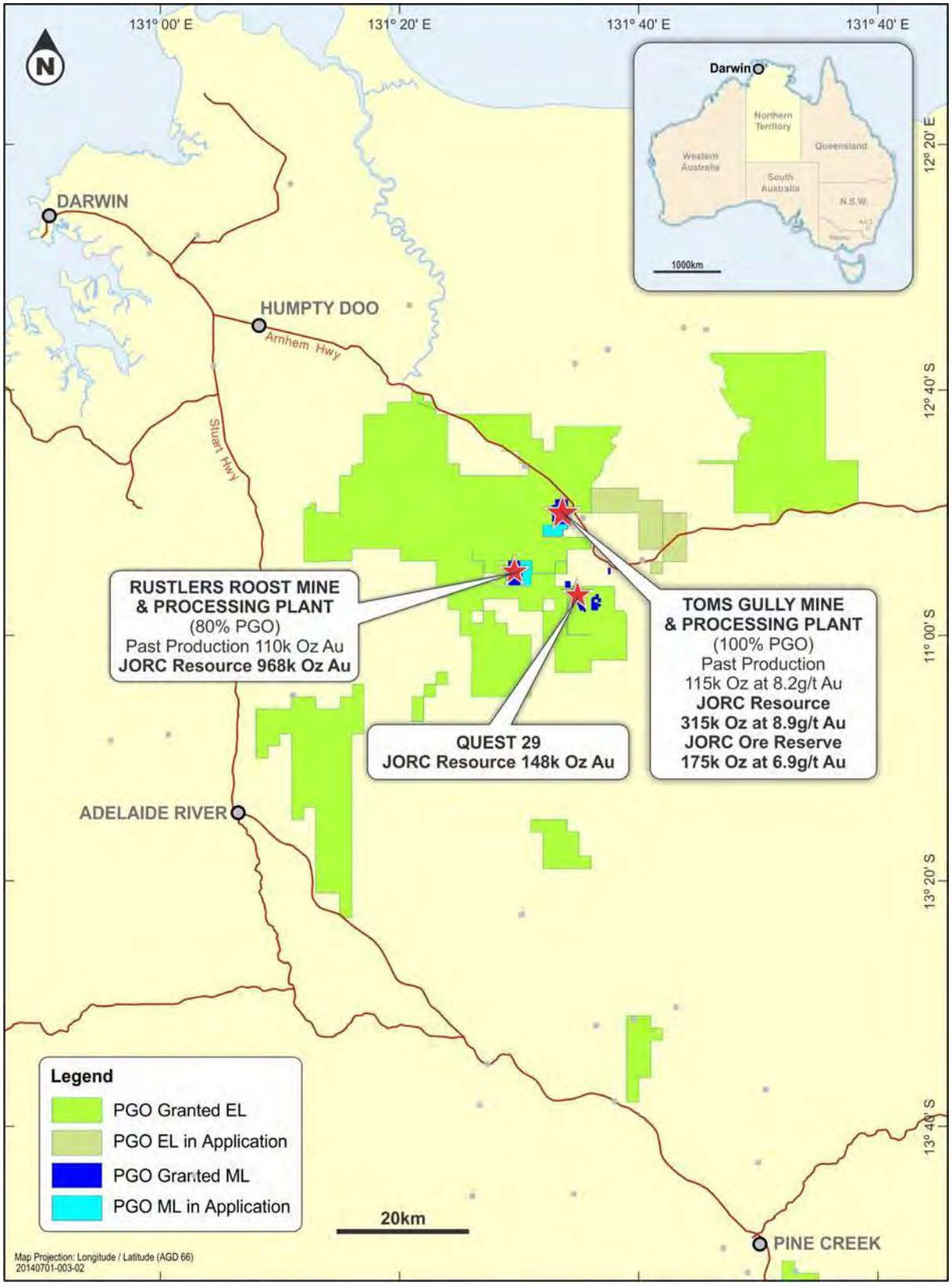



**Figure 1-2 Project locality plan** (source: PGO)

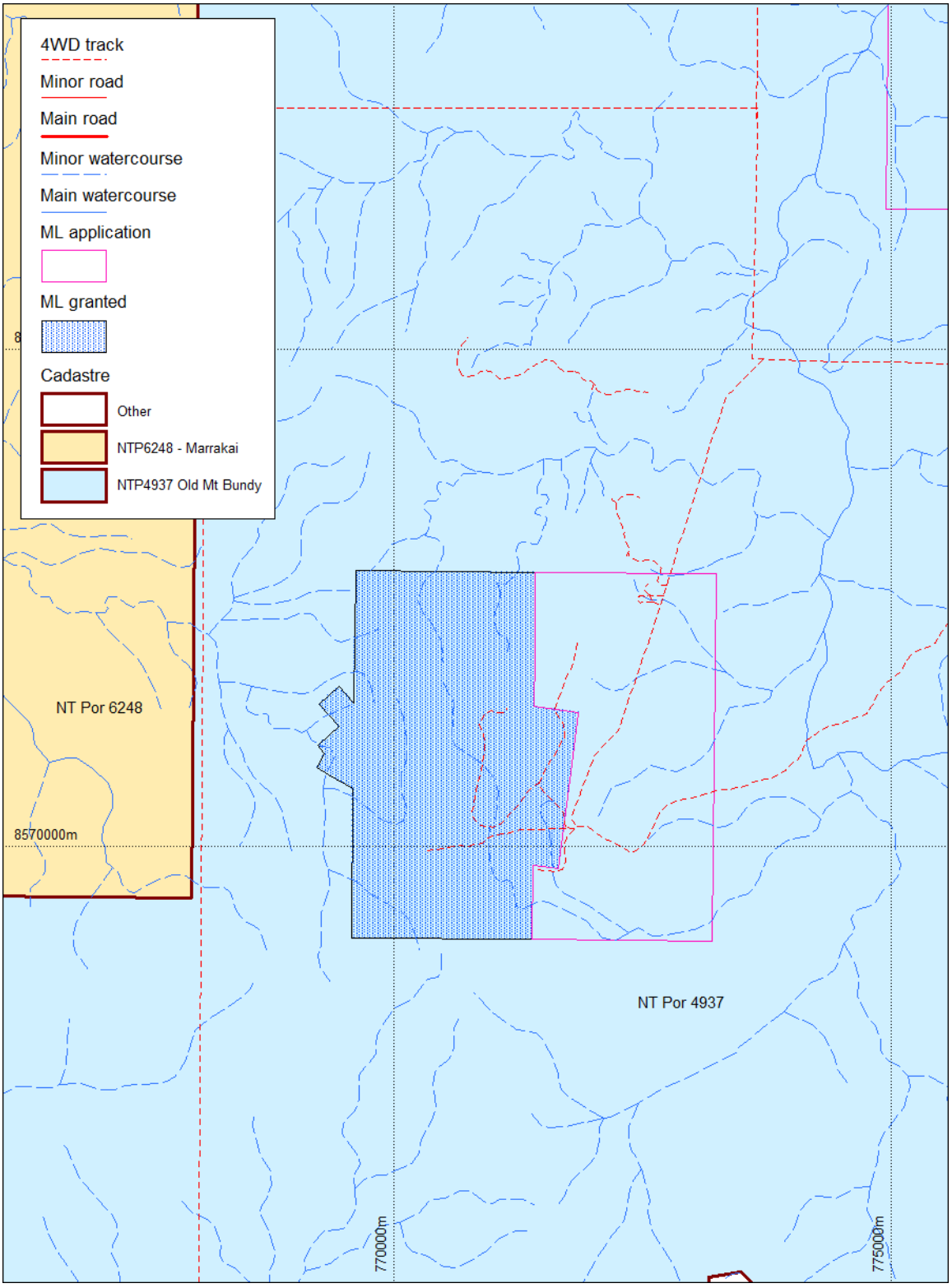



**Figure 1-3 Mining Tenements**

# Section 2 Data and information sources

## 2.1 Overview

A listing of sources of data and information accessed as part of the review presented in this report is provided in this section. Much of the data and information have been provided by PGO but additional publicly available references have also been accessed.

**Information sources for guidance relevant to AMD include the following:**

- Australian Government Department of Industry Tourism and Resources Leading Practice Sustainable Development Program for the Mining Industry Handbooks:
  - Managing Acid and Metalliferous Drainage (2007, updated 2016);
  - Tailings Management (2007);
  - Water Management (2008);
  - Mine Closure and Completion (2006); and
  - Mine Rehabilitation (2006).
- Government of Western Australia, Guidelines for Preparing Mine Closure Plans (2011);
- Queensland Department of Environment and Heritage Protection, Assessment and Management of Acid Drainage (1995);
- Northern Territory Minerals Council (Inc.) and the Mines and Petroleum Management Division of the Northern Territory Government, TEAM NT: Technologies for Environmental Advancement of Mining in the Northern Territory (2004); and
- The International Network for Acid Prevention sponsored the production of the Global Acid Rock Drainage Guide (GARD Guide) intended to summarise best practices and technology to address AMD issues. While the GARD Guide has a decided North American focus, it provides very useful and detailed information on AMD prediction, prevention, and mitigation.

## 2.2 Rustlers Roost

- PGO. 2017. Mining management plan - Rustlers Roost project area 2016-2017 care and maintenance tenements MLN 1083. Primary Gold Ltd, July 2017.
- Valdora. 1994. Rustler's Roost Gold Mine Preliminary Environmental Report. Prepared by Valdora Minerals N.L., January 1994.
- William. 1997. Annual report Mineral Claims N26710N2683 Rustler's East. Prepared by William Australia N.L.
- Draft EIS 1997 Stage 2 mining – by Rustlers Roost Mining Company – and appendices (incl GCA ore and waste characterisation)
- Rustlers Roost Decommissioning Plan For William Resources – Fawcett Mine Rehabilitations Services Pty Ltd, July 1997
- Primary Gold ASX Announcement 2017
- Higham, I.H., 1989. Annual Exploration Report for year four EL4773 and 4578, a report for Pegasus Gold Australia Limited by Eupene Exploration Enterprises Ltd, September 1989.

- Fabray, J., 2005. Annual Report Y/E 20/06/05 EL 9154 Rustlers Roost North, Northern Territory, Australia (Northern Gold Farm-In), vol. 1 text and diagrams, prepared for Rustlers Roost Mining Company Pty Ltd by Exploremin Pty. Ltd. In September 2005.


## 2.3 Tom's Gully


- GHD. 2015. Toms Gully Draft EIS - AMD Management Plan GHD 2015. Prepared by GHD for Primary Gold Ltd, March 2015.

# Section 3 Background to the Assessment of Acid and Metalliferous Drainage

Mining activities have the potential to impact local surface and groundwater resources over short and long-term time frames through the exposure, disturbance and/or deposition of geological and waste materials. Internationally and in Australia, acid and metalliferous drainage (AMD) is recognised as one of the most serious environmental issues associated with mining.

## 3.1 Acid Generation

AMD is most commonly formed by natural oxidation of sulfide minerals (INAP, 2010). Oxidation occurs when sulfide minerals are exposed to air and water. The most common AMD source minerals are pyrite, marcasite, arsenopyrite and pyrrhotite, because these sulfide minerals typically release acid when oxidised. Thus, it is common for the chemical testing of rock units and tailings to focus on their sulfur content.

However, there are many other sulfide and non-sulfide mineral phases that may be present that can contribute to metalliferous drainage. A few are acid forming when oxidised, but many can be a source of chemicals of interest (COI) also referred to as elements of environmental concern (EECs), without further oxidation. For example; complexation reactions of metals with water molecules is also an acid-forming process (hydrolysis) which can release metals into solution, this can result in saline drainage with low sulfate concentrations. Saline drainage can also occur from processes that do not involve acidification and neutralisation, but rather via the accumulation of dissolved salts from enhanced weathering of non-acid forming rocks.

## 3.2 Neutralising materials

The acid generated on site can be neutralised in situ by the host rocks. Carbonate minerals generate significantly more neutralisation potential than silicate minerals, while they also tend to buffer at higher pH values. Effective neutralization, in practice is therefore generally directly related to the abundance of non-Fe/Mn carbonate minerals.

## 3.3 Acid base accounting

Acid base accounting (ABA) is a series of chemical analyses and calculated values that provide a preliminary evaluation of the amounts, and relative balance, of the acid generation potential (acidity potential, AP or maximum potential acidity, MPA) and acid-neutralization potential (NP or acid neutralising capacity, ANC) of a sample. The calculated values are used to make preliminary projections about whether a sample will produce acid drainage. Note that in Australia, acid base accounting calculations are based on the net acidity of samples (kg of $H_2SO_4$/t), whereas in North America it is based on the net neutralizing potential available (kg of $CaCO_3$/t). ABA includes the most common static tests used in the prediction of acid rock drainage. The potential acid production (AP) is commonly determined by analysis for sulfur species. The neutralization potential (NP) can be determined by strong acid (Sobek, modified Sobek and BC Research) bulk NP procedures, weak acid bulk NP procedures and/or various carbonate measures (INAP 2010).

It is important to note that on their own these procedures should only be used as a screening tool which can determine the acid-producing nature of a mine waste only if there is a large imbalance between the AP and NP. Accurate AMD prediction and ABA data interpretation requires an understanding of the analysis procedures, the future physical and geochemical conditions and the identity, location and reactivity of the contributing minerals. Kinetic tests, mineral identification and detailed material characterisation are required to provide this information (INAP 2010).

## 3.4 Drainage chemistry prediction

The prediction of the drainage chemistry is generally the required outcome from a geochemical assessment, it is then compared to the receiving environment to assess the risk of a negative outcome with respect to an environmental value. However, the prediction of drainage chemistries from geological materials is complex, and the baseline condition of the environment surrounding a mining area is often poorly understood. This site is no exception.

With respect to down gradient transport, the chemical, physical and biological factors that applied to the rate of release of the elements within the acid and or metalliferous drainage also apply to the transport of these elements through the receiving environment.

## 3.5 Geochemical characterisation approach

INAP (2010) states that "geochemical characterisation aims to identify the distribution and variability of key geochemical parameters (such as sulfur content, acid neutralising capacity and elemental composition) and acid generating and element leaching characteristics. A basic screening level investigation is essential and should commence at the earliest possible stage".

The need and scope for detailed investigations will depend on the findings of initial screening. As some tests, such as leach tests or oxidation rate measurements, require a long time frame to provide the necessary data, it is important to initiate this work well ahead of key project milestones.

DOITR (2007) guidance also stresses that it is critical that sampling for geochemical testing be representative of geological materials at the project site (including country and host rock) and provides further specific information on sampling procedures (including sample sizes and maximum intervals between drill holes).

Consistent with that approach, if the geology of the area is such that acid and/or metalliferous drainage may be an issue, the results of appropriate geochemical testing and risk assessment for both acid drainage and metalliferous drainage must be presented upfront at the approval stage. Current methods of geochemical testing and risk assessment are set out in the US AMD handbook (Maest et al 2005), and the international AMD handbook known as the “GARD Guide” (INAP 2009).

Static testing allows for an initial acid base accounting assessment. This will provide information on the acid generating and acid neutralising potential of the geological materials to a greater degree of certainty than the assay data can provide. If acid generation is likely, kinetic tests should be completed to assess the timing of acid generation and the likely composition of leachates.

Static test results are used to provide a classification of materials with respect to their acid generating potential. There are two common classification suites adopted in Australia:

- Guidelines for evaluating acid forming potential of mine wastes presented by AMIRA International (AMIRA) and
- Mine Environment Neutral Drainage Program (MEND)

Each classification scheme is summarised in Table 3-1. The AMIRA guidelines (AMIRA, 2002) are commonly used in Western Australia for the evaluation of acid-base accounting (ABA) and non-acid generating (NAG) results. Consideration is also given to the MEND (Price, 2009) classification scheme when classifying the materials.

The following categories are used in the AMIRA classification system:

- Non-acid forming (NAF)
- Potentially acid forming (PAF)
- Uncertain (UC).

Terminology used in the MEND classification system differs from that used in the AMIRA guidelines.

The results of a kinetic program are those which inform the assessment of potential drainage chemistries and allow for prediction of chemical loads to the environment.

**Table 3-1 Acid Generation Classification Systems**

| AMIRA (2002)* | | |
|---|---|---|
| **Sample Potential** | **Criteria** | **Comments** |
| PAF | NAPP > 0<br>NAG pH < 4.5 | A sample classified as PAF always has a significant sulfur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. |
| NAF | NAPP < 0<br>NAG pH ≥ 4.5 | A sample classified as NAF may, or may not, have a significant sulfur content but the availability of ANC within the sample is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulfide minerals. |
| UC | NAPP > 0<br>NAG pH ≥ 4.5 | An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results. Uncertain samples are generally given a tentative classification that is shown in brackets e.g. UC (NAF). |
| | NAPP < 0<br>NAG pH < 4.5 | |
| **MEND (2009)**** | | |
| **Sample Potential** | **Sample Potential** | **Sample Potential** |
| PAF | NPR<1 | Potentially acid generating material, unless sulfide minerals are non-reactive, or NP is preferentially exposed on surfaces. |
| UC | 1<NPR<2 | Possibly PAF if NP is insufficiently reactive or is depleted at a faster rate than sulfides. |
| NAF | NPR>2 | Non-potentially acid generation material, unless NP is insufficiently reactive, extremely reactive sulfides are present, or preferential exposure of sulfides is found in the material. |

*Adapted from: Test Handbook - Prediction and Kinetic Control of Acid Mine Drainage (AMIRA, 2002).

**Adapted from: "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials", published by MEND, to convert North American terminology to Australian terminology for equivalent parameters (Price, 2009).

# Section 4 Data and information review – Site Setting

## 4.1 Geology

### 4.1.1 Regional setting - Pine Creek inlier

The Pine Creek inlier can be divided into five sub-regions: Lichfield Province, Rum Jungle Region, Central Region, South Alligator Valley and Alligator River (Ahmed 1998[1]).

Pine Creek is a metamorphosed and deformed Palaeoproterozoic sequence of pellites and psammites (silty and sandy sediments), with minor carbonate sediments and volcanics (Figure 4-1). Dolerite sills intruded into the region (Zamu Dolerite and equivalents) before the metamorphism and deformation (Ahmed 1998[1]).

During the regional deformation and metamorphism, the lithologies were tightly folded and faulted, metamorphic grades range from sub-greenschist facies (Lichfield Province) to upper Amphibolite facies (western Lichfield Province to eastern Alligator River). A series of younger granites cut through the Proterozoic metamorphic sequence (refer to Figure 4-2, Ahmed 1998[1]).

The mineral deposits are predominantly found within the central region where the granitoids dominate the geology. The deposits contain most of the gold, base metal and tin bearing veins as well as stratabound gold and polymetallic deposits (Ahmed 1998).

The Pine Creek Inlier gold deposits have been into three groups; gold-quartz vein, stratiform gold lenses in iron rich sediments and stratabound zinc-lead-copper-gold-silver lenses (Ahmed et al., 1993[2]).

[1] Ahmed M., 1998, Geology and Mineral Deposits of the Pine Creek Inlier and McArthur Basin, Northern Territory. AGSO Journal of Australian Geology and Geophysics, 17(3), 1-17.
[2] Ahmed, M., Wygralak, A.S., Ferenczi, P.A. and Bajwah, Z.U. 1993, 1:250 000 Metallogenic Map Series, Pine Creek, Northern Territory Geological Survey, Explanatory Notes, SD52-8.

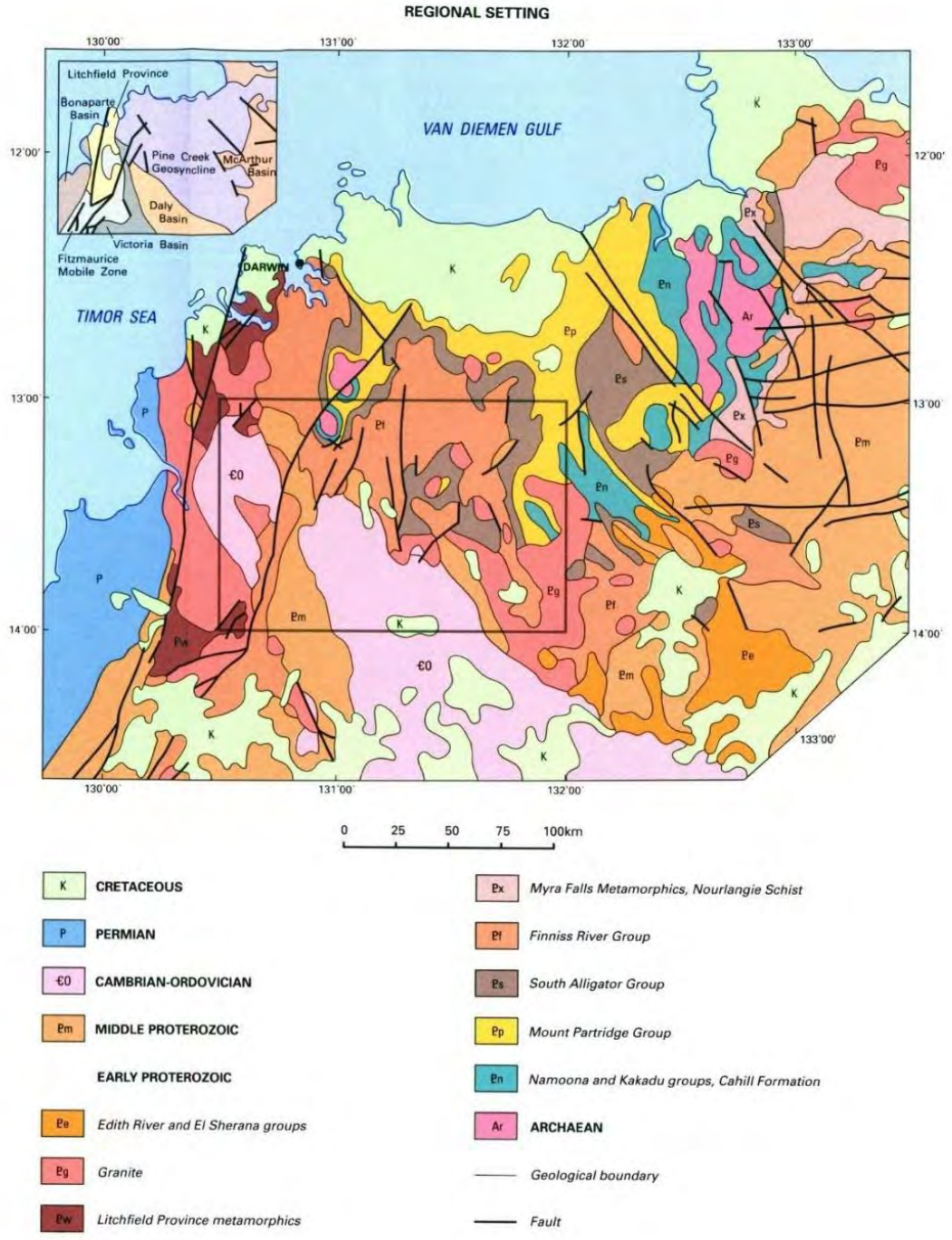



**Figure 4-1 Geological Map of Pine Creek Inlier (GA online resource, Geological Map sd5208 Pine Creek)**

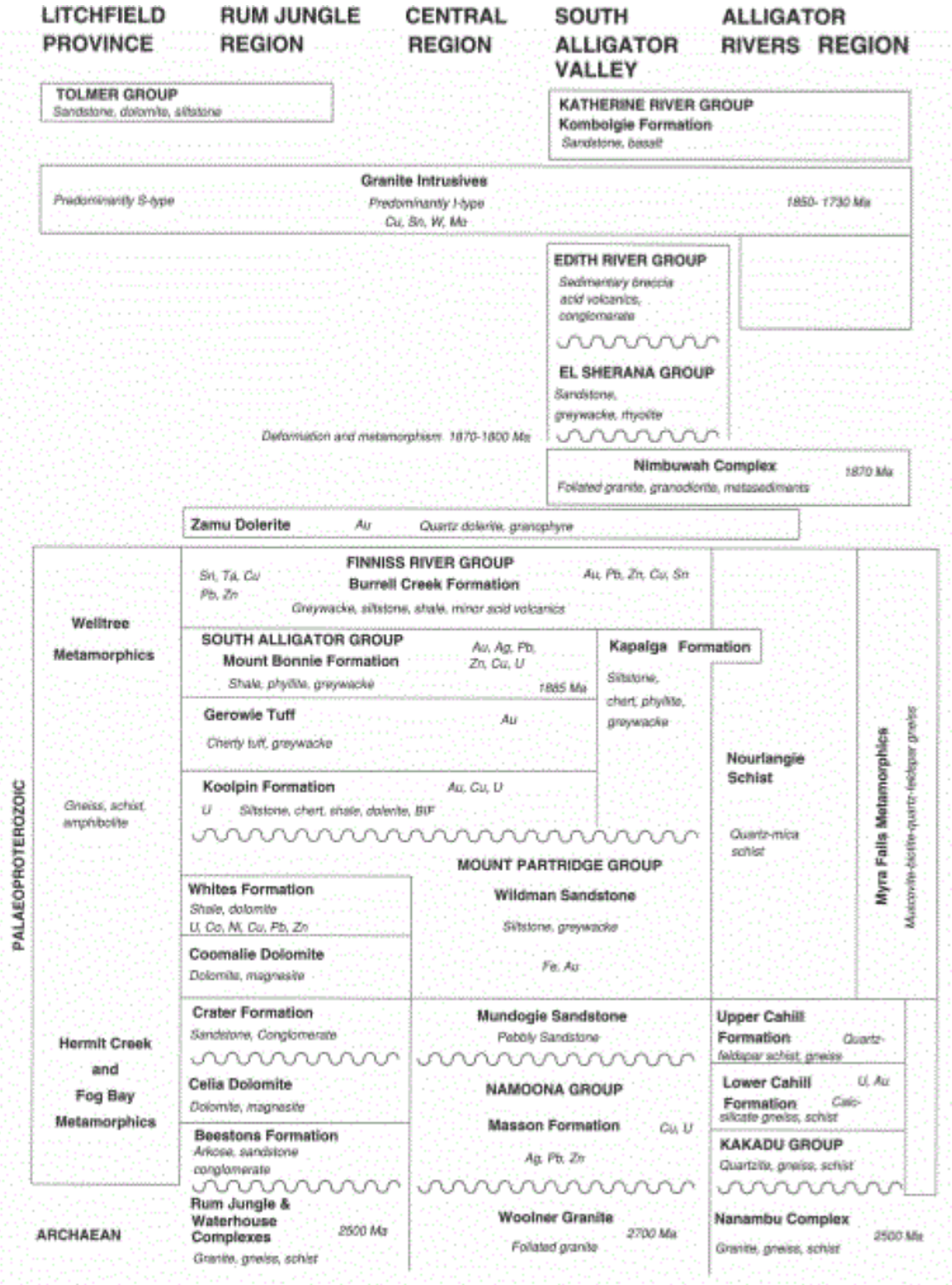



**Figure 4-2 Regional stratigraphy from Ahmed 1998.**

### 4.1.2 Local geological setting

The deposit type is described as "post Archean lode Au (Cu-Pb-Zn)" (Geoscience Australia, 2012) and sits within sediments of the Wildman Siltstone (sandstone) and locally within Burrell Creek Formation (refer to Figure 4-3) which are a series of Proterozoic turbidite marine sediments.

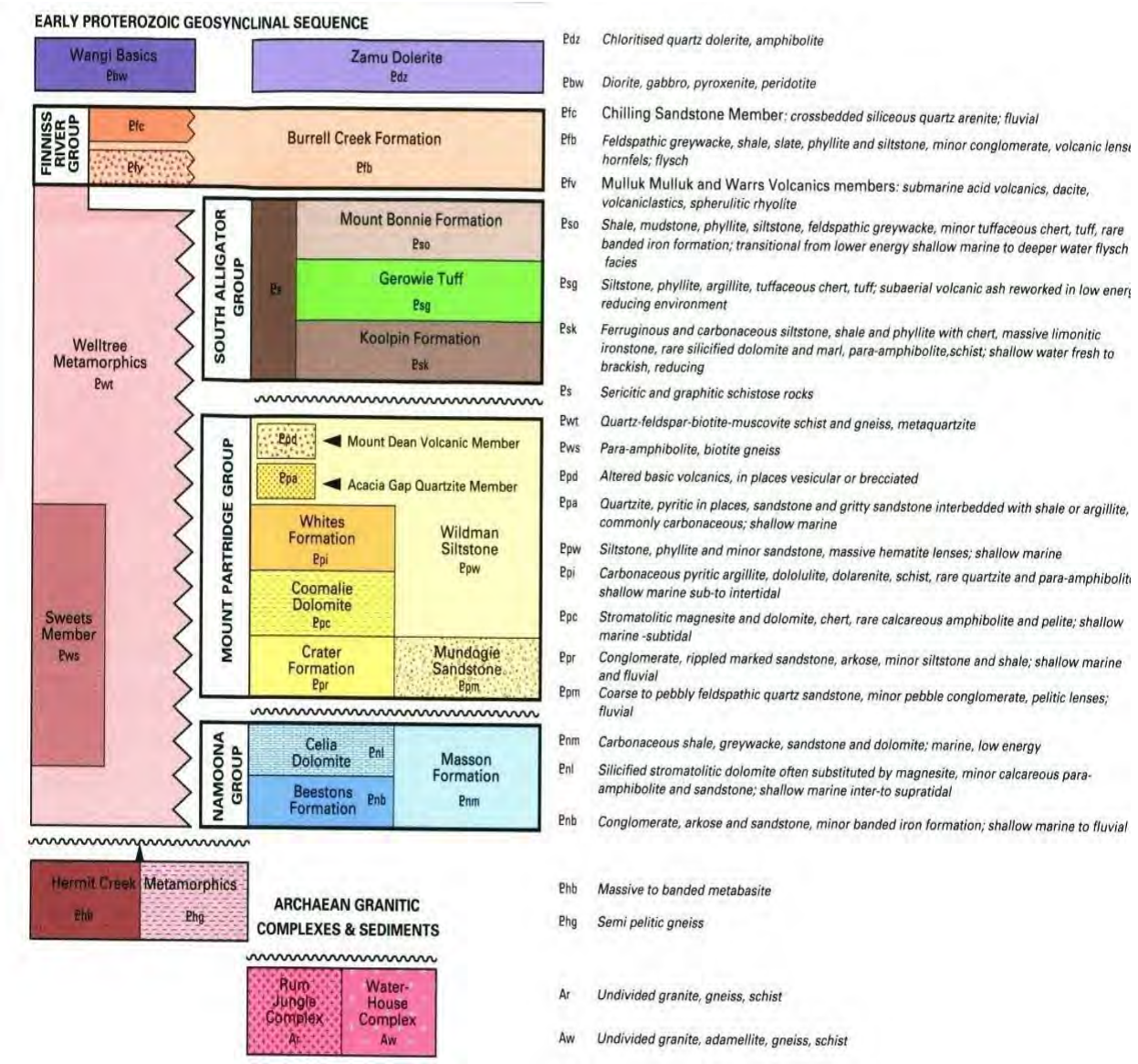



**Figure 4-3 Archaean to Early Proterozoic Stratigraphy and lithological descriptions (Geological Map Northern Territory Geological Survey 1993).**

Rustlers Roost deposit is of the gold-quartz vein type. These veins can be up to 2m thick and contain gold as free metal. The gold in the host sediments is present as sub-micron particles in arsenopyrite and pyrite, but also can occur as free gold (Ahmed, 1998). Toms Gully is a deposit close by that has formed in a similar geological setting.

Locally the geology is described as highly weathered, thus the mining operations in the region have predominantly developed the oxide ore. A substantial amount of transitional and sulphide mineralisation occurs beneath the oxide ore.

At Rustlers Roost four pits were developed to extract this oxide ore; Backhoe, Sweat Ridge, Beef Bucket and Dolly Pot (Figure 4-4).

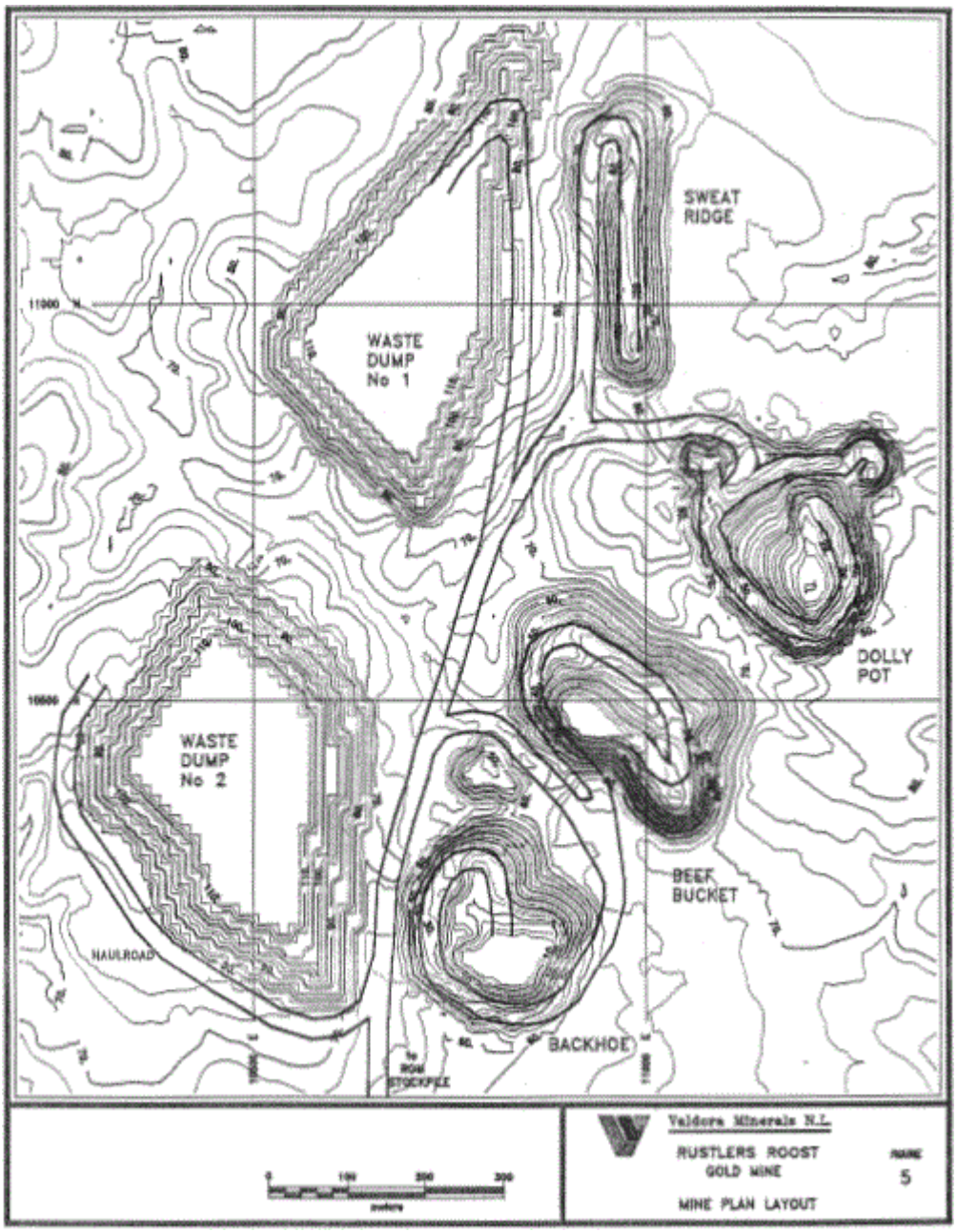



**Figure 4-4 Mine plan layout depicting location of each pit, Backhoe, Sweat Ridge, Beef Bucket and Dolly Pot (Valdora 1994)**

### 4.1.3 Mineralogy and Ore forming processes

The mudstones are the oxidised unit and are characterised by hematisation forming a distinctive red colour (with some green banding). The carbonate and pyrite can be seen to have been replaced either by a void (the carbonate) or by limonite (the pyrite), this is documented as evidence of groundwater movement (Higham, 1989).

In the fresh zone the mudstones contain chlorite, dolomitic carbonate, carbonaceous material (possibly graphite), clastic quartz and accessory leucoxene. Chert nodules surrounded by pyrite are common in the chlorite rich layers, pyrite rich zones can often be seen 1mm to 1cm in thickness (Higham, 1989). The pyrite within these zones is disseminated throughout the layer, in both euhedral (up to 1mm in size) and framboidal (cluster) forms (Higham, 1989).

The chert is possibly formed from carbonate, these cherty units also contain pyrite, which can form up to 30% of the unit which can be anything from 5cm to 1m in thickness (Higham, 1989).

Is was noted by Higham, 1989, that Beef Bucket resource did not contain these cherty units, only pyrite was reported within the mudstones. This pyrite layer was reportedly a good marker band as it sits directly above a thick greywacke unit, as is locally laterally extensive.

In general, for the region, it is documented that the gold-quartz veins formed at pressure-temperatures of approximately 1kbar and 300°C in low to moderate salinity $CO_2$-$CH_4$-$H_2O$-Na-Ca-Mg-Cl brines of a mixed metamorphic and magmatic source. It is likely that this mixing of the magmatic and metamorphic fluids caused the precipitation of the gold (Ahmed, 1998). It is also likely that the lack of correlation with gold mineralisation and any particular mineral assemblage is a result of these multiple phases of fluid rock interaction.

From a review of exploration core and other relevant data, Higham, 1989, provided more detail regarding the mineralisation style for each deposit:

1. Dolly Pot mineralisation is stratiform with gold mineralisation in the cherts.
2. Sweat Ridge and Beef Bucket are mainly stratiform with significant mineralisation in sub-horizontal quartz veins.
3. Backhoe mineralisation is mainly in sub-horizontal quartz veins with little contribution from mudstones or chert. However, the chert is a significant proportion of the deposit as a whole.

It is noted that the bedding parallel quartz veins are generally not mineralised and are volumetrically insignificant.

### 4.1.4 Regolith

The youngest rocks in the region are described in the geological stratigraphy as Mesozoic (Jurassic and Cretaceous) ferruginous quartz sandstones, siltstones and conglomerates (Northern Territory Geological Survey 1993). ASRIS (2011) describes the regolith as saprolite (>50%) and saprolith (20-50%), both these are representative of a deeply weathered profile with the saprolith being the transported member of the saprolite. Deep weathering will have contributed to supergene ore formation, providing a further geochemical process, in addition weathering, to mobilise in situ elements.

### 4.1.5 Soils

The national soils data base ASRIS records the soil pH for the region surrounding the site as likely to have a pH of less than 4.5 (red regions, refer to Figure 4-5).

Surface soil and costean sampling events occurred during the major phases of exploration at the site (Higham 1989, Fabray 2005). Numerous Au and As anomalies were recorded which were used to design the exploration programs given the known relationship of high soil Au concentrations and economic deposits at shallow depths below ground surface.

Most soil sampling that has occurred on the site has had little elemental data other than Au and As concentration data measured. Surface As concentrations of up to 300 ppm were reported with Au.

Soils were described as thin and there was little correlation with Au and soil type or distribution, other than thickness of cover; the gold anomalies were highest where the oxidised and weathered Proterozoic units outcropped.

However, correlation with soil type and plant communities have been noted. From a flora, fauna and soils study completed (Valdora Minerals, 1994) there were distinctive soil type areas associated with each of the three plant communities observed in the project area, as follows:

- Low woodland – skeletal and gravelly yellow lithosoils;
- Open forest – shallow lithosoils and deep red earths; and
- Low open woodland/grassland – alluvium.

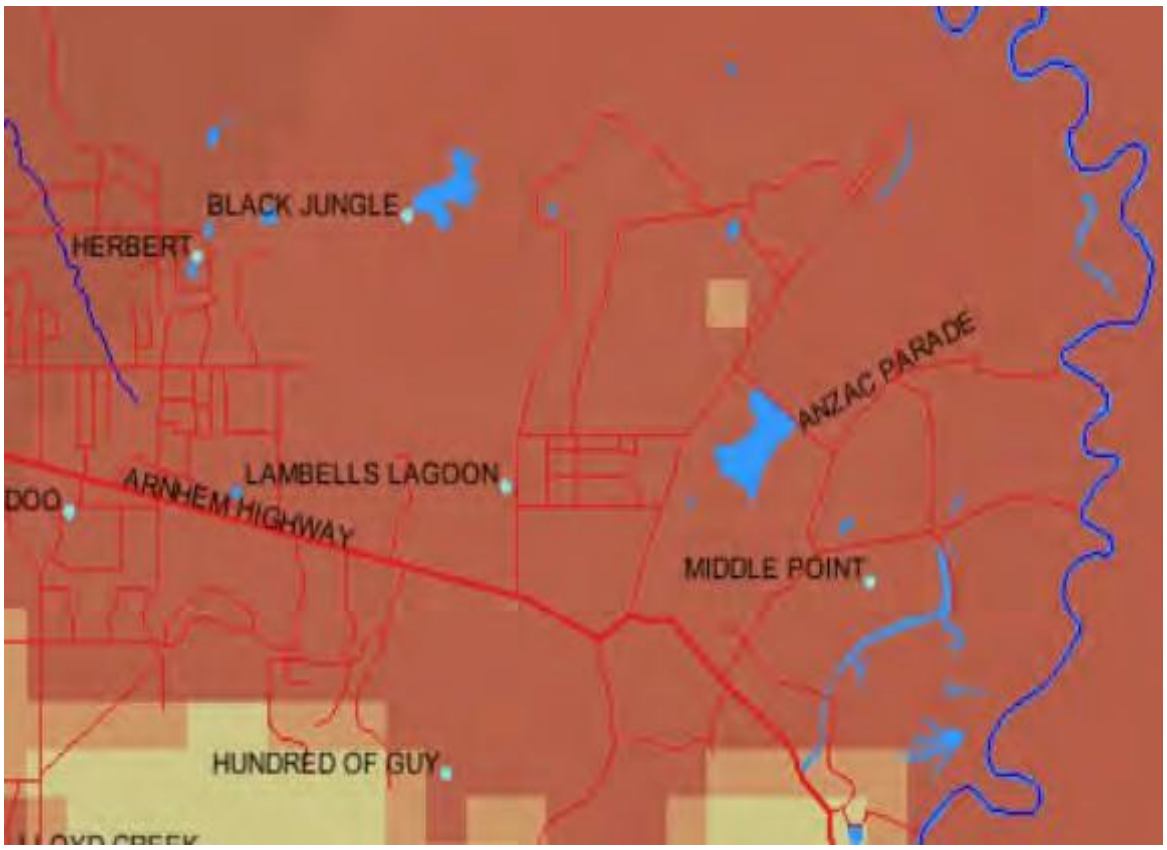



**Figure 4-5 Soil pH (ASRIS)**

### 4.1.6 Stream Sediments

Stream sediment sampling was conducted as part of the exploration studies prior to the development of the mine (Higham 1989). Higham reports stream sediment samples were analysed for total Au, As, Pb, Zn and Cu. However, the report does not provide any interpretation of the results and only presents results for Au, As, and Zn.

Interpretation and better presentation of these data would provide a useful indication of baseline conditions at Rustlers Roost.

## 4.2 Climate

The climate of the Darwin Katherine regional is monsoonal with only two distinct seasons. There are on average 7.7 days per season when a cyclone is present. These cyclones and associated winds may affect the site.

The rainfall is affected by the cyclones, with 95% of the annual rainfall arriving in the region between December and March (typical cyclone season). This wet season can deliver 1,511 mm/yr on average (as recorded at Toms Gully Mine, PG 2017), with the maximum rainfall occurring in January (Figure 4-6).

Historical evaporation data previously reported for the site has depicted a net evaporative environment with annual evaporation (2008 mm/year) exceeding annual rainfall.

The dry season is typically May to September. The hot dry-wet transition occurs from October to November where humidity can be high, and winds can be variable.

The mean daily maximum temperature on site is reportedly 31.5°C in the cooler months and 35.2°C in the hotter months.

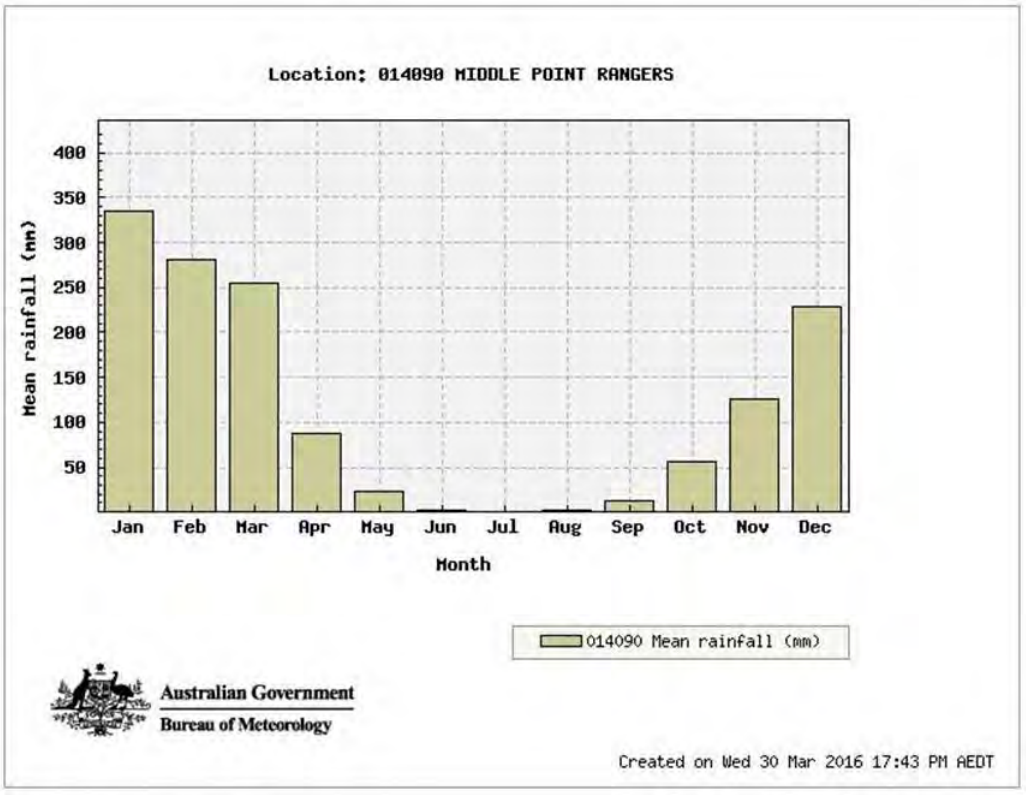



**Figure 4-6 Average Monthly Rainfall**

## 4.3 Hydrology

The following section is a summary of the information presented in PGO-100338-RPT-Hydro-001-A (CDM Smith 2019).

### 4.3.1 Catchment description

The Site is situated near a catchment divide at the headwaters of Mount Bundey Creek, which drains to the east. The Mount Bundey Creek catchment has a total area of approximately 150 km$^2$ and is a tributary catchment of Mary River. The confluence of Mount Bundey Creek and Mary River is located near the Arnhem Highway crossing of Mount Bundey Creek. Mount Bundey Creek is ephemeral and typically only flows for four to six months of the year during the wet season (November to April inclusive).

The local catchment comprises a series of ridges and dissected hills that are drained by small steep rivulets, which converge into two main creek channel, flowing to the west from Annie's Dam and to the east from near the former ROM pad (Figure 4-7). The catchment upstream of Rustler's Roost operations covers around 2.2 km$^2$ and is characterised by outcropping rock. Runoff from the catchment is expected to occur rapidly following rainfall events.

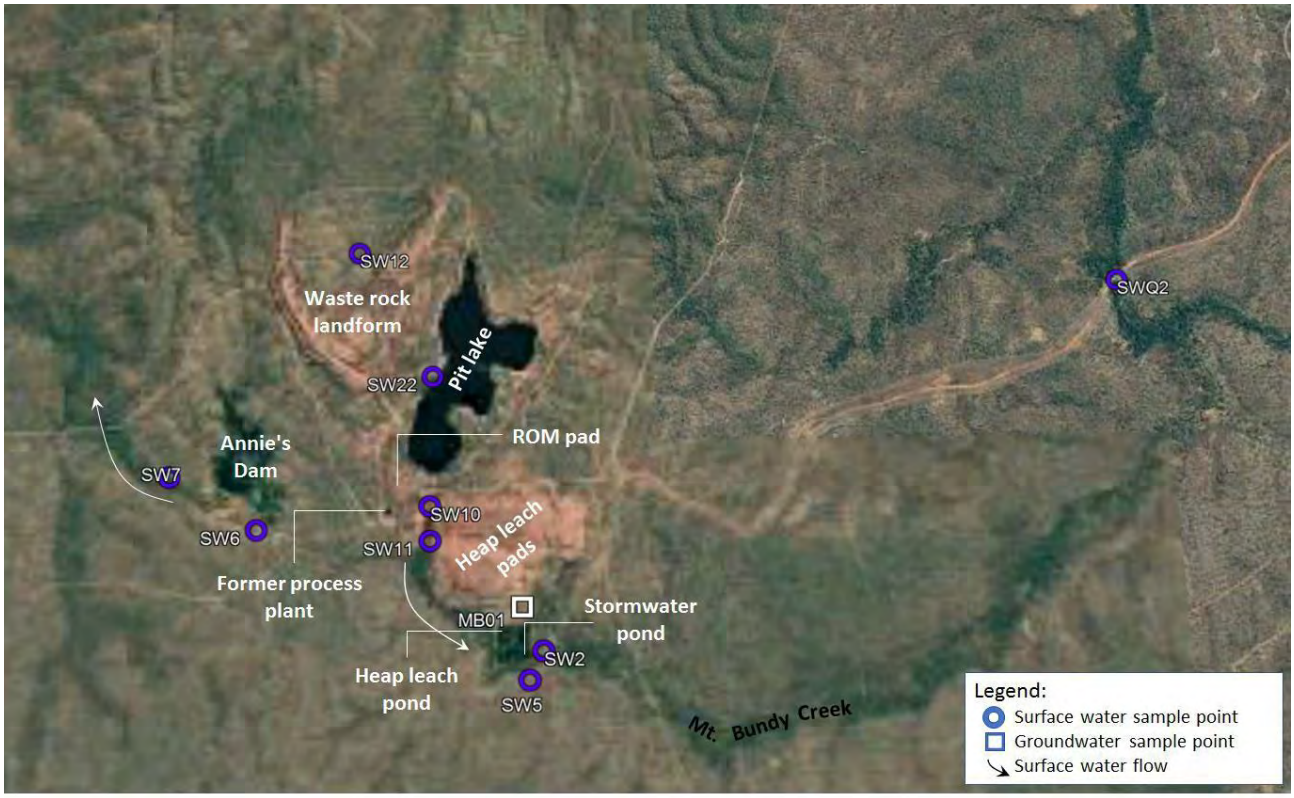



**Figure 4-7 Site locality plan**

The landscape has been altered due to prior mining and processing operations at the Site. Today, there are two permanent water bodies located on the Site – the pit lake and Annie's Dam. Water stored in the pit is likely to be a combination of stormwater runoff, incident rainfall and (possibly) groundwater (assuming the pit lake surface lies below the pre-mine water table), whilst Annie's Dam is likely a combination of stormwater runoff and incident rainfall.

There are no flow data available for Mount Bundey Creek. However, average annual runoff for most small to medium-sized ephemeral creeks in the Top End usually accounts for between 10 and 30 % of incident rainfall. Based on the available flow records held by the Power and Water Authority (PAWA), the average annual runoff in the Mary River catchment approximated 23 % of the mean annual rainfall (310 mm).

### 4.3.2 Surface water quality

There are nine surface water quality monitoring locations around the Site, these locations are shown on Figure 4-7. Hydrogeology

### 4.3.3 General

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2013). The Site is situated near the northern flank of the Pine Creek Geosyncline. Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments and are recharged by direct infiltration of rainfall and stream run-off. A single monitoring well (MB01) is located on the Rustler's Roost site, immediately downstream of the heap leach pad (Figure 4-7).

Recent groundwater monitoring depicts:

- The water table likely occurs within basement rocks, and in Cainozoic sediments where they occur in topographic lows.

- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons.
- With the exception of Al, many of the dissolved metals display freshening trend that may be associated with wet season recharge.
- Groundwater quality is similar to end of dry season surface water quality, potentially indicating groundwater and surface water connectivity.

Results of recent surface water sampling report:

- Surface water is fresh and acidic to neutral, with the most acidic samples collected from and downstream of Annie's Dam and on the northern side of the waste rock landform;
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons.
- Groundwater quality is similar to end-of-dry season surface water quality, potentially indicating groundwater and surface water connectivity.
- With the exception of Al, many of the dissolved metals are reported at lower concentrations at the end of the wet season that may be associated with wet season recharge;
- Elevated concentrations of Fe are typical in surface water samples;
- Mn concentrations are elevated below Annie's Dam;
- Al concentrations are elevated on the northern side of the waste rock landform;
- Pit water quality is distinctly different to all of surface water features, particularly in terms of As, Fe and Zn concentrations.

## 4.4 Hydrogeology

### 4.4.1 General

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2013). The Site is situated near the northern flank of the Pine Creek Geosyncline. Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments and are recharged by direct infiltration of rainfall and stream run-off. A single monitoring well (MB01) is located on the Rustler's Roost site, immediately downstream of the heap leach pad (Figure 4-7).

Recent groundwater monitoring depicts:

- The water table likely occurs within basement rocks, and in Cainozoic sediments where they occur in topographic lows.
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons.
- With the exception of Al, many of the dissolved metals display freshening trend that may be associated with wet season recharge.
- Groundwater quality is similar to end of dry season surface water quality, potentially indicating groundwater and surface water connectivity.

### 4.4.2 Groundwater flow system

Limited aquifer testing has been undertaken at the Site, but the data that are available suggests:

- Aquifer transmissivity ranging between 80 and 110 $m^2/d$
- Aquifer storativity ranging between $10^{-5}$ and $2x10^{-3}$
- Dewatering requirements for the mine (as per the 1997 mine plan) would be in the order of 9 ML/d.

MB01 groundwater levels (heads) have not be gauged / reported and, so, there are no wet and dry seasonal groundwater level variation data by which to assess seasonal fluctuations in the water table. However, Power and Water Authority (PAWA) records indicate that late-wet season water tables are up to 8 m higher than end of dry season water tables, suggesting recharge rates are relatively high or aquifer storativity is low, or a combination of both.

Standing water levels have been measured in uncased and undeveloped exploration holes. Although the integrity of the holes for this purpose is uncertain, the gaugings indicate a fairly steep hydraulic gradient beneath the site, and this is consistent with observed topographic relief. "Backhoe" pumping tests were conducted in the 1990s and indicated the fractured rock aquifer has a high secondary permeability.

Groundwater flow beneath the site is likely to be structurally controlled, with a regional-scale flow path toward Mary River (approximately 20 km) to the east/northeast of the Site. However, at the Site level it is considered probable that local groundwater flow systems exist, with recharge occurring in elevated areas and discharging to small creek lines.

## 4.5 Beneficial use categorisation

Records of registered bores held by PAWA indicate there are two stock/ domestic bores (RN 5912 and RN 27956) located within a 12-kilometre radius of Rustler's Roost. Based on the 1:2 000 000 hydrogeological map sheet (Tickell, 2013) and position in the landscape there is unlikely to be any springs in the immediate project area.

The available groundwater quality data for the Site indicates groundwater is suitable for most beneficial uses, although some treatment may be required where used for potable purposes.

Potentially sensitive groundwater receptors in the area of the Rustler’s Roost site include:

- Commercial and social - Domestic water users, livestock, agricultural enterprises
- Environmental - aquatic ecosystems in baseflow maintained pools or watercourses, riparian vegetation

# Section 5 Data and Information review - Mine Site Layout and Project History

## 5.1 Site history

A brief history of key activities since discovery of gold at the Rustlers Roost site is presented in Table 5-1.

**Table 5-1 Site History**

| Year | Description of activities |
|---|---|
| 1948 | Alluvial gold at Rustlers Roost was discovered by prospectors.<br>Subsequent trenching and pitting identified the Sweat Ridge, Dolly Pot, Beef Bucket and Backhoe prospects. A fivehead stamp battery was erected at Pighole on Mount Bundy Creek, 4 km east of the workings. It is estimated that 200 – 250 tonnes of ore was mined for the production of about 3.7 kg of gold. |
| 1977 | EL 1473 was granted over the area which became known as Rustlers Roost. |
| 1978 | EL 1473 explored by Engineering Excavations NT Pty Ltd in 1978 |
| 1981 | EL 1473 explored by Northern Metals Pty Ltd / Aurex Pty Ltd |
| 1985 | EL 1473 explored by Naron Investments |
| 1988 | EL 1473 explored by Kintaro Gold Mines NL and Pegasus Gold Australia Ltd |
| 1989 | A single Mineral Lease application was made in August 1989. The Mineral Lease, No. 1083, was granted to Valdora Minerals; and, it expired in 1996 |
| 1990 | Pegasus Gold Australia Ltd outlined a resource of 4.8 Mt at 1.6 g/t Au |
| 1994 | Further exploration by Valdora Minerals NL led to an increase in the resource to 34 Mt at 1.17 g/t Au production from heap-leach commencing in June 1994. The initial plan was to combine the open pits at Sweat Ridge, Dolly Pot, Beef Bucket and Backhoe into a single, large oxide pit. |
| 1994-1998 | A feasibility study of the primary resource was also completed which indicated a resin-in-leach treatment facility was the most appropriate treatment route, however, adverse global financial conditions contributed to the closure of operations in early 1998. Total production to March 1998 was approximately 3,425 kg Au and 337 kg Ag from 4.58 Mt of ore at an estimated recovery of 70%. Thus, the figures of the WRD in July 1997 report, are similar to current WRD shape and volume given that mining likely finished soon after the submission of this report. |
| 2002 | Rustlers Roost was purchased by a Canadian Company, Valencia Ventures Inc. who conducted a feasibility study and reported reserves at 13Mt at 1.2g/t Au. |
| 2009 | Crocodile Gold acquired the Rustlers Roost Project and reported resources of 30.24 Mt at 0.9 g/t Au for 875 koz of gold |
| 2012 | Primary Gold acquired the Rustlers Roost |
| 2017 | Primary Gold undertook resource drilling<br>The jorc Code ASX announcement was dated October 2017 |
| 2019 | Current program of work |

## 5.2 Summary of mine plan

Figure 5-1 presents the current mine layout with a description of each area outlined in Table 5-2.

**Table 5-2 Mine Plan Infrastructure with approximate aerial extent**

| Area | Location | Description | Size |
|---|---|---|---|
| A1 | Pit | Three pits have been developed, in the latest extension of mining in 1997 the pit was extended; the oxide berms at the edge of each pit were removed (refer to figure in KP report Draft EIS 1997) | Bathymetry unknown |
| A2 | WRD | Two WRDs were planned, only 1 was constructed, it is located to the west of the pit. The WRD was extended with oxide waste in the last phase of mining in 1997.<br>The WRD should only contain oxide waste. The waste has been placed in small lifts. During the second phase of mining, the construction of the perimeter batters had started, extending the footprint to the west. | Area approx. 304,200 $m^2$<br>209,000 $m^3$ of batters (Fawcett 1997) |
| A3 | Heap Leach pads | Two out of the proposed four heap leach pads have been constructed. They are located to the south of the site, the materials remaining on the pads are red in colour with white precipitates noted and display evidence of erosion (gullys). | Pad A – surface area – 73,600 $m^2$<br>Pad B Surface area 129,000 $m^2$ |
| A4 | Water storage ponds | There are four ponds containing water to the south of the heap leach pads.<br>Based on the plan provided in the 1997 EIS, three are process water ponds and the larger more southernly pond is the stormwater pond. | Unknown |
| A5 | ROM Pad | The ROM pad is likely to be just to the south of backhoe (refer to Fig 5 Study sites for proposed tailings dam Greenbase 1997 in Draft EIS 1997). | Area = approx. 2.5 Ha<br>250 m wide, by 100 m deep by 10 m high (Fawcett 1997). |
| A6 | Tailings pond | The tailings pond was not constructed. In the draft tailings pond design by KP (Draft EIS 1997) the dam wall was to be constructed using oxide waste. There may be evidence of the start of this construction on site to the south of the pit. | Not constructed. |

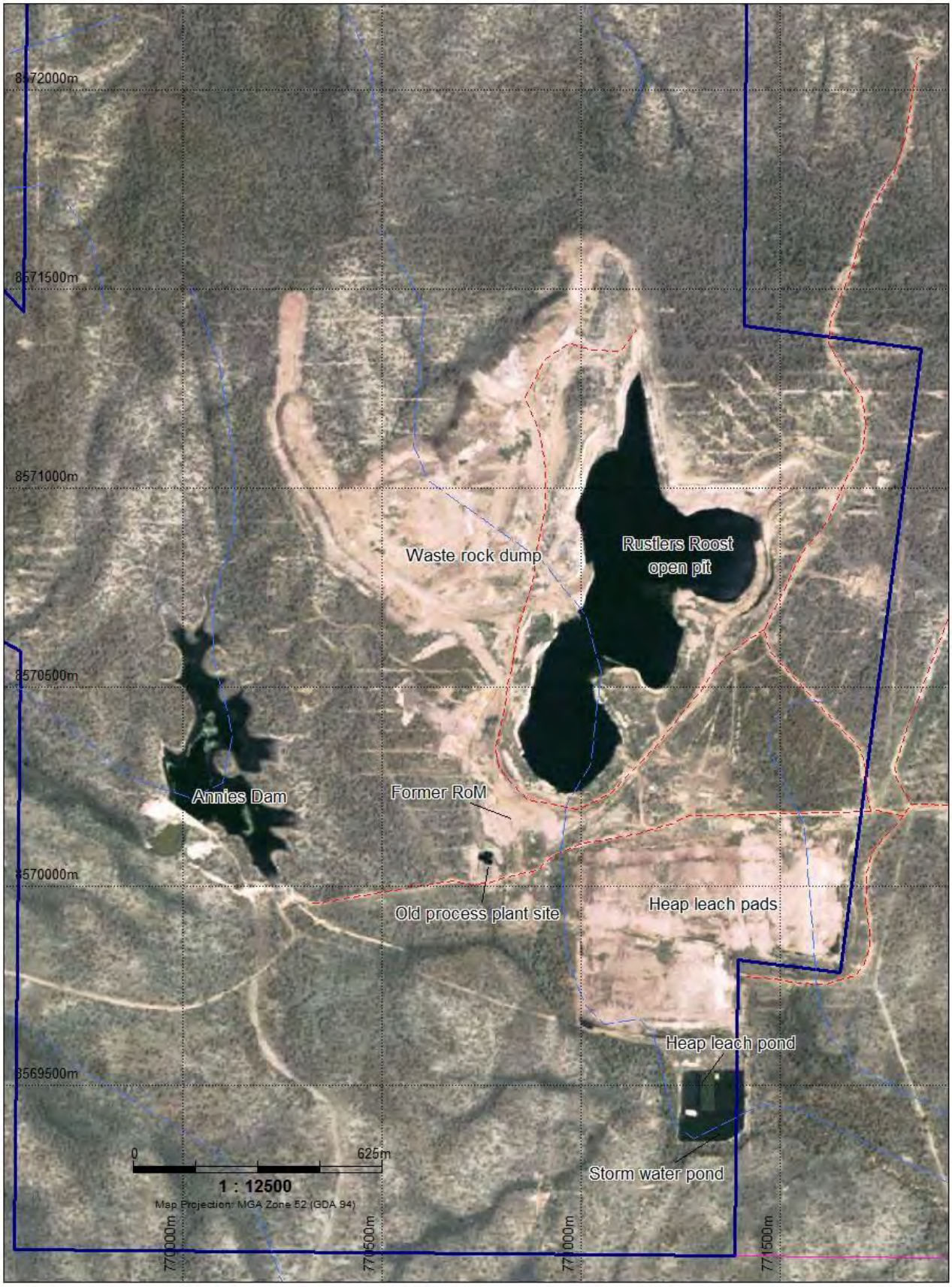



**Figure 5-1 Mine layout (PGO 2018)**

## 5.3 Ore waste ratio summaries

It is unclear as to the exact ore-to-waste ratios that were mined at the site given that there were two phases of active mining (refer to Table 5-1 above), the second of which terminated before completion, therefore given the available data we can only estimate what is currently on site. The reserve volumes of the ore and waste for the site are provided in Table 5-3.

**Table 5-3 Mineable reserves by oxidation state (excerpt from Valdora 1994)**

| TABLE 4 MINEABLE RESERVE VOLUMES BY OXIDATION STATUS | | | | | | |
|---|---|---|---|---|---|---|
| PIT NAME | ORE VOLUMES (103 BCM) | | WASTE VOLUMES (103 BCM) | | TOTAL VOLUME (103 BCM) | |
| | OXIDE | TRANS. | OXIDE | TRANS. | | |
| Dolly Pot | 855 | 76 | 1,054 | 16 | 2,001 | |
| Backhoe | 952 | 179 | 687 | 35 | 1,853 | |
| Beef Bucket | 553 | 255 | 1,315 | 167 | 2,291 | |
| Sweat Ridge | 260 | 0 | 523 | 9 | 791 | |
| TOTAL | 2,620 | 510 | 3,579 | 227 | | 6,936 |

Mining initiated in July 1994 and continued until the end of 1997. The second EIS, (Rustlers Roost Mining Company 1997) provided as draft was developed for the extension of the mine to stage 2, which would deepen the open cut mining into the transition and fresh rock zones.

The first activity required to extend the mine was to remove more of the oxide waste to build the batters of the WRD and tailings dam wall. From the site photographs it appears that this work had started by the time the mine went into care and maintenance.

Consequently, the above table provide the best estimate for the maximum volumes of waste that would have existed at the site by the end of mining the oxide zone.

Future mining at the site will intercept the transition and fresh rock zones. No estimation of waste-to-ore ratios have been reported to date for these reserves.

Primary Gold (PG) conducted a drilling program across the Rustlers Roost deposits for exploration purposes. This new data was compiled along with data from historical drilling campaigns to create an updated resource estimate.

These new data demonstrate the consistency in the description of the geological profile and the gold mineralisation, and concurred with previous results from exploration.

PG note that their resource estimation is based on assay data for Au only, no correlation between elements was conducted as only Au assay data were supplied in the drilling records. A cut-off grade of 0.5 g/t was advised.

## 5.4 Mining and ore processing

Ore was drilled and blasted, then hauled and crushed on site. The ore is likely to be metamorphosed sedimentary lithologies (pellites and psammites) with elemental gold, however, some of the surrounding host sediments may also have been considered economic.

The crushed product was cement agglomerated and cyanide pre-treated which was followed by heap leach and carbon-in-column recovery processes to produce gold Dore. Further details on the cyanide process is provided in section 5.5 below.

The cyanide-gold solution drained through the leap pad to lined ponds. The ponds were lined with a synthetic geotextile.

The recovery room housed the adsorption and elution circuits. In the adsorption circuit, the pregnant solution was passed through activated carbon (possibly a coconut charcoal product) where the gold is adsorbed onto the carbon surface. In the elution circuit the loaded carbon was stripped of gold (we note that the elution solution was not documented).

The gold room housed the electrowinning circuit and smelting circuit. In the electrowinning circuit the final solution from the carbon column is electrically plated on to steel wool. This product was then smelted to produce gold Dore.

Resin in leach processing was planned for phase 2, this method would have required investment in method development. Based on the data available it is unlikely that this processing facility was commissioned and hence mining ceased prior to reaching the transition zone ore where this method was the only one likely to have produced economic extraction efficiencies (RRMC Pty Ltd 1997).

RRMC Pty Ltd 1997 state that there are two WRD's of approximately 23 Ha in total which are up to 25 m in height on site. The final volume was to be 50 Ha with an additional 20 m height (raised WRD height to 45m).

The planned final design of the WRD was to mimic the local landform shape, utilising local gullies for waste placement thus the final effective height may be only 25m, but total waste height will likely be greater (Figure 5-2).

## 5.5 Cyanide and gold extraction

There have been no documents reviewed that detail the full cyanide extraction process adopted at the site, thus for information purposes the following is a summary of the gold extraction process documented in Cyanide Management, Leading Practice Sustainable Development Program For the Mining Industry, Australian Government Department of Resources, Energy and Tourism, May 2008.

Cyanide is a compound containing carbon and nitrogen where the carbon is triple bonded to the nitrogen. Hydrogen cyanide (HCN) is a colourless gas that has a slight bitter almond odour when wet. Sodium cyanide and potassium cyanide (the common cyanidation agents) are white powders that can also have a bitter almond odour when in contact with water.

The use of cyanide is strictly controlled. Cyanide is a fast acting poison (causing cyanosis), it binds to iron containing enzymes in the body that cells use to utilise oxygen, thus when these are blocked tissues cannot take up oxygen from the blood stream.

The process of dissolving gold with cyanide is simple; the crushed ore is mixed to a wet slurry with a solution of sodium cyanide. The slurry is made alkaline with lime (calcium oxide) the alkaline pH ensures that the free cyanide ions, which combine selectively with the gold, are not lost as free cyanide gas.

Cyanide can be lost in other ways; complexation with copper, iron and zinc or through reaction with sulfur to form thiocyanate, can occur if the ore has a mixed mineralogy. Generally, separation techniques prior to cyanide processing minimise these losses. Given the geology of the site, it is possible that these complexes will exist in any cyanide solution entrained within the HLP or in sediments at the base of the decant ponds on site.

It is known that the carbon in column method was to be used for the expansion of the mine following the initial phase of mining completed in 1997 (refer to section 5.4 above). The first phase of gold extraction only adopted the heap leach method without further treatment.

The initial metallugical data reported by Primary Gold in their ASX announcement Jorc report (October 2017) noted that heap leach would be affected by the graphite content of the ore, limiting the gold ore cyanidation, thus pre-treatment of the graphite with kerosene followed by a resin in leach extraction method would be required to improve the gold recovery. It is unclear whether any previous proponents used the kerosene pre-treatment method.

Knowledge of cyanide complexation reactions can inform the understanding of the potential persistence of cyanide metal complexes in the environment.

The most toxic forms of cyanide are measured as weak acid dissociable (WAD) cyanide, free cyanide and complexed forms. Any analysis of solids; tailings or heap leach residue, surface and groundwater should include these species.

Acid forming ores processed on heap leach pads will have had to be characterised via acid base accounting techniques to ensure sufficient lime was added to neutralise the acidity and maintain the optimum pH for cyanide management both during operation and at closure. If insufficient lime was used, acidification may have occurred on site, resulting in the degradation of the cyanide complexes and ultimately, cyanide oxidation to nitrogen gas.

## 5.6 Rehabilitation

As part of the 1997 EIS for phase 2 of mining (RRMC Pty Ltd 1997), a decommissioning plan was developed for the site:

- Rustlers Roost Decommissioning Plan For William Resources – Fawcett Mine Rehabilitations Services Pty Ltd, July 1997 (Fawcett 1997)

As part of the development of the plan, fieldwork was conducted on 7th and 8th July 1997.

Fawcett discusses the use of oxide waste from the WRD to rehabilitate other areas on site including the surface water pond (dry at time of site visit) and other ponds. However, there is no discussion of testing any soil or waste to assess its quality before use for rehabilitation purposes. Further, with reference to the soils and oxide materials at the site, it was recommended that these materials, were to be dosed into the pits to lower the berm height. As the pit is now flooded it is unclear how much material may have been pushed into the pit.

Fawcett makes the recommendation that to manage water at the site, all WRD and other run off from the site should report to the pits. Four pits were reported to be open at the time of the site visit.


**Figure 5-2 Outline of Waste Rock Dump in July 1997 (Fawcett, 1997)**

# Section 6 Previous Geochemical Characterisation Studies

The following section provides a summary of the historical geochemical studies conducted at the site. The geochemical assessments were conducted as part of the environmental impact Statements conducted in 1994 and 1997. The reports reviewed are:

- EIS 1994 Valdora Minerals - contains a summary of the Environmental Earth Sciences (EES) geochemical characterisation report for two deposits; Dolly Pot and Backhoe, we note that the appendices to this report were not provided, and thus raw data has not been sighted.
- Draft 1997 EIS RRMC Pty Ltd, appendices
    - Acid forming potential and multi-element composition of tailings – Implications for waste management. Report prepared by Graeme Campbell and Associates Pty Ltd for Rustlers Roost Mining Pty Ltd in September 1996.
    - Acid forming potential and multi-element composition of waste rock and ore samples – Implications for waste rock management. Report prepared by Graeme Campbell and Associates Pty Ltd for Rustlers Roost Mining Pty Ltd in January 1997.

## 6.1 Valdora Minerals EIS 1994 – summary of test work completed by Environmental Earth Sciences

Chemical characterisation of the ore from Dolly Pot and Backhoe was completed by Environmental Earth Sciences in 1994. The samples were collected from 40 micron pulped drill cuttings from the exploration program. A summary of the ore characteristics reported in this study are provide in Table 6-1.

**Table 6-1 Summary of ore characteristics (EES 1994)**

| PIT NAME | ORE VOLUMES (103 BCM) | | WASTE VOLUMES (103 BCM) | | TOTAL VOLUME (103 BCM) | | |
|---|---|---|---|---|---|---|---|
| | OXIDE | TRANS. | OXIDE | TRANS. | | | |
| Dolly Pot | 855 | 76 | 1,054 | 16 | 2,001 | | |
| Backhoe | 952 | 179 | 687 | 35 | 1,853 | | |
| Beef Bucket | 553 | 255 | 1,315 | 167 | 2,291 | | |

It was noted that the net acid generation potential (NAGP) was positive for both ore types in both deposits, however ANC was present. Sulfur levels were considered low and consequently, the risk of acidification was considered to be low.

It was noted that these ores would be leached at a high pH, the assertion was made that the addition of the high pH heap leach lixiviant would provide further neutralising capacity in any waste produced from this process. This was not validated.

## 6.2 Graeme Campbell and Associates, GCA 1996 - Tailings Characterisation

The geochemical characterisation of tailings produced by bench scale metallurgical leaching of primary and transitional zone ore was conducted and reported by GCA in 1996.

The test suite included:

- Total S
- Sulfate-S (measured)
- Sulfide–S (calculated)
- ANC
- NAG
- NAPP (calculated)
- Multi – element assay via a four acid digest.

GCA 1996 reported that:

- Primary ore tailings had sulfide S content of 1.5% S
- Transitional ore tailings sample had sulfide sulfur = 0.5% S
- Sulfate contents were in the range of 0.02-0.04% S
- ANC values were low to moderate; 2.1 and 13 kg/H2SO4/T respectively.
- Both samples were classified as PAF.

GCA concluded that:

- although the pyrite content of both samples was considered low, both had limited neutralising capacity and thus both held the potential to acidify.
- total elemental content of tailings were generally low, with the exception of As, Ag and Se. The GAI were low which correlates with the low concentrations measured.

In order to assess the possible drainage quality of tailings slurry decants, GCA discussed the pH and EC of the decant water generated during preparation of the filter cake from the bench test:

- Transition Zone ore tailings – pH 7.7, EC 1100 uS/cm
- Primary ore tailings – pH 7.3, EC 1300 uS/cm

## 6.3 Graeme Campbell and Associates 1997 - Waste rock and ore characterisation

Sampling for the geochemical characterisation studies for waste was collected from exploration drill core, and in general represents materials still to be mined.

Three drillholes were selected for the project. Siltstone was the dominant lithology in the geological logs provided.

The samples represent the oxide (weathered), transitional and fresh zones. Samples of primary ore were also selected for testing to assess the potential acid forming nature of any future tailings.

Samples were selected at 1 m intervals from drill cuttings and pulped to 40 microns. A total of 134, 89 and 149 samples were collected from Dolly Pot/Sweat Ridge, Beef Bucket and Backhoe respectively. The particle size of the material in the WRD will likely range from 10-250mm or greater (GCA 1997) and thus the tested material had a much higher surface area to mass ratio and consequently it is considered that reactivities estimated from the test work are conservative.

The test suite included:

- Total S
- ANC
- NAG
- NAG-pH
- Multi – element assay via a four acid digest.

However, we note that this test suite was not employed to all samples, only a select few.

For ease of reference we have reproduced the results of the weathered zone samples tested by GCA during the 1997 program of work (Table 6-2). These data may be the most representative of the last materials to be disposed of to the WRD or dosed into the pit during rehabilitation. The full dataset and laboratory certificates are provided in GCA 1997.

**Table 6-2 All results from weathered samples analysed by GCA (GCA 1997)**

| Sample no. | RL m | location | rock type | weathering code | ore/waste category | Sulfur S % |
|---|---|---|---|---|---|---|
| 141091 | 555.1 | DP/SR | Siltstone | WZ | W | <0.01 |
| 141092 | 554.1 | DP/SR | Siltstone | WZ | W | <0.01 |
| 141093 | 553.1 | DP/SR | Siltstone | WZ | W | <0.01 |
| 141094 | 552.1 | DP/SR | Siltstone | WZ | W | <0.01 |
| 141095 | 551.1 | DP/SR | Siltstone | WZ | W | <0.01 |
| 141096 | 550.1 | DP/SR | Siltstone | WZ | W | 0.04 |
| 141097 | 549.1 | DP/SR | Siltstone | WZ | W | 0.09 |
| 141098 | 548.1 | DP/SR | Siltstone | WZ | W | 0.01 |

Where DP = Dolly Pot, SR = Sweat Ridge, WZ = Weathered zone, W = waste

| Sample no. | RL m | location | rock type | weathering code | ore/waste category | Sulfur S % |
|---|---|---|---|---|---|---|
| 141231 | 553.0 | BB | Siltstone | WZ | W | <0.02 |
| 141232 | 552.0 | BB | Siltstone | WZ | W | <0.01 |
| 141233 | 551.0 | BB | Siltstone | WZ | W | <0.01 |
| 141234 | 550.0 | BB | Siltstone | WZ | W | <0.01 |
| 141235 | 549.0 | BB | Siltstone | WZ | W | <0.01 |
| 141236 | 548.0 | BB | Siltstone | WZ | W | <0.01 |
| 141237 | 547.0 | BB | Siltstone | WZ | W | <0.01 |
| 141238 | 546.0 | BB | Siltstone | WZ | W | <0.01 |
| 141239 | 545.0 | BB | Siltstone | WZ | W | <0.01 |
| 141240 | 544.0 | BB | Siltstone | WZ | W | <0.01 |
| 141241 | 543.0 | BB | Siltstone | WZ | W | <0.01 |
| 141242 | 542.0 | BB | Siltstone | WZ | W | <0.01 |
| 141243 | 541.0 | BB | Siltstone | WZ | W | <0.01 |
| 141244 | 540.0 | BB | Siltstone | WZ | W | <0.01 |
| 141245 | 539.0 | BB | Siltstone | WZ | W | <0.01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 141246 | 538.0 | BB | Siltstone | WZ | W | <0.01 |
| 141247 | 537.0 | BB | Siltstone | WZ | W | <0.01 |
| 141248 | 536.0 | BB | Siltstone | WZ | W | <0.01 |
| 141249 | 535.0 | BB | Siltstone | WZ | W | <0.01 |
| 141250 | 534.0 | BB | Siltstone | WZ | W | <0.01 |
| 141251 | 533.0 | BB | Siltstone | WZ | W | <0.01 |
| 141252 | 532.0 | BB | Siltstone | WZ | W | <0.01 |
| 141253 | 531.0 | BB | Siltstone | WZ | W | <0.01 |

Where BB = Beef Bucket, WZ = Weathered zone, W = waste

| Sample no. | RL m | location | rock type | weathering code | ore/waste category | Sulfur S % |
|---|---|---|---|---|---|---|
| 140941 | 555.2 | BH | Greywacke | WZ | W | <0.02 |
| 140942 | 554.3 | BH | Greywacke | WZ | W | <0.01 |
| 140943 | 553.3 | BH | Greywacke | WZ | W | 0.01 |
| 140944 | 552.4 | BH | Greywacke | WZ | W | <0.01 |
| 140945 | 551.4 | BH | Greywacke | WZ | W | <0.01 |
| 140946 | 550.5 | BH | Greywacke | WZ | W | <0.01 |
| 140947 | 549.6 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140948 | 548.6 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140949 | 547.7 | BH | Siltstone | WZ | W | <0.01 |
| 140950 | 546.7 | BH | Siltstone | WZ | W | <0.01 |
| 140951 | 545.8 | BH | Siltstone | WZ | W | <0.01 |
| 140952 | 544.9 | BH | Siltstone | WZ | W | <0.01 |
| 140953 | 543.9 | BH | Clay | WZ | W | <0.01 |
| 140954 | 543.0 | BH | Clay | WZ | W | <0.01 |
| 140955 | 542.0 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140956 | 541.1 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140957 | 540.2 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140958 | 539.2 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140959 | 538.3 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140960 | 537.3 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140961 | 536.4 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140962 | 535.5 | BH | Greywacke/silt | WZ | W | <0.01 |
| 140963 | 534.5 | BH | Siltstone | WZ | W | <0.01 |
| 140964 | 533.6 | BH | Siltstone | WZ | W | <0.01 |
| 140965 | 532.7 | BH | Siltstone | WZ | W | <0.01 |
| 140966 | 531.7 | BH | Siltstone | WZ | W | 0.01 |
| 140967 | 530.8 | BH | Greywacke | WZ | W | <0.01 |
| 140968 | 529.8 | BH | Siltstone | WZ | W | <0.01 |

Where BH = Backhoe, WZ = Weathered zone, W = waste

Oxidised waste rock (weathered and transition zone materials) from the pits assessed was considered barren with respect to sulfur content (total S ranged from 0.02 to 0.11 % in Dolly Pot/Sweat Ridge, 0.02 % in Beef Bucket and 0.02 to 0.07% in Backhoe) and had a negative net acid generating potential (NAGP; -3.4 to 1.0 kgH2SO4/T, Dolly Pot/Sweat Ridge, and – 1.8 to 0.4 kgH2SO4/T in Backhoe), thus it was not expected that acidic leachate would form from the oxidised material.

The transition zone materials of Beef Bucket contained total S up to 1.37%, with varying ANC values giving a range of NAPP 15-34 kg $H_2SO_4$/tonne. GCA classified the material as NAF, PAF-low capacity and PAF-moderate capacity. GCA noted that the samples had very little capacity to consume acid, and that up to 30% of the waste rock produced from Beef Bucket in the transition zone may be PAF.

*Fresh Zone*

The materials in the fresh zone (Dolly Pot/Sweat Ridge) had total S values ranging from 0.01 to 1.17% and had a range of NAPP -76 kg $H_2SO_4$/tonne to 18 kg $H_2SO_4$/tonne. GCA gave a combined classification of these samples of PAF/low capacity.

The materials in the fresh zone of Beef Bucket had Total S ranging from 0.08-0.12%. The NAPP ranged from 0.2-26 kg $H_2SO_4$/tonne. Thus, GCA concluded that these materials also classified as PAF (low-moderate capacity), which would apply to most of the fresh zone waste from Beef Bucket.

The materials in the fresh zone of Backhoe had total S ranging up to 1.36%. NAPP ranged from -100 to 33 kg $H_2SO_4$/tonne. The fresh zone of Backhoe was classified as both NAF-low capacity and PAF- moderate capacity, although it was stated that the PAF – moderate capacity would apply to the bulk of the waste from this deposit.

GCA noted that data presented in the report was consistent with the previous study of the transitional-ore and primary ore tailings.

GCA concluded that waste rock from the weathered zone from all deposits was NAF, the waste rock from the transition zone with the exception of Beef Bucket was also NAF.

The fresh zone waste rock from all deposits and the transition zone waste rock from Beef Bucket was PAF – low to moderate capacity.

*Multi element assessment*

Low levels of a broad suite of elements were reported (B, Ba, Bi, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Sn, Th, Tl, U, V and Zn).

# Section 7 Data Review Summary and Discussion

The site geology is predominantly weathered materials. The base of the oxidation zone is estimated as 60 m below the initial ground surface.

Regionally and locally the soil pH is acidic, the cause of the acidity is likely due to soluble and slightly soluble iron and aluminium oxide minerals in the weathered soil profile. These oxides provide a source of non-sulfur derived acidity. Reactions with $Fe^{2+}$ can produce various forms of iron hydroxide precipitates (floc) e.g. goethite, depending on the pH of the system. The oxidation of $Fe^{2+}$ and the hydrolysis of $Fe^{3+}$ can liberate large amounts of acid often far down gradient from the source, and far more that than the oxidation of pyrite in conditions without free iron. It is noted that the release of acidity by hydrolysis can occur without the need for oxygen.

Given the deep weathering profile at the site, acid forming secondary sulfate minerals may exist. However, with the relatively shallow groundwater table they may have mostly dissolved. Low levels may be actively forming from the oxidation of remnant sulfides within the WRD/heapleach and or sub-surface geological profile.

The sulfide content of the geological materials is described as low, however, the pyrite particle size in regional studies has been described as small euhedra and or framboids, which have a large surface area for reaction. This finely disseminated sulfide is present in both the ore and waste units and, given that it is thought to be a precipitate from the mixing of multiple fluids, it does not correlate with any particular stratigraphic unit. The gold formed in a similar way, consequently, there is little correlation of gold concentrations and sulfur levels in the data available (which is limited).

A further source of sulfate is from the concentration of minerals from the evaporation of surface water. During periods of rainfall, the dried salts will report back to surface water and potentially infiltrate into groundwater. The concentration delivered will be dependent on the water volume. Thus, it is important to note the rainfall in the region when interpreting water quality results.

Although there are several potential acid sources at the site (as summarised in Table 7-1), there are also minerals present that provide a source of neutralising potential for the released acidity. The potential acid neutralising minerals at the site are likely to be carbonates and silicates, these are summarised in Table 7-2.

**Table 7-1 Potential Acid Forming Minerals at Site**

| Mineral | Unit |
|---|---|
| Pyrite | Proterozoic – ore and waste |
| Arsenopyrite | Proterozoic – ore and waste |
| Jarosite | Mesozoic – saprolitic grit |
| Alunite | Mesozoic – saprolitic grit |
| Clays | Mesozoic – saprolitic grit |

**Table 7-2 Potential Acid Neutralising Minerals at Site**

| Mineral | Unit |
|---|---|
| Calcium carbonate (calcite) | Mesozoic – saprolitic grit – overburden |
| Magnesium carbonate (dolomite) | Proterozoic – ore and waste |
| Chlorite (silicate) | Proterozoic – ore and waste |
| Quartz (silicate) | Proterozoic – ore and waste |
| Oxides and clays | All |

Given the presence of a variety of neutralising minerals, it is likely that any acid generated within the groundwater zone will be neutralised. The effects of the mobilisation of metals and metalloids will be reflected in the distribution of the elements in the water and the final EC.

The low pH of the soils in the region limits the potential for attenuation of released metals and metalloids through adsorption. The sub-surface geologies may have some attenuation potential given the possibility of the presence of clays and organic matter (graphites).

The low pH of the soils also provides evidence to support the lack of availability of the insitu neutralising potential. It is likely that these minerals are armoured by iron oxides in these superficial environments. This can be confirmed through mineralogical and kinetic testing.

It is also noted here that Total C cannot be used as a proxy for ANC as the geology contains a significant graphitic content which is a non-acid neutralising form of carbon.

The sulfide content of the geological profile increases with depth. The oxide materials are NAF, however, the waste materials from the transition zone to the fresh zone will likely be acid forming.

A classification as NAF does not inform the solubility of the materials only their likelihood of generating acidic leachates. Weathered lithologies commonly release Al and Fe into water courses. This can generate acidic conditions particularly in freshwater environments.

Any seepage generated from the PAF zones may contain measurable levels of metals such as Ag, and metalloids such as As and Se. From these data, we can surmise that groundwater flowing through the deeper geologies may be more saline and may contain elevated concentrations of these metals and metalloids in concert with the regional commodity elements such as Pb and Zn.

The assessment of bench scale tailings chemistry demonstrated that there is the potential that processed wastes will produce seepage that is of a higher pH and EC than local groundwater.

The use of cyanide leaching on site will have augmented the release of base and precious metals from their source materials. It is unlikely that cyanide will remain in the surface materials of the current heap leach pads, however it may still be present at depth given that the heap leach pads may be up to 25m in height and the materials may have limited hydraulic conductivity.

The leachates from the heap leach pads have been stored in lined ponds which appear to be located within the flow path of a creek. During rainfall events it is possible that these ponds may have overtopped releasing their contents to the creek. The ponds may currently be filled with rainwater from a subsequent rainfall event. As a consequence of this, the sediments/precipitates at the base of each pond may be the best media to sample to provide information on the potential inputs to the creek.

A summary of the potential sources of elements and compounds of potential environmental concern is presented in Table 7-3.

**Table 7-3 Summary of potential sources and their chemicals of interest**

| Sources | Chemical signature – chemicals of interest |
|---|---|
| Waste rock dump - oxide waste | Sulfides – arsenopyrite and pyrite Al, Fe, As, Pb, Zn, Cu, Sn, low pH.<br>Sulfates, oxides and hydroxides |
| Pit Walls - oxide and possibly transition zone at base | Sulfides – arsenopyrite and pyrite Al, Fe, As, Pb, Zn, Cu, Sn, low pH<br>Sulfates, oxides and hydroxides |
| ROM pad – oxide ore | Sulfides – arsenopyrite and pyrite Al, Fe, As, Pb, Zn, Cu, Sn, low pH<br>Sulfates, oxides and hydroxides |
| Heap leach pad – oxide ore | Cyanide complexes, high pH may have stabilised the cyanide sufficiently for it still to be present on site.<br>Sulfates, oxides and hydroxides |

| | |
|---|---|
| Leachate ponds | Cyanide complexes, high pH, Fe, As, Pb, Zn, Cu, Sn, Au<br><br>Carbon Column acid wash cycle decant – low pH, broad suite of metals and metalloids in solution.<br><br>Cyanide will have oxidised, given the length of time since operation it is likely that all nitrogen compounds have oxidised to nitrogen gas. |

# Section 8 Conceptual Geochemical Model

To develop the geochemical conceptual model, we combined the information gathered above with likely source terms and release mechanisms into the hydrogeological conceptual model already developed (PGO-1000338-RPT-GW-001-A (CDM Smith 2019)).

As noted in the hydrogeological model, there is limited available data from which to develop a detailed conceptual geochemical model.

Table 8-1 and Figure 8-1 present the preliminary hydrogeological conceptualisation with the addition of likely geochemical processes.

**Table 8-1 Geochemical Conceptual Site Model**

| Hydrogeological Process | Geochemical process |
|---|---|
| ① Wet season rainfall generates surface water runoff (sheet and stream flow) and groundwater recharge<br>② Runoff to local catchments, the Rustler's Roost pit lake and Annie's Dam[3]<br>③ Seasonal runoff from waste rock[4] (to northern creek and mine pit) and heap leach pads[5] (to Mt Bonny Creek) | The geological units at the site will likely not deliver a large load of dissolved constituents to surface water bodies. The local surface geology is highly weathered. The dissolved constituents in the run-off will likely be dominated by Fe and Al. The total sulfur content of the geological materials at the site are low, and thus there is little source of sulfate form these units. The pH of the run off is likely to be between 4 and 5 reflecting that of the local soils.<br>Thus, the release of EEC from the soil is controlled by solubility and pH. The low pH is likely not derived from sulfide oxidation. |
| ④ Rainfall infiltration and recharge | The resultant water quality due to rainfall rechange is most likely very similar to that of the run off. The slightly acidic pH of the soils will likely impart that signature to the percolating rainfall, thus the resultant water will mobilise Fe and Al from the soils.<br>Thus, the release of EEC from the soil is controlled by solubility and pH. |
| ⑤ Infiltration of water from waste materials and leach pads to underlying groundwater system | The EC from the static testing of bench scale tailings testing indicated that the leachates from these materials may have an EC in the order of 1100-1300 µS/cm, which is several orders of magnitude higher than surface and groundwater levels. Thus, there is the potential that the materials in the heap leach pads may contribute to increasing salinities in surface water at the site.<br>The heap leach materials are not likely to be acid forming and thus the geochemical process here is likely to be a solubility controlled release. |
| ⑥ Pit lake formed from groundwater discharge to former mine pit, incident rainfall and seasonal runoff, it is unknown whether the pit overflows during extreme rainfall events or whether it is essentially a flow-through system (water quality data does not indicate the pit lake is a terminal water body). | Leachates from the WRD may reach the pit, however based on the mine plan layout it is likely that the runoff and leachate from the heapleach pads will flow eastward or south away from the pit. The WRD leachates and run off will likely enter the pit, delivering additional dissolved load.<br>WRD leachates likely to be low EC, similar to other run off sources. |

[3] Annie's Dam is located in a separate catchment (Marakai Creek) to the pit lake and Mt Bonny Creek
[4] Northern side of waste rock landform drains to separate catchment
[5] Waste rock landform and heap leach pads are not integrated as shown on schematic.

| | |
|---|---|
| ⑦ Evaporative losses from pit lake maintain a dynamic steady state pit lake level (seasonal fluctuations) | Evaporation causes evapoconcentration, this may lead to increased chemical mass loss from the pit if it is a through flow system as superficial water of the pit evapoconcentrate and flow out through the weathered surficial deposits. |
| ⑧ Groundwater discharge to pit lake | The quality of groundwater discharge to the pit may reflect the host rock composition. The presence of sulfides increases with depth. If the dewatering employed for the first phase of mining intercepted the transition or fresh zone, this groundwater may display signs of impact form AMD or neutral drainage. This may cause stratification of the pit if the deeper groundwater source is more saline than the shallow groundwater and surface water inputs.<br><br>pH and solubility controls on water quality, evidence of neutralised sulfide oxidation products driving groundwater/deep pit water quality with pit water containing elevated levels of As, Mn and Zn compared to other surface water bodies on site. |
| ⑨ Possible seasonal groundwater discharge to creeks (reliant on water table rise due to seasonal recharge) | If the pit lake has not mixed and remains stratified it is likely that the water quality discharging from overtopping of the pit would be similar to site run off.<br><br>pH and solubility controls on water quality (non- sulfidic acidity) |
| ⑩ Deep regional groundwater flow toward Mary River (Rustler's Roost catchment) | As discussed above, the deeper groundwater may mobilise oxidation products from sulfidic materials within the ore zone off site.<br><br>The water at the base of the pit may reflect this sulfidic input.<br><br>The water quality is likely to be neutral as there are a range of acid neutralising minerals in the geological profile.<br><br>Neutral mine drainage which may contain As, Fe, Mn, Se and Zn with low concentrations of sulfate.<br><br>pH and solubility controls on water quality, evidence of neutralised sulfide oxidation products driving water quality |

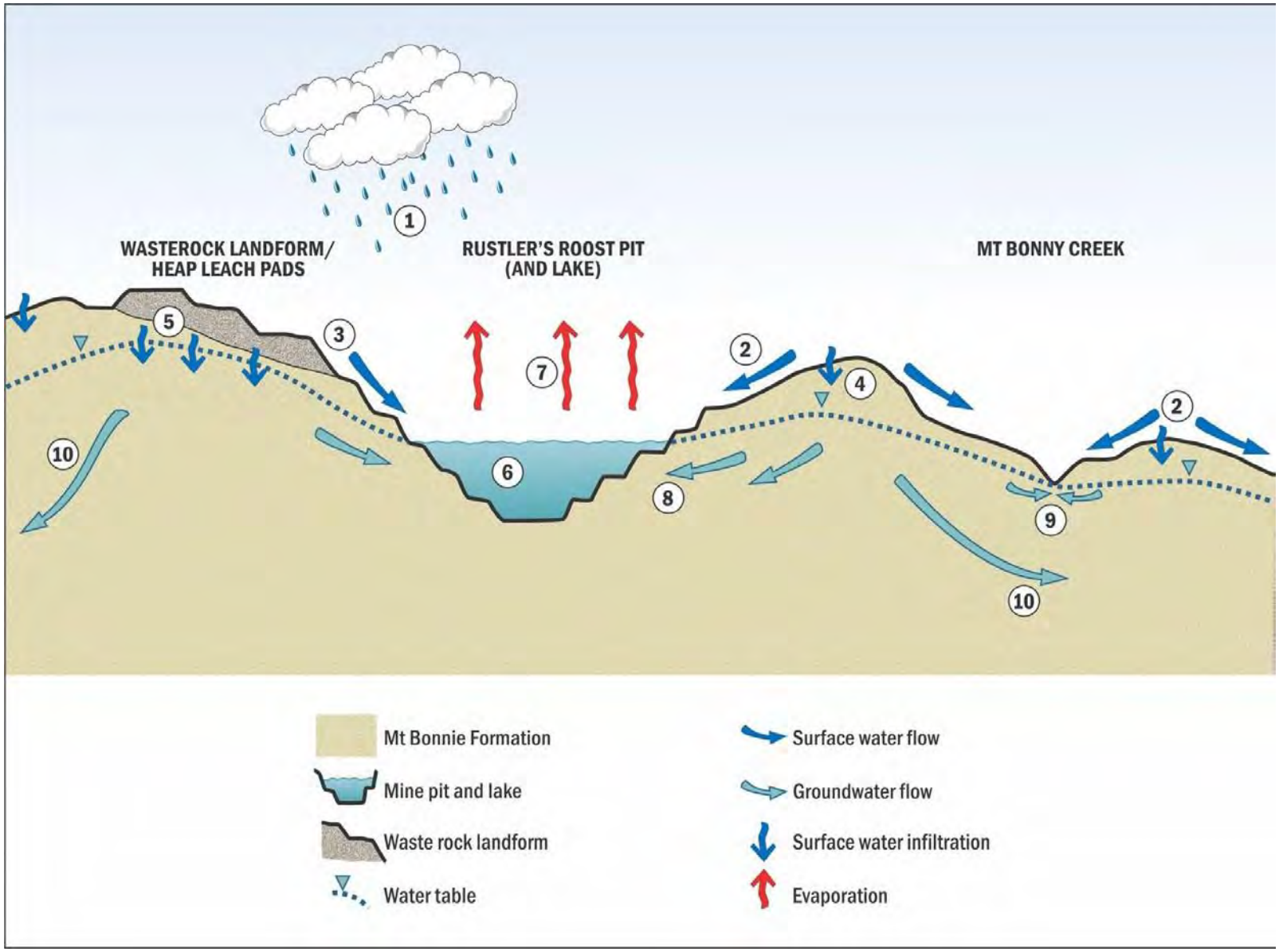



**Figure 8-1 Conceptual hydrogeological model for the Rustler's Roost site**

# Section 9 Data Gaps

The data acquired for Rustlers Roost has generally been sufficient for the early stages of mine development and approval. Further data collection and interpretation is required if the mine is to be further extended into the deeper more sulfidic geologies.

Based on the review of the historical data available for the site, there is limited data on the following:

- material tracking during past operation of the site, waste materials have potentially been used across the site as a construction material.
- composition of the materials on site:
  - mineralogical composition of the materials is not well known;
  - limited data exists on the elemental composition data of waste and ore;
  - limited geochemical characterisation via acid base accounting has been conducted - oxide waste is reported to be NAF but the acid base accounting analysis was limited to sulfur content for most samples collected;
  - sulfur speciation or solubility testing has not been conducted;
  - there is no leachate data for ore or wastes; and
  - there is no kinetic data.
- water quality data is limited. There is only 1 monitoring bore on site.
- hydrogeological information, given the above, there is very little information on groundwater flow or composition, particularly in relation the pit lake.
- Stream sediment quality data – is available but has not been interpreted.
- Soils data to inform baseline conditions and catchment run off quality is available but has not been fully interpreted.
- Pit lake bathymetry is unknown.

# Section 10 Sampling and Analysis Plan

In order to address the data gaps with respect to the chemical characterisation of the oxide waste materials currently stored on site, a sampling and analysis plan was developed.

The focus of the SAP was to assess the immediate risk the wastes landforms may present to water quality at the site. Water sampling and sediment sampling is excluded from the SAP.

Each waste landform was ranked in terms of its potential chemical load to the surrounding environment (where, concentration of EEC x size = potential chemical load). See risk ranking matrix in Table 10-1.

**Table 10-1 Risk ranking matrix based on content, size and location**

| Content | Low volume | | High volume |
|---|---|---|---|
| Low concentrations | | | |
| Moderate concentrations | | | |
| High concentrations | | | |
| Unknown | | | |

## 10.1 Sampling rationale

- Sampling (number and location) is justified by the risk ranking in the areas of interest as defined by the data review.
- Water sampling is outside the scope.
- The location of each sampling point within the areas of interest is to be selected based on ease of access on the day of sampling.

## 10.2 Screening criteria for data collected

The following screening criteria shall be adopted for the data collected as part of this SAP:

### Soil and rock

- ABA data – AMIRA 2002 classification for acid forming potential
- Metal content – Global Abundance Indices approach

### Leachates

- ANZECC 2000 guidelines for protection of surface water quality, and any site surface water quality data.
- There are no guidelines in NT for the protection of groundwater quality. Comparison will be made to any available groundwater quality data.

**Table 10-2 Areas of interest and risk ranking**

| Area | Location | Description | Size | Risk ranking |
|---|---|---|---|---|
| A1 | Pit | Three pits have been developed, in the latest extension of mining in 1997 the pit was extended; the oxide berms at the edge of each pit were removed (refer to figure in KP report Draft EIS 1997) | Bathymetry unknown | High |
| A2 | WRD | Two WRDs were planned, only 1 was constructed, it is located to the west of the pit. The WRD was extended with oxide waste in the last phase of mining in 1997.<br>The WRD should only contain oxide waste. The waste has been placed in small lifts. During the second phase of mining, the construction of the perimeter batters had started, extending the footprint to the west. | Area approx. 304 200 $m^2$<br>209000 $m^3$ of batters (Fawcett 1997) | Moderate |
| A3 | Heap Leach pads | Two out of the proposed four heap leach pads have been constructed. They are located to the south of the site, the materials remaining on the pads are red in colour with white precipitates noted and display evidence of erosion (gullys). | Pad A – surface area – 73600 $m^2$<br>Pad B Surface area 129,000 $m^2$ | High |
| A4 | Water storage ponds | There are four ponds containing water to the south of the heap leach pads. Based on the plan provided in the 1997 EIS, three are process water ponds and the larger more southernly pond is the stormwater pond. | Unknown | Moderate |
| A5 | ROM Pad | The ROM pad is likely to be just to the south of backhoe (refer to Fig 5 Study sites for proposed tailings dam Greenbase 1997 in Draft EIS 1997). | Area = approx. 2.5 Ha<br>250 m wide, by 100 m deep by 10 m high (Fawcett 1997). | Low |
| A6 | Tailings pond | The tailings pond was not constructed. In the draft tailings pond design by KP (Draft EIS 1997) the dam wall was to be constructed using oxide waste. There may be evidence of the start of this construction on site to the south of the pit. | Not constructed. | |

As water quality sampling is not included in the SAP, a visual assessment of potential impacts was conducted.

## 10.3 Sampling and analysis of source areas of interest

- Rock and soil from the heap leach pad are the priority areas of interest;
- Samples from the WRD and ROM pad to be collected with the number of samples from each area of interest outlined in Table 12;
- Samples shall be discrete. No compositing shall occur;
- Samples were collected from surface material and at least 2 samples at depth in each area (depth should be the maximum possible by the sampling tool used); and
- Photograph all samples and location.

### 10.3.1 Sampling equipment

- All sampling equipment was thoroughly cleaned between sampling locations;
- Nitrile gloves were worn when sampling;
- Soil and rock samples were collected into snap lock plastic bags;
- Each soil/rock sample was about 1 kg in size;
- Date/time/discrete sample number/sampler/job number was noted on each individual sample; and
- Samples were kept dry and cool for transport.

**Table 10-3 Sampling and analysis plan summary**

| Area | Location | Media | Analysis | Number of samples Primary # (dup) |
|---|---|---|---|---|
| A2 | WRD | Rock and soil | Rock/soil<br>• Total Sulfur (TS, by LECO)<br>• Total Sulfate<br>• Total Carbon<br>• Acid neutralising capacity<br>• Single addition NAG<br>• Multi-element solids content determination by X-ray fluorescence<br>Salts<br>XRF<br><br>Salts and Rock/Soil<br>Paste pH and electrical conductivity (EC) using a liquid to solids (L: S) ratio of 5:1<br><br>Bottle Leach | ▪ 10 (1)<br>▪ (5 from stage 1 WRD, 5 from stage 2 WRD)<br>▪ 2 salt samples |

| | | | | |
|---|---|---|---|---|
| A3 | Heap Leach pads | Rock/tailings Salts | • Total Sulfur (TS, by LECO)<br>• Total Sulfate<br>• Total Carbon<br>• Acid neutralising capacity<br>• Single addition NAG<br>• Multi-element solids content determination by X-ray fluorescence<br>• Total and WAD Cyanide<br><br>Paste pH and electrical conductivity (EC) using a liquid to solids (L: S) ratio of 5:1<br><br>Bottle leach – analytical suite must include total and WAD cyanide | • 10 (1)<br>(5 from south berm area, 5 from east berm area)<br>• 2 salt samples |
| A5 | ROM Pad | Rock | • Total Sulfur (TS, by LECO)<br>• Total Carbon<br>• Acid neutralising capacity<br>• Single addition NAG<br>• Multi-element solids content determination by X-ray fluorescence<br><br>Paste pH and electrical conductivity (EC) using a liquid to solids (L: S) ratio of 5:1<br><br>Bottle leach | • 3 (1) |

*Note no salt samples were observed on the day of sampling

### 10.3.2 Multi - Elemental Suite for solids

Given the lack of geochemical data available to determine a suitable suite of analytes, a broad suite of metals and metalloids were assessed in each sample.

The multi-elemental analysis via XRF reported the following metals:

- Aluminium, antimony, arsenic, barium, boron, bismuth, calcium, cadmium, caesium, chromium, cobalt, copper, iron, gold, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, phosphorous, selenium, sodium, silver, silica, tin, thorium, thallium, uranium, vanadium and zinc.

### 10.3.3 Generation and Analysis of leachates

- A bottle leach test was conducted on all a selection of samples collected from each area of interest.
  - Three samples with the highest total S values from each area will be selected for leachability.
- The bottle leach will be conducted at a solid to liquid ratio of 1:20 with de-ionised water.

The leachates generated were analysed for the following suite:

- General chemistry: pH, electrical conductivity (EC), alkalinity, calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride, nitrate and ammonia.
- Dissolved metals: aluminium, antimony, arsenic, barium, boron, bismuth, cadmium, caesium, chromium, cobalt, copper, iron, gold, lead, lithium, manganese, mercury, molybdenum, nickel, phosphorous, selenium, silver, silica, tin, thorium, thallium, uranium, vanadium and zinc.

Cyanide species analysis was included in the samples collected from the heap leach pad and any leachates generated from those materials.

# Section 11 Results of Field Sampling and Analysis

CDM Smith completed a site walkover with opportunistic sampling in general accordance with the SAP above on 8 March 2019.

Sampling was conducted by hand by a qualified CDM Smith environmental practitioner using a spade and trowel.

A total of 26 samples were collected from the WRD, ROM pad location and the heap leach pads (HLP) (refer Figure 2)

The sample depths were superficial depths only as the materials, particularly at the WRD were quite compacted and difficult to sample.

Georeferenced photographs of all samples and locations were taken of all sample locations, drainages and other sites of interest.

At the time of sampling, it had recently rained, no evidence of surface salts on the WRD, ROM or HLP were present, and thus salt samples were not collected.

## 11.1 General Observations

- No staining of rocks within drainages, salts or scaling indicative of neutral or acid mine drainage was evident;
- Apart from flooded trees within Annies Dam, vegetation appeared in good condition;
- Berms mostly functional noting several locations recommended for management (i.e. settlement pond bund wall, bund walls to be extended in sections along west and east tailings dam); and
- Groundwater bores in addition to those included in the current groundwater monitoring program were observed on site noted and could be assessed for incorporation into future monitoring.

## 11.2 Laboratory results

All samples were submitted to ALS Environmental, a NATA accredited analytical facility. The samples were split upon receipt and a portion was retained by CDM Smith. The remaining samples were crushed and then split to allow for the various analyses to be conducted.


**Figure 2 Surface Rock Sample Locations from 8th March 2019**

## 11.3 Static Test Results

A summary of all tests results received is provided in Table 11-1 and Table 11-2.

**Table 11-1 Static test results for all samples – paste pH/EC, ANC, total Sulfur, sulfate and carbon.**

| Sample | Paste pH | Paste EC (µS/cm) | ANC (kgH2SO4/t) | Sulfur S (%) | Sulfate (mg/kg) | Total C (%) |
|---|---|---|---|---|---|---|
| HLP-1 | 7.9 | 203 | 8.3 | <0.01 | 20 | 0.04 |
| HLP-10 | 8.1 | 184 | 21.3 | 0.02 | 10 | 0.19 |
| HLP-11 | 8.1 | 158 | 9.4 | 0.02 | <10 | 0.06 |
| HLP-2 | 7.9 | 209 | 9.4 | 0.04 | 10 | 0.04 |
| HLP-3 | 7.9 | 184 | 6.6 | 0.03 | <10 | 0.03 |
| HLP-4 | 7.5 | 120 | 7.2 | 0.03 | 10 | 0.03 |
| HLP-5 | 8.1 | 197 | 10.4 | 0.02 | 10 | 0.06 |
| HLP-6 | 7.8 | 170 | 8.8 | 0.02 | 50 | 0.05 |
| HLP-7 | 8.1 | 184 | 7.8 | 0.03 | 10 | 0.05 |
| HLP-8 | 7.8 | 165 | 8 | <0.01 | <10 | 0.03 |
| HLP-9 | 8 | 183 | 9.4 | 0.03 | 20 | 0.08 |
| ROM 1 | 7.9 | 179 | 7.8 | <0.01 | <10 | 0.03 |
| ROM 2 | 7.4 | 119 | 4.5 | <0.01 | 20 | 0.04 |
| ROM 3 | 7.2 | 96 | 4.9 | <0.01 | <10 | 0.04 |
| ROM 4 | 7 | 91 | 3.7 | <0.01 | <10 | 0.06 |
| WRD-1-1 | 6.8 | 111 | 4.1 | 0.02 | 10 | 0.07 |
| WRD-1-2 | 6.8 | 82 | 3 | 0.02 | <10 | 0.07 |
| WRD-1-3 | 6.7 | 90 | 3.4 | <0.01 | 20 | 0.08 |
| WRD-1-4 | 6.8 | 90 | 4.1 | <0.01 | <10 | 0.04 |
| WRD-1-5 | 6.6 | 69 | 5.1 | 0.02 | <10 | 0.06 |
| WRD-1-6 | 7.1 | 118 | 3 | <0.01 | 20 | 0.08 |
| WRD-2-1 | 6.7 | 111 | 4.6 | 0.02 | 20 | 0.08 |
| WRD-2-2 | 7 | 147 | 5.6 | <0.01 | 20 | 0.05 |
| WRD-2-3 | 6.7 | 88 | 5.2 | 0.02 | <10 | 0.06 |
| WRD-2-4 | 6.8 | 97 | 3.9 | <0.01 | <10 | 0.08 |
| WRD-2-5 | 7.5 | 146 | 6.8 | 0.03 | <10 | 0.05 |

**Table 11-2 Static test results for all samples – pHox, NAG, NAPP and MPA**

| Sample | pHox | NAGpH4.5 | NAG pH7.0 | NAPP ($kgH_2SO_4/t$) | MPA ($kgH_2SO_4/t$) |
|---|---|---|---|---|---|
| HLP-1 | 7.7 | <0.1 | <0.1 | -8.3 | 0.306 |
| HLP-10 | 8.7 | <0.1 | <0.1 | -20.7 | 0.612 |
| HLP-11 | 8.7 | <0.1 | <0.1 | -8.8 | 0.612 |
| HLP-2 | 7.4 | <0.1 | <0.1 | -8.2 | 1.224 |
| HLP-3 | 8 | <0.1 | <0.1 | -5.7 | 0.918 |
| HLP-4 | 7.4 | <0.1 | <0.1 | -6.3 | 0.918 |
| HLP-5 | 8.4 | <0.1 | <0.1 | -9.8 | 0.612 |
| HLP-6 | 8.2 | <0.1 | <0.1 | -8.2 | 0.612 |
| HLP-7 | 8.3 | <0.1 | <0.1 | -6.9 | 0.918 |
| HLP-8 | 7.6 | <0.1 | <0.1 | -8 | 0.306 |
| HLP-9 | 8.5 | <0.1 | <0.1 | -8.5 | 0.918 |
| ROM 1 | 7.7 | <0.1 | <0.1 | -7.8 | 0.306 |
| ROM 2 | 7.2 | <0.1 | <0.1 | -4.5 | 0.306 |
| ROM 3 | 7.2 | <0.1 | <0.1 | -4.9 | 0.306 |
| ROM 4 | 7 | <0.1 | <0.1 | -3.7 | 0.306 |
| WRD-1-1 | 7 | <0.1 | <0.1 | -3.5 | 0.612 |
| WRD-1-2 | 6.9 | <0.1 | 0.4 | -2.4 | 0.612 |
| WRD-1-3 | 7 | <0.1 | <0.1 | -3.4 | 0.306 |
| WRD-1-4 | 7.2 | <0.1 | <0.1 | -4.1 | 0.306 |
| WRD-1-5 | 6.8 | <0.1 | 0.4 | -4.5 | 0.612 |
| WRD-1-6 | 7.5 | <0.1 | <0.1 | -3 | 0.306 |
| WRD-2-1 | 6.7 | <0.1 | 0.7 | -4 | 0.612 |
| WRD-2-2 | 7.1 | <0.1 | <0.1 | -5.6 | 0.306 |
| WRD-2-3 | 6.9 | <0.1 | 0.2 | -4.6 | 0.612 |
| WRD-2-4 | 7 | <0.1 | <0.1 | -3.9 | 0.306 |
| WRD-2-5 | 7.4 | <0.1 | <0.1 | -5.9 | 0.918 |

### 11.3.1 Paste pH and EC

The paste tests give an indication of availability of readily soluble weathering products and salts. An acidic pH (pH <5) may indicate the presence of acidic reaction products generated by sulfide oxidation. An alkaline pH (pH >8) suggests the presence of reactive neutralising minerals or, if categorised as potentially acid generating, that the sample has, as yet, not oxidised sufficiently to become acidic.

Paste EC can be used to indicate the state of oxidation/weathering, where higher EC values usually suggest more advanced state of oxidation/ weathering. Where the sample originates from a naturally saline environment, an elevated paste EC may simply indicate the presence of residual salts in the sample.

The pH of samples collected ranged from pH 6.6 to pH 8.1. The lowest pH was recorded in WRD 1, the highest pH was recorded in the HLP.

EC in the paste ranged from 69 µS/cm to 209 µS/cm. The lowest EC was reported in WRD 1, the highest EC was reported in the HLP.

A clear correlation between pH and EC exists for the samples taken, refer to Figure 11-3.

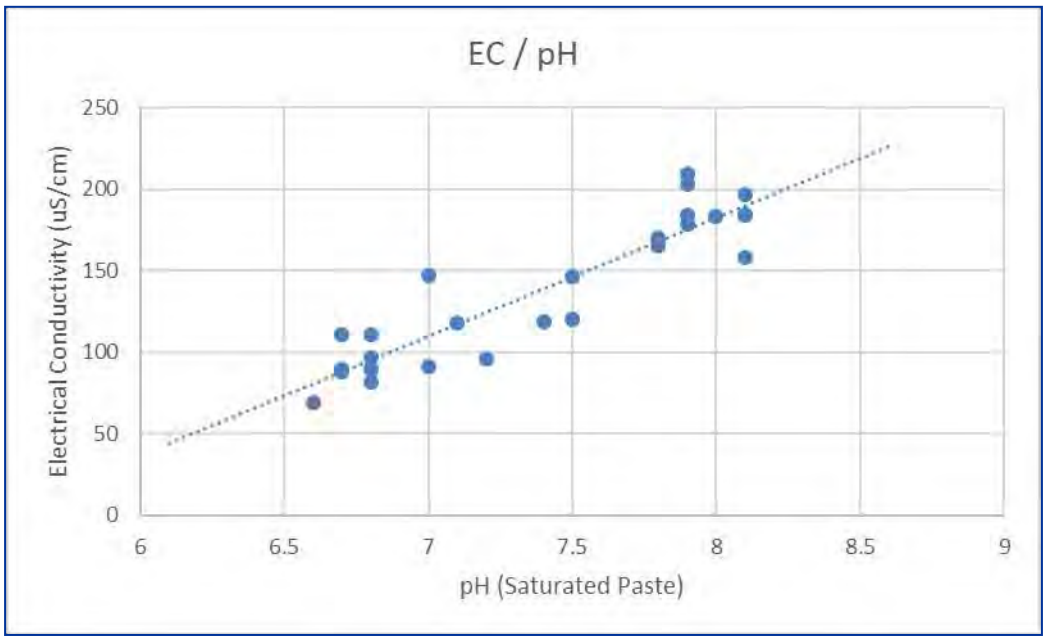



**Figure 11-3 Relationship between paste pH and EC**

### 11.3.2 Acid Base Accounting

The static acid base accounting (ABA) test methods provide a means to assess the acid forming and neutralising characteristics of materials tested. For these calculations, although sulfur speciation was conducted on all samples collected through assessment of the total sulfur and total soluble sulfate content, we conservatively used the total sulfur value to calculate the acidity component.

During the NAG test, samples are mixed with the strong oxidant, hydrogen peroxide, to oxidise sulfide minerals contained in the sample. Concurrently, neutralising minerals present in the sample consume the acidity generated until either the ANC or sulfide is depleted. Should the ANC be depleted first, excess acidity is generated and the sample pH decreases. In addition to measurement of the solution pH (NAG pH), the acidity of the sample is quantified by titration with a base (sodium hydroxide). The acidity generated at pH 4.5 and below is generally attributed to free sulfuric acid and ferric iron resulting from the oxidation of sulfide minerals after consumption of any neutralising mineral phases. The acidity generated between pH 4.5 and pH 7 includes contribution from metals such as copper, soluble at pH 4.5, but insoluble at pH 7.

The results of the static ABA assessment indicted that:

- Sulfur levels in all samples were low (<0.01-0.03%);
- Soluble sulfate was also low (10-20 mg/kg) but this may be due to recent rainfall;

- The remaining sulfur may be poorly soluble sulfates such as jarosite, remnant sulphides or organic sulfur (from soils);
- The total carbon was also low (0.03 - 0.19%); and
- ANC was low (3.0-21.3 kgH2SO4) but given the low total sulfur values, all samples are classified as non-acid forming (NAF) please refer to Figure 11-4.

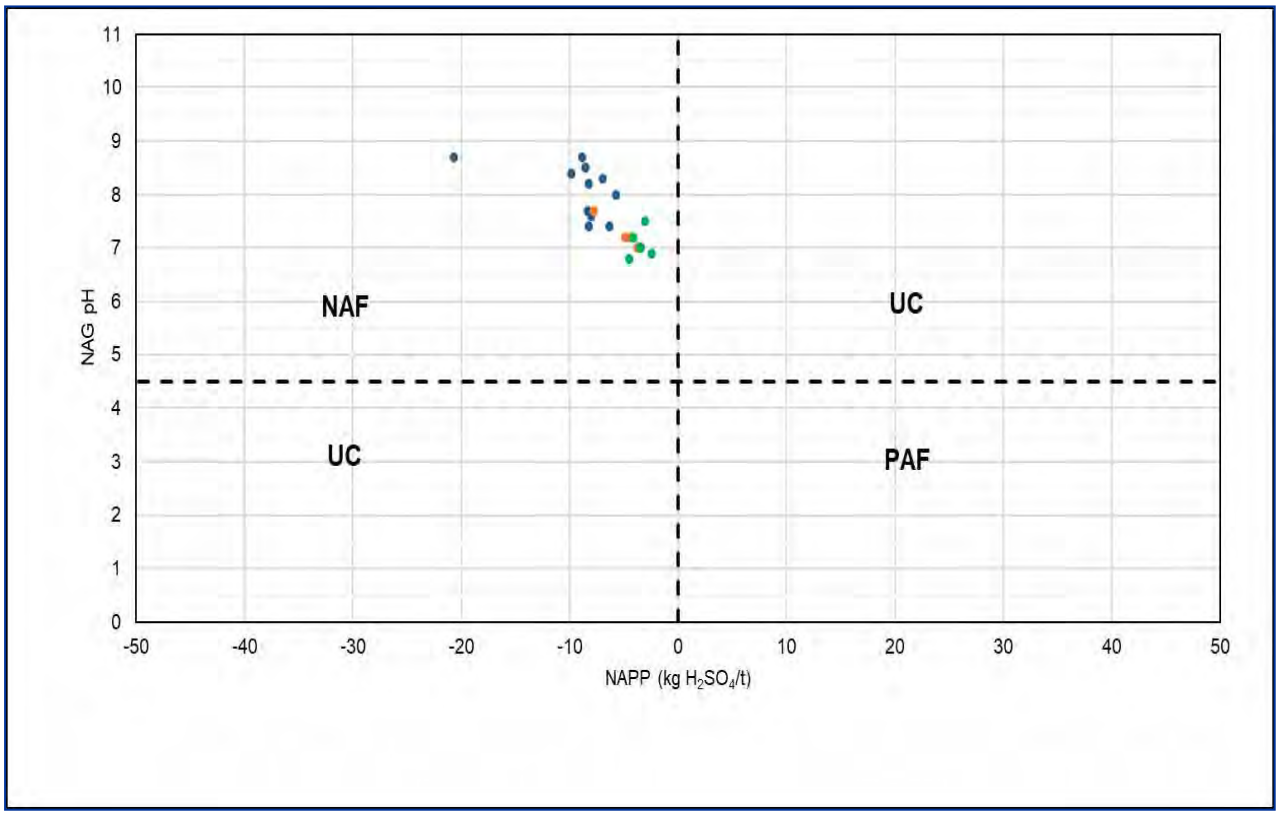



**Figure 11-4 AMIRA classification of all samples. Blue = WRD, Orange = ROM, Green = HLP.**

### 11.3.3 Total Elemental Content

The total elemental content was determined via x-ray fluorescence for all elements with the exception of Au. Au content was determined via fire assay (Table 11-3 and Table 11-4).

**Table 11-3 Major elemental composition (mean % and standard deviation, SD)**

| Element | Mean % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | WRD 1 | SD | WRD 2 | SD | HLP | SD | ROM | SD |
| Al | 7.49 | 0.52 | 7.47 | 1.24 | 7.40 | 0.50 | 9.55 | 0.80 |
| **Ca** | 0.01 | 0.01 | 0.02 | 0.01 | 0.27 | 0.13 | 0.01 | 0.01 |
| Fe | 8.32 | 2.57 | 7.68 | 2.51 | 8.97 | 2.72 | 6.65 | 1.55 |
| K | 2.05 | 0.76 | 2.20 | 1.30 | 1.87 | 0.65 | 3.36 | 0.93 |
| Mg | 0.27 | 0.08 | 0.30 | 0.15 | 0.25 | 0.08 | 0.42 | 0.11 |
| Na | 0.03 | 0.01 | 0.03 | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 |
| S | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.00 |
| Ti | 0.24 | 0.06 | 0.24 | 0.05 | 0.20 | 0.02 | 0.28 | 0.04 |
| SiO2 | 65.20 | 2.32 | 65.04 | 3.88 | 63.75 | 2.70 | 61.03 | 0.39 |

**Table 11-4 Trace elemental composition (mean ppm and standard deviation, SD)**

| Element | Mean ppm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | WRD 1 | SD | WRD 2 | SD | HLP | SD | ROM | SD |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Au | 0.47 | 0.34 | 0.43 | 0.48 | 0.27 | 0.21 | 0.28 | 0.09 |
| Ag | 0.25 | 0.06 | 0.26 | 0.20 | 0.27 | 0.09 | 0.18 | 0.03 |
| As | 158 | 36.73 | 225 | 263.71 | 298 | 139.63 | 176 | 52.29 |
| B | 40.00 | 10.95 | 48.00 | 20.49 | 37.27 | 7.86 | 57.50 | 12.58 |
| Ba | 810 | 241.50 | 748 | 210.29 | 602 | 118.50 | 702 | 92.15 |
| Be | 2.95 | 0.47 | 3.3 | 0.14 | 2.83 | 0.53 | 3.27 | 0.20 |
| Bi | 0.66 | 0.22 | 0.69 | 0.28 | 0.65 | 0.06 | 0.48 | 0.19 |
| Cd | 0.03 | 0.01 | 0.06 | 0.07 | 0.05 | 0.02 | 0.03 | 0.01 |
| Ce | 88.2 | 10.82 | 95 | 19.47 | 87.6 | 11.45 | 81.8 | 9.39 |
| Co | 19 | 7.82 | 28.9 | 7.77 | 14.9 | 10.08 | 22.1 | 11.51 |
| Cr | 47.8 | 4.45 | 59.8 | 32.11 | 54.3 | 10.25 | 57 | 8.76 |
| Cs | 5 | 1.41 | 6.3 | 2.98 | 4.7 | 1.82 | 7.7 | 1.42 |
| Cu | 38.9 | 11.63 | 48.7 | 24.95 | 36.6 | 12.11 | 27.4 | 4.48 |
| Ga | 19.2 | 1.23 | 19.6 | 3.13 | 19.9 | 2.12 | 25.4 | 2.30 |
| Ge | 0.31 | 0.08 | 0.25 | 0.07 | 0.25 | 0.03 | 0.26 | 0.05 |
| Hf | 3.88 | 0.34 | 4.18 | 0.50 | 4.3 | 0.93 | 5.02 | 1.00 |
| Hg | 0.007 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.008 | 0.00 |
| In | 0.07 | 0.00 | 0.07 | 0.01 | 0.08 | 0.01 | 0.08 | 0.00 |
| La | 45.3 | 5.92 | 45.6 | 10.10 | 44.5 | 6.83 | 42.9 | 5.52 |
| Li | 15.7 | 3.97 | 21.5 | 3.40 | 13.6 | 3.44 | 21.6 | 3.21 |
| Mn | 2223 | 1564.36 | 1954 | 1307.36 | 1398 | 1049.96 | 810 | 122.89 |
| Mo | 0.8 | 0.39 | 0.77 | 0.36 | 1.02 | 0.28 | 0.79 | 0.75 |
| Nb | 9.2 | 0.89 | 9.7 | 1.30 | 10.5 | 2.44 | 12.4 | 1.99 |
| Ni | 24.9 | 4.32 | 34.8 | 9.78 | 23.7 | 5.52 | 25.7 | 3.38 |
| P | 861 | 497.29 | 872 | 284.99 | 897 | 373.87 | 392 | 217.47 |
| Pb | 13.8 | 2.05 | 16.7 | 13.10 | 16.9 | 2.58 | 13.9 | 1.55 |
| Rb | 124.5 | 38.92 | 138.9 | 67.17 | 119.8 | 41.36 | 206.7 | 43.48 |
| Re | <0.002 | - | <0.002 | - | <0.002 | - | 0.002 | 0.00 |
| Sb | 1.3 | 0.38 | 1.8 | 1.28 | 1.6 | 0.63 | 1.2 | 0.04 |
| Sc | 12.4 | 1.82 | 12.56 | 3.11 | 11.16 | 1.05 | 16.12 | 2.03 |
| Se | 0.3 | 0.18 | 0.5 | 0.59 | 0.5 | 0.19 | 0.3 | 0.15 |
| Sn | 3.35 | 0.27 | 3.52 | 0.59 | 3.82 | 0.69 | 4.45 | 0.26 |
| Sr | 42.8 | 15.79 | 54.12 | 42.40 | 58.46 | 15.21 | 30.05 | 22.55 |
| Ta | 0.77 | 0.09 | 0.81 | 0.11 | 0.84 | 0.18 | 1.025 | 0.12 |
| Te | 0.088 | 0.07 | 0.092 | 0.07 | 0.098 | 0.03 | 0.05 | 0.00 |
| Th | 16.5 | 1.64 | 16.5 | 2.01 | 17.9 | 3.45 | 19.7 | 3.99 |
| Tl | 0.8 | 0.26 | 0.8 | 0.26 | 0.7 | 0.18 | 1.0 | 0.22 |
| U | 4.6 | 0.60 | 4.6 | 0.70 | 5 | 0.35 | 4.6 | 0.62 |
| V | 69 | 6.52 | 69 | 14.88 | 67 | 8.59 | 76 | 13.30 |
| W | 2.3 | 0.38 | 2.4 | 0.54 | 2.6 | 0.45 | 3.1 | 0.45 |
| Y | 28 | 5.26 | 25 | 2.48 | 27 | 2.86 | 27 | 2.81 |
| Zn | 54 | 17.63 | 77 | 36.76 | 44 | 9.03 | 57 | 8.04 |
| Zr | 140 | 12.40 | 149 | 20.77 | 149 | 29.68 | 168 | 35.96 |

The most abundant elements (those with the highest total concentrations measured as %) are $SiO^2$, Al, Fe, K, Ca, Mg, Ti, Na, and S (in decreasing order).

The next most abundant elements (measured as ppm) within the samples tested are As, Ba, Mn, and P.

Gold (Au) concentrations in the samples collected ranged from 0.06 ppm to 1.29 ppm. The highest concentration of Au reported was in WRD2.

The major elemental composition of each sampled areas was very similar. However, in the trace elemental data, WRD 1 contained elevated concentrations of Ba and Mn compared to the other sampled areas.

Trace and major elemental distribution graphs for each area sampled are presented in Figure 11-5 and Figure 11-6.

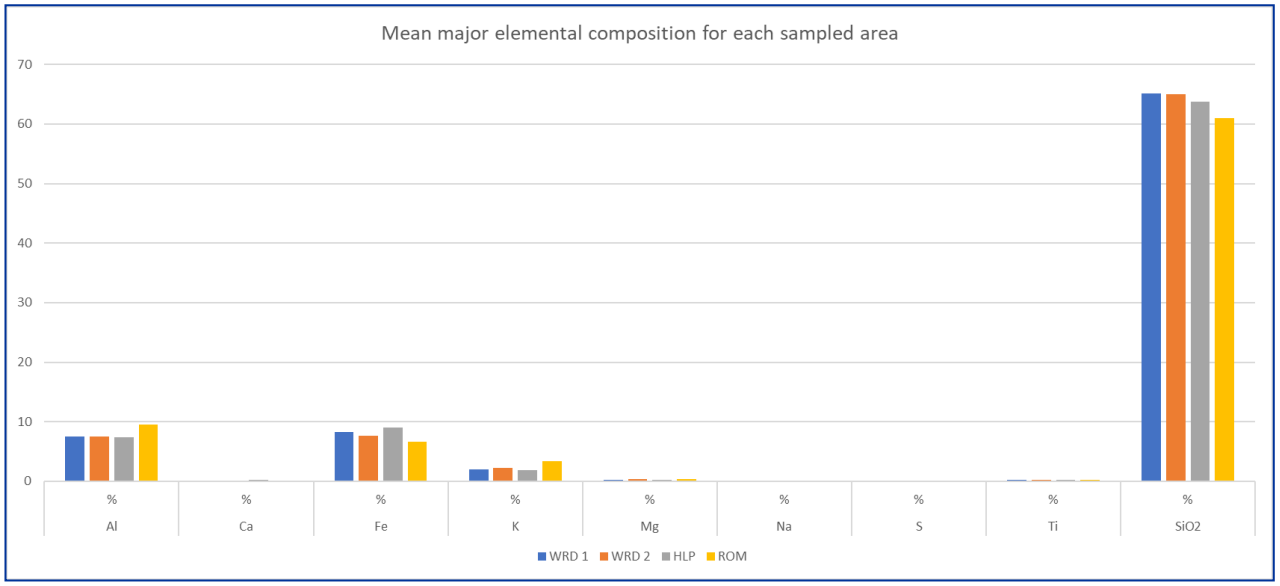



**Figure 11-5 Major elemental distribution (concentrations reported in %)**

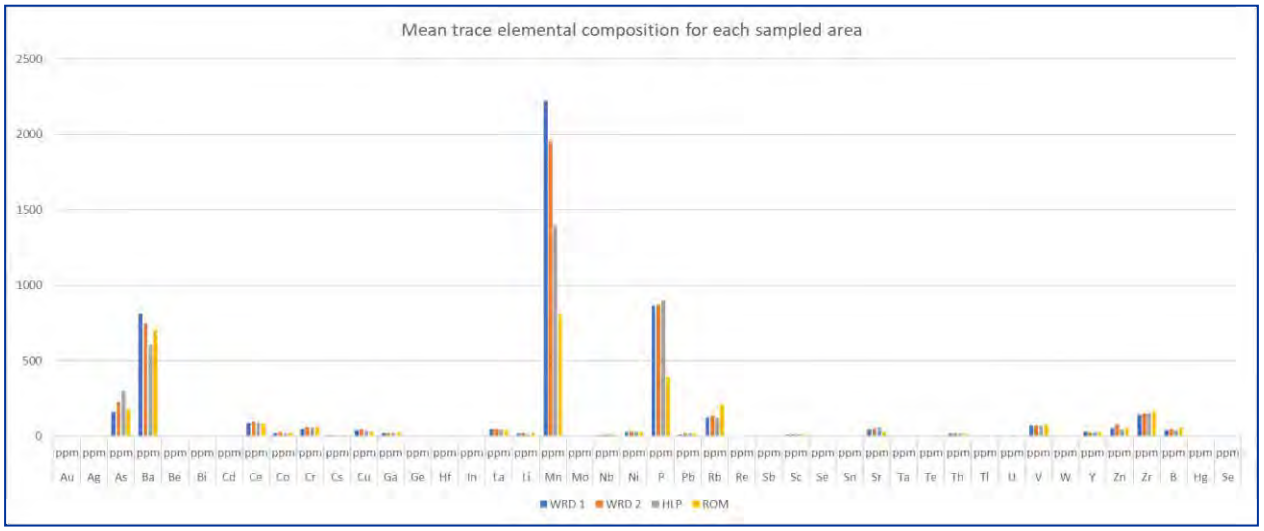



**Figure 11-6 Trace elemental composition (concentrations reported in ppm)**

### 11.3.4 Leachate analysis

Due to delays in the receipt of the static data, leaching of the samples collected at the site has not been conducted. Samples remain with the laboratory and thus leaching can commence if deemed required.

# Section 12 Conclusions and recommendations

## 12.1 Conclusions

The available geological, geochemical and water quality data, suggests that for the waste materials currently stored on the sites surface, the potential to leach a significant dissolved chemical load to surface or groundwater is low. However, if mining were to progress and materials from deeper within the geological profile were disturbed either by being raised to the surface or dewatered, the quality of groundwater and surface water may decrease.

The total number of samples collected to date is not considered sufficient to fully characterise the ore and wastes that have been mined and are likely to be mined. Once an assessment of the leachability is conducted on the oxide waste samples, a better understanding of the potential for the materials currently stored on site to pose a risk to water quality will be gained.

Nevertheless, it has been demonstrated that the total sulfide content of all weathered materials sampled is low. All samples collected in the current study are classified as NAF, this is consistent with previous geochemical assessments of the weathered materials within the geological profile.

The acidity reported in surface soils is likely due to the hydrolysis of clays and the presence of iron oxides and hydroxides. Additional organic acidity may also be present. Consequently, runoff from the catchment and potentially the WRD may be acidic (with pH in the range of 5-6.5). The run off will likely contain elevated concentrations of Al, Fe and Mn compared to all other metals, and phosphorus (P) may also be present.

Based on paste pH and EC results, the HLP materials have the highest propensity to deliver dissolved constituents to surface and or groundwater, this is as would be expected as these materials have the highest surface area per unit mass and have been chemically leached. The pH of the HLP pastes were higher than the other samples collected, this may be evidence to suggest that entrained process fluid is still present in the HLP.

Any decrease in water quality is likely to present as increased salinity, increased concentrations of Al, As, Fe, Mn, Se and Zn. It is possible that the pH of ground and surface water will remain neutral.

Given the local geological profile, which is reported to host increasing levels of sulfide minerals with depth, the pit lake may be stratified. The water quality at the surface of the lake may represent surface run off, whereas deeper within the lake the water quality may be indicative of a greater input from groundwater that may have a neutral mine drainage signature which may be a consequence of historical dewatering.

## 12.2 Recommendations

It is recommended that to fulfil the requirements of developing source, pathway receptor linkages that the following is implemented:

Additional sampling and analysis of the geological materials (ore and waste) at site should include:

- Mineralogical assessment of the materials
- Static testing on waste and ore
    - Acid Base accounting on all samples collected.
    - Include sulfur speciation
    - Include total carbon analysis
- Kinetic testing of waste and ore - Given the likelihood that the deeper geologies are more sulfidic than the materials raised to date, it is recommended that a kinetic test program is initiated as soon as practicable to inform the rate of oxidation of the materials and composition of leachates.

- Sampling of sediments in streams down gradient from and at the base of the decant ponds.

The data from the kinetic column work can be used to inform the groundwater and surface water monitoring suite of analytes.

We acknowledge that a number of recommendations have already been provided with respect to the locations and frequency of surface and groundwater monitoring at the site. Based on the conclusions of the geochemical assessment presented above, it is recommended that the water quality suite adopted for the site monitoring should include the following as a minimum:

- Physical parameters: pH, temperature, EC and redox.
- Major ions (Ca, Mg, Na, K, Cl, total alkalinity)
- Metals and metalloids:
    - Total – Al and Fe (speciated)
    - Dissolved: Al, As, Cd, Cu, Fe, Mn, Pb, Se, Sn and Zn.
- Nutrients: total N, nitrate and ammonia, and total P

# Appendices

**Table A-1 Description of geochemical analytical tests**

| Parameter | Description |
|---|---|
| Paste pH | pH measurements are performed on a 1:5 solid/water extract. |
| Paste EC | Electrical conductivity measurements are performed on a 1:5 solid/water extract. |
| Acid neutralising capacity (ANC) | Determined by adding HCl to the sample, heating it, and then back-titrating the mixture with NaOH in order to determine the amount of HCl that remains on completion of the reaction. The amount of acid consumed in the initial reaction is calculated and expressed as the ANC. Details of the procedure are outlined in the AMIRA International ARD Test Handbook (AMIRA, 2002). |
| Total sulphur | The sample is combusted in oxygen at 1350°C. Sulphur present in the sample is evolved as sulphur dioxide and swept to a measurement cell for quantification by infrared detection (LECO). The infra-red cell output is calibrated against the value of a known standard sample to provide the total sulphur of the unknown sample. |
| Total carbon | The sample is combusted in oxygen at 1350°C. Carbon present in the sample is evolved as carbon dioxide and swept to a measurement cell for quantification by infrared detection (LECO). The infra-red cell output is calibrated against the value of a known standard sample to provide the total carbon of the unknown sample. |
| Single addition net acid generation (NAG) test | The NAG test involves addition of hydrogen peroxide to prepared samples (to oxidise any reactive sulphides). The NAG pH is the pH of the final solution. The resultant acidity is then titrated (using NaOH) to pH 4.5 and then to pH 7. Details of the procedure are outlined in the AMIRA International ARD Test Handbook (AMIRA, 2002). |
| Whole rock multi element assay | Involves the near total dissolution of most elements using a variety of digestion techniques (e.g. aqua regia (hydrochloric and nitric acid digest), four acid digest and lithium borate fusion). Analytical techniques are selected depending on the elements under investigation and include XRF, ICP-AES, ICP-MS, AAS, ISE and TGA. |
| Acid soluble sulfate | The sample is extracted with dilute hydrochloric acid, the dissolved sulfate is then determined using ICP-AES. |
| Total Oxidisable Sulfur | Is the calculated difference between total S and sulfate-S. |

## 10.4 Mine Closure Plan

## 10.5 Stakeholder Consultation Register

| Date | Description of Engagement | Stakeholders | Stakeholder Comments / Issues | Proponent Response and/or Resolution | Stakeholder Response |
|---|---|---|---|---|---|
| 6 Feb 2014 | Pastoralist and Miner Agreement. | Old Mt Bundey Station Owner (B Coulter) | Agreement accepted and signed. | Execution of agreement as required. | Acceptable |
| 17 Feb 2013 | RRPA MMP 2012-2013 Submission. | DPIR | Documentation unavailable. | Documentation unavailable. | Approved |
| 28 May 2013 | Authorisation 0738-01 | DPIR | Authorisation granted. | - | Approved |
| 7 February 2014 | Authorisation 0738-01 (Variation 1) | DPIR | Authorisation granted. | - | Approved |
| 28 May 2014 | RRPA MMP 2013-2014 Submission. | DPIR | Documentation unavailable. | Documentation unavailable. | - |
| 10 Dec 2014 | Location of Sacred Sites of Restricted Work Areas. | AAPA | No sites in or around the RRPA. | Not required. | - |
| 21 Jul 2015 | RRPA MMP 2014-2015 Submission. | DPIR | Documentation unavailable. | Documentation unavailable. | - |
| 3 Dec 2015 | RRPA MMP 2014-2015 Amendment Submission. | DPIR | Documentation unavailable. | Documentation unavailable. | - |
| 22 Mar 2016 | Site Inspection | DPIR | Concerns regarding cattle accessing poor quality water, management of declared weeds, overtopping of Toms Gully Pit and rehabilitation of old drill holes. | Water quality assessed against livestock guidelines, only Toms Gully above. Discussed with Pastoralist to keep stock out of area. Ongoing weed spraying undertaken. Sufficient freeboard at Toms Gully Pit. Drill hole list compiled, and rehabilitation status being assessed. | - |
| 24 Jun 2016 | RRPA MMP 2015-2016 Submission. | DPIR | Request for additional information and resubmission. | Response provided. | - |
| 10 Aug 2016 | Proposed exploration drilling, future plans for Toms Gully and RRPA evaluation. | Old Mt Bundey Station Owner (T Harrower) | Requested not to use RRPA access bridge for heavy vehicles as repairs required. | Contract pastoralist to undertake water monitoring. Bridge not used as requested. | Acceptable |

| Date | Description of Engagement | Stakeholders | Stakeholder Comments / Issues | Proponent Response and/or Resolution | Stakeholder Response |
|---|---|---|---|---|---|
| 15 Aug 2016 | Livestock access to Toms Gully Oxbow area at Mt Bundey Creek. Water quality at RRPA meets livestock drinking quality. | Old Mt Bundey Station Owner (T Harrower) | Confirmed livestock contained by fencing at Toms Gully and Oxbow area paddock not used as vegetation made stock mustering and management difficult. | Ongoing stock exclusion at Toms Gully. | - |
| 19 Aug 2016 | Proposed exploration drilling, future plans for Toms Gully and RRPA evaluation. | McKinlay River Station Owner (P Maley) | Supportive of drilling and projects and no concerns regarding existing mine site areas. | Ongoing communication as project develops. | Acceptable |
| 23 Aug 2016 | Proposed exploration drilling. | Old Mt Bundey Station Owner (T Harrower) | Approval letter for drilling provided. Access agreement to be formalised in the longer term. | Formal access agreement to be developed. | Acceptable |
| 29 Aug 2016 | Advice on Threatened Species Management. | DLRM (now DENR) | Proposal ok with additional listed management strategies. | Incorporated into MMP Amendment. | - |
| 13 Oct 2016 | RRPA MMP 2015-2016 Resubmission. | DPIR | Request for additional security prior to approval. | Security provided. | Approved |
| 7 Dec 2016 | Authority Certificate Issued. | AAPA | AAPA Authority Certificate 2016/790 (Doc:201608611). | Not required. | Approved |
| 7 Dec 2016 | Application for Variation of Authorisation | DPIR | Documentation unavailable. | Not required. | - |
| 7 Dec 2016 | RRPA MMP 2015-2016 Amendment. | DPIR | Request for additional security prior to approval. | Security provided. | Approved |
| 13 Dec 2016 | Concerns regarding vegetation across Toms Gully and near infrastructure. | Old Mt Bundey Station Owner (T Harrower) | Concerns regarding vegetation across Toms Gully and near infrastructure. | Pastoralist contracted to spray vegetation, maintain firebreaks and controlled burning during cooler months. | - |
| 25 January 2017 | Authorisation 0738-01 (Variation 2) | DPIR | Authorisation granted. | - | Approved |

| Date | Description of Engagement | Stakeholders | Stakeholder Comments / Issues | Proponent Response and/or Resolution | Stakeholder Response |
|---|---|---|---|---|---|
| 24 Mar 2017 | Introductory meeting regarding project approvals, studies, and development. | McKinlay River Station Owner (R Anictomatis) | Supportive of project.<br>Discussed access of cattle around Quest 29. A fence was erected and no current concerns.<br>Any additional concerns would be raised immediately and directly with Primary Gold. | Commitment to ongoing dialogue. | - |
| 27 Jun 2017 | Toms Gully water quality. | Landowner north of Arnhem Highway and downstream of Mt Bundey Creek. | Concerns that gates are rusting due to being downstream of Toms Gully. | Provided details of activities and studies at Toms Gully, Quest 29 and RRPA.<br>No permitted water releases since operations ceased and excess water from evaporation pond pumped to Toms Gully Pit.<br>Contact details provided to discuss any further concerns. | - |
| 28 Jun 2017 | Proposed AMD baseline testing (WRL and TSF) and water quality at Toms Gully. | Old Mt Bundey Station Owner (T Harrower) | General discussion on sampling and reasons why it was required. | Ongoing consultation on site AMD conditions and work undertaken. | - |
| 23 Jul 2017 | RRPA MMP 2016/2017 Submission | DPIR | Request for additional information and resubmission. | Response provided. | - |
| 29 Oct 2017 | Planned exploration drilling. | McKinlay River Station Owner (R Anictomatis) | Supportive of drilling but requested that it be undertaken after the wet season, gates and fences left how they were found, remove rubbish, no shooting and give prior notice when personnel were accessing the area. | Committed to requests associated with the drill program and not commenced until after wet season. | Acceptable |
| 8 Nov 2017 | Details on project progress, intended future work programs and gold find by prospector. | McKinlay River Station Owner (R Anictomatis) | Keep informed of ongoing activities and any issues with the old mining area would be raised if required. | Ongoing communications with information to be provided. | - |

| Date | Description of Engagement | Stakeholders | Stakeholder Comments / Issues | Proponent Response and/or Resolution | Stakeholder Response |
|---|---|---|---|---|---|
| 9 Nov 2017 | Prospector Fossicking, Toms Gully approvals and wet season maintenance requirements, Toms Gully water treatment and disposal options. | Old Mt Bundey Station Owner (T Harrower) | Concerned about unauthorised prospector fossicking.<br>Interested in potential water use but needs to be of a suitable quality. | Keep Pastoralist informed regarding fossicking permits.<br>Water treatment needs to deliver suitable outcomes.<br>Pastoralist to continue water management to prevent overtopping at Toms Gully, Quest 29 and RRPA. | - |
| 30 Nov 2017 | Planned exploration drilling. | McKinlay River Station Owner (R Anictomatis) | - | Exploration approval letter provided. | - |
| 15 Dec 2017 | Water use for pasture irrigation and mango production. | Old Mt Bundey Station Owner (T Harrower) | Pastoralist interested in using treated water for pasture irrigation and mango production provided it is of suitable quality. | Ongoing discussion as water treatment option is developed. | - |
| 22 Jan 2018 | RRPA MMP 2016-2017 Resubmission | DPIR | MMP approved and comments to be addressed in next MMP submission. | Comments addressed in 2018-2019 submission. | Approved |
| 11 May 2018 | Planned exploration drilling. | McKinlay River Station Owners<br>(R Anictomatis and P Maley) | No objections to Primary Gold access to undertake drilling provided gates and fences left how found, rubbish removed, no fires or shooting. | Not required. | Acceptable |
| 14 May 2018 | Planned exploration drilling. | Old Mt Bundey Station Owner (T Harrower) | No objections to Primary Gold access to undertake drilling. | Not required. | Acceptable |
| 16 May 2018 | Advice on Declared Weed Management | DNER | Proposal ok with additional listed management strategies. | Incorporated into Exploration MMP. | - |
| 6 August 2018 | Drilling at TGPA and RRPA | Old Mt Bundey Station Owner (T Harrower) | Can assist with drill pad preparation and ok to drill at TGPA and RRPA. | Will inform 10 days prior to drilling to prepare drill pads. | Acceptable |
| 27 May 2019 | RRPA MMP 2018-2019 Submission | DPIR | Request for additional information and resubmission. | Response being prepared. | - |

## 10.6 Risk Assessment

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| Heap Leach Pads | | | Y | Y | Oxidation of PAF materials | Release of AMD water causing soil or water contamination | Land and Soils | C | 1 | Low | Constructed mostly of NAF oxide ore, limited PAF transitional ore may be present.<br>PAF ore placed in the centre of the pad and the inclusion of cement and a high pH leach likely to offset any acidity.<br>Containment berms established.<br>HDPE geomembrane lined over a prepared clay fill subgrade testwork undertaken.<br>Routine water sampling.<br>Impacted water and seepage is captured in the Heap Leach Ponds.<br>Spread benign oxide across the entire surface of the Heap Leach Pads to a maximum depth of 500mm and batter slopes to a maximum batter angle of 18.5°. | D | 1 | Low |
| | | | Y | Y | | | Water Resources | C | 1 | Low | | D | 1 | Low |
| | | | Y | Y | Erosion of materials from rainfall runoff | Increased sedimentation in catchment and natural drainage channels | Water Resources | B | 1 | Moderate | Implementation of the Landform, Erosion and Sediment Control EMP.<br>Oxide and transitional ore classified as non-dispersive.<br>Containment berms established.<br>Impacted water and seepage is captured in the Heap Leach Ponds.<br>Areas susceptible to erosion will be routinely inspected and monitored.<br>Fencing installed to prevent livestock access.<br>Shape the upper surfaces to control water run-off and construct 1m high crest, berm and toe bunds.<br>Scarify to following the contour and remaining horizontal, application of fertiliser and hand seeding with a local provenance seed mix. | C | 1 | Low |
| | | | | Y | | Reduction in rehabilitation success due to loss of soil or seeds | Rehabilitation and Mine Closure | B | 1 | Moderate | | C | 1 | Low |
| Waste Rock Landform | | | Y | Y | Oxidation of PAF materials | Release of AMD water causing soil or surface water contamination | Land and Soils | D | 1 | Low | Material characterisation undertaken confirming oxide material with has been assessed as NAF, non-dispersive and low salinity.<br>Constructed of NAF oxide waste.<br>Routine water sampling. | E | 1 | Low |
| | | | Y | Y | | | Water Resources | D | 1 | Low | | E | 1 | Low |
| | | | Y | Y | Erosion of materials from rainfall runoff | Increased sedimentation in catchment and natural drainage channels | Water Resources | C | 1 | Low | Implementation of the Landform, Erosion and Sediment Control EMP.<br>Oxide waste rock classified as non-dispersive.<br>Shape the upper surfaces to control water run-off and construct 1m high crest, berm and toe bunds.<br>Scarify to following the contour and remaining horizontal, application of fertiliser and hand seeding with a local provenance seed mix. | D | 1 | Low |
| | | | | Y | | Reduction in rehabilitation success due to loss of soil or seeds | Rehabilitation and Mine Closure | C | 1 | Low | | D | 2 | Low |

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| Non-Process Waste Materials | | | Y | Y | Increase in feral animal species or litter across site | Alteration of fauna habitat or fauna injury/death | Biodiversity | D | 1 | Low | Minimal waste generated onsite.<br>Any site wastes are disposed at an approved off-site landfill.<br>Implementation of the Weed and Pest EMP.<br>Monitor the presence of feral animals on site to determine if additional controls are required.<br>Pastoralist currently controls wild dog populations on-site.<br>Pond liners and concrete footings will be disposed in an appropriate manner (i.e. buried in-situ or in the WRL). | E | 1 | Low |
| | | | Y | Y | Inappropriate disposal of waste material | Release of leachate causing surface water or groundwater contamination | Water Resources | C | 1 | Low | | D | 1 | Low |
| Hard Rock Pit(s) | | | | Y | Overtopping release of pit lake water | Release of water causing native vegetation death and/or decline in vegetation condition or surface water contamination | Rehabilitation and Mine Closure | D | 1 | Low | Pit lake modelling indicates the pit water level equilibrium is in the range of 56m to 62m AHD. This is below the approximate pit crest level of 67m AHD.<br>Inspections of pit lake water level.<br>Routine water sampling. | E | 1 | Low |
| | | | Y | Y | | | Water Resources | D | 2 | Low | | E | 2 | Low |
| | | | Y | Y | Seepage of water from pit lake | Post-mining groundwater quality impacts on surrounding groundwater users | Rehabilitation and Mine Closure | C | 1 | Low | Nearest identified groundwater user was the Mount Bundey Outstation (around 12km north-east).<br>Bores at the Outstation are located across the regional strike and in a different drainage system.<br>Material characterisation undertaken confirming oxide material with has been assessed as NAF, non-dispersive and low salinity. Some transitional material is potentially PAF.<br>Pits have flooded above the transitional material which minimises potential oxidation due to exposure to air. | C | 1 | Low |
| | | | Y | Y | Potential collapse within the zone of instability | Inadvertent access by the Public or Livestock resulting in serious injury | Rehabilitation and Mine Closure | C | 1 | Low | Pits constructed in accordance with geotechnical design criteria.<br>Abandonment bunding and/or fencing established in accordance with WA DMIRS Guidelines.<br>Pits have flooded in the range of 56m to 62m AHD. This is below the approximate pit crest level of 67m AHD. | D | 1 | Low |

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| Hard Rock Pit(s) | | | Y | Y | Inadequate bunding, barriers and signage | Inadvertent access by the Public or Livestock resulting in serious injury | Rehabilitation and Mine Closure | D | 3 | Moderate | Abandonment bunding and/or fencing established in accordance with WA DMIRS Guidelines. | E | 3 | Low |
| | | | Y | Y | Oxidation of PAF materials | Release of AMD causing groundwater contamination | Water Resources | C | 1 | Low | Material characterisation undertaken confirming oxide material with has been assessed as NAF, non-dispersive and low salinity.<br>Some transitional material is potentially PAF.<br>Pits have flooded above the transitional material which minimises potential oxidation due to exposure to air. | D | 1 | Low |
| General RRPA and Rehabilitation Activities | | | Y | Y | Uncontrolled fire generated by activities within the Project area | Decline in vegetation health/condition or vegetation death<br>Alteration of fauna habitat or fauna injury/death<br>Destruction of neighbouring landholder vegetation, buildings, or infrastructure | Biodiversity | C | 3 | Moderate | Implementation of the Fire Prevention EMP.<br>Controlled burns and/or weed spraying will be undertaken as required.<br>Inspect site and fire breaks to determine if there are any developing fire risks.<br>Install and maintain required fire breaks.<br>Regularly service vehicles which will carry fire extinguishers and no vehicles left running unattended.<br>Monitor the fire danger rating and comply with restrictions. | C | 3 | Moderate |
| | | | Y | Y | Introduction and/or spread of weed species | Decline in vegetation health/condition or vegetation death and/or reduction in rehabilitation success | Biodiversity | B | 2 | Moderate | Implementation of the Weed and Pest EMP.<br>Weeds will be controlled via spraying, and/or controlled burning as required.<br>Vehicles will be inspected and cleaned prior to entering and exiting site.<br>Weeds will be mapped to determine whether the spread of weed species is being maintained and minimised.<br>Undertake a vegetation/weeds inspection, prior to any disturbance or rehabilitation activities.<br>Ensure all vehicles and mobile machinery are restricted to designated access tracks.<br>Inspections and monitoring of rehabilitated areas and weed management implemented if required. | C | 2 | Moderate |

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| General RRPA and Rehabilitation Activities | | | | Y | Dust emissions generated during earthworks, haulage, and material handling | Decline in vegetation health/condition or vegetation death or local community disturbance | Biodiversity | D | 1 | Low | Regular visual monitoring and implement appropriate dust controls if dust levels are excessive.<br>Regular watering as required during rehabilitation activities.<br>Use defined roads with speed restrictions.<br>Avoid dust generating activities during high winds (where practical).<br>No sensitive receptors have been identified within or surrounding the RRPA.<br>Complaints from stakeholders regarding dust emissions will be acted on immediately and management measures reviewed accordingly. | E | 1 | Low |
| | | | | Y | | | Social | C | 1 | Low | | D | 1 | Low |
| | | | Y | Y | Vehicle/machinery movement interactions with native fauna<br>Driving off authorised roads through native vegetation | Decline in vegetation health/condition or vegetation death<br>Alteration of fauna habitat or fauna injury/death | Biodiversity | C | 1 | Low | Minimal vehicle access at site.<br>Driving restricted to marked/cleared roads and to designated speed limits.<br>Education of employees/contractors at site inductions including reporting of any interactions. | D | 1 | Low |
| | | | Y | Y | Clearing outside of the disturbance areas | Decline in vegetation health/condition or vegetation death<br>Alteration of fauna habitat or fauna injury/death | Biodiversity | C | 1 | Low | Implementation of the Flora and Fauna EMP.<br>Clearing activities will be managed via Permit to Clear system and SOPs. | D | 1 | Low |
| | | | Y | Y | Clearing or activities damage heritage site | Damage to heritage sites | Social | D | 2 | Low | AAPA confirmed that no heritage sites were known to exist in or around the RRPA.<br>Archaeological surveys completed and AAPA Certificate issued.<br>Rehabilitation works limited to existing disturbance areas.<br>Any chance finds will be managed in accordance with the Chance Find SOP.<br>Any clearing activities require a Permit to Clear prior to any works. | E | 2 | Low |
| | | | | Y | Changing stakeholder expectations | No agreement on post mining land use or closure objectives | Rehabilitation and Mine Closure | C | 2 | Moderate | Continue to facilitate consultative relationships with key stakeholders.<br>Maintenance of a stakeholder engagement register to ensure that all concerns are recorded and actioned appropriately. | D | 2 | Low |

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| General RRPA and Rehabilitation Activities | | | Y | Y | Contamination of surface water runoff following heavy rainfall | Release of mine impacted water or sediment causing surface water contamination | Water Resources | C | 2 | Moderate | Modelling completed to understand drainage flow paths.<br>Site diversion bunds designed for storm events and constructed to engineered designs.<br>Bunds not required for closure will be removed, reprofiled and rehabilitated.<br>Routine inspections for erosion and remediation undertaken as required.<br>Implementation of the Landform, Erosion and Sediment Control EMP. | D | 2 | Low |
| | | | | Y | | | Rehabilitation and Mine Closure | C | 2 | Moderate | All surface infrastructure removed, and any contaminated soil remediated.<br>Site recontoured to establish flood drainage paths.<br>Disturbed areas scarified and seeded with appropriate vegetation cover. | D | 2 | Low |
| | | | | Y | Ineffective establishment of vegetation | Reduction in rehabilitation success due to topsoil or seed viability and/or loss of topsoil or seed via erosion | Rehabilitation and Mine Closure | C | 2 | Moderate | All disturbed areas will be scarified on the contour to improve soil structure and infiltration capacity.<br>Local provenance seed spread on disturbed areas.<br>Monitoring implemented on rehabilitation areas to measure progression towards completion criteria and identify improvement actions (if required). | D | 2 | Low |
| | | | | Y | Environmental noise generated from mining equipment and operations | Local community disturbance | Social | D | 1 | Low | Rehabilitation activities undertaken during dayshift only.<br>No sensitive receptors have been identified within or surrounding the RRPA.<br>Complaints from stakeholders regarding noise emissions will be acted on immediately and management measures reviewed accordingly. | E | 1 | Low |
| | | | Y | Y | Spills or leaks of hydrocarbons or chemicals<br>Inadequate remediation of spills | Release of hydrocarbons causing soil or surface water contamination<br>Contaminated sites persisting into closure | Land and Soils | C | 1 | Low | Minimal vehicle access at site and no existing chemical or hydrocarbon storage facilities<br>All refuelling, vehicle maintenance or washdown is undertaken in offsite or designated areas.<br>Spillages reported and cleaned up immediately.<br>Contaminated sites investigation and remediation (if required) in accordance with MCP. | D | 1 | Low |
| | | | Y | Y | | | Water Resources | C | 1 | Low | | D | 1 | Low |
| | | | | Y | | | Rehabilitation and Mine Closure | C | 1 | Low | | D | 1 | Low |

| Activity | Project Phase | | | | Risk Pathway | Potential Impacts | Environmental Factor | Likelihood | Consequence | Inherent Risk | Treatment | Likelihood | Consequence | Residual Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Operation | Care and Maintenance | Closure | | | | | | | | | | |
| Dams (Leach Ponds and Storm Water Pond) | | | Y | | Fauna or Livestock entrapment in dams | Fauna or Livestock illness, injury, or death | Biodiversity | B | 1 | Moderate | Fauna egress ramps installed.<br>Fencing around Leach and Storm Water Ponds.<br>Regular inspections during water monitoring. | C | 1 | Low |
| | | | Y | | | Damage to pond liners | Water Resources | B | 1 | Moderate | | C | 1 | Low |
| | | | Y | | Overtopping release of water from dams | Release of water causing native vegetation death, decline in vegetation condition and/or soil or surface water contamination | Biodiversity | D | 2 | Low | Ponds were sized to contain water from the processing operations plus excess wet season runoff.<br>Only wet season (rainfall) storage undertaken during care and maintenance which evaporates during dry season.<br>Leach Ponds are interconnected with 0.35m spillways and in turn overflow into the Storm Water Pond which provides an additional capacity.<br>Routine water sampling.<br>Inspections during the wet season and the water is pumped to Open Pit if/when required to prevent water overtopping. | E | 2 | Low |
| | | | Y | | | | Land and Soils | D | 2 | Low | | E | 2 | Low |
| | | | Y | | | | Water Resources | D | 2 | Low | | E | 2 | Low |
| | | | Y | | Seepage of water from dams | Release of water causing groundwater contamination | Water Resources | D | 2 | Low | The Leach Ponds and Storm Water Pond are lined with a 1.5mm HDPE geomembrane with a geotextile under-lining.<br>Routine water sampling. | E | 2 | Low |
| Exploration Activities | | | Y | | Inadequate rehabilitation of drill holes, sumps, and tracks | Increased sedimentation in catchment and natural drainage channels | Water Resources | C | 1 | Low | Plastic sample bags not used; drill samples will be laid out on the ground and disposed of either by placing below ground and/or dispersed across the surface if the drill spoils are inert and aesthetically compatible to the surface soils.<br>Rehabilitation will be in accordance to the Department of Mines and Energy advisory notes titled “Construction and Rehabilitation of Exploration Drill Sites”<br>Inspections and photographs of rehabilitation at the end of the drill program and after the wet season.<br>Remediation to occur if required. | D | 1 | Low |
| | | | Y | | | Introduction and/or spread of weed species<br>Fauna or Livestock injury or death | Biodiversity | C | 1 | Low | | D | 1 | Low |

## 10.7 Water Quality Data

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW2 | Minimum | 6.4 | 38 | 8 | 11 | 5 | 2.4 | 0.6 | 0.5 | 1.9 | 15 | 5 | 5 | 15 | 1 | 2 | 8 | 0.01 | 0.004 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.05 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.01 | 0.007 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.25 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 |
| | Maximum | 7.4 | 120 | 1000 | 40 | 11 | 6.3 | 4.1 | 1.9 | 17 | 45 | 5 | 5 | 45 | 4 | 7 | 18 | 0.72 | 0.015 | 0.0001 | 0.005 | 0.002 | 0.004 | 1.6 | 0.036 | 0.18 | 0.001 | 0.0005 | 0.03 | 0.44 | 0.051 | 0.0001 | 0.006 | 0.002 | 0.004 | 2.6 | 0.12 | 0.095 | 0.002 | 0.0005 | 0.045 |
| | Average | 6.76 | 70.60 | 218.20 | 21.75 | 7.50 | 4.20 | 1.74 | 0.92 | 7.68 | 26.6 | 5 | 5 | 26.6 | 2.6 | 3.2 | 13.8 | 0.258 | 0.0114 | 0.0001 | 0.002 | 0.0012 | 0.0022 | 0.702 | 0.0124 | 0.044 | 0.001 | 0.0005 | 0.0098 | 0.208 | 0.0262 | 0.0001 | 0.0022 | 0.0014 | 0.002 | 1.072 | 0.0466 | 0.0334 | 0.0012 | 0.0005 | 0.013 |
| | 80th | 7.08 | 90.4 | 242.4 | 30.4 | 9.8 | 6.14 | 2.26 | 1.1 | 11.08 | 37.8 | 5 | 5 | 37.8 | 3.2 | 3.8 | 17.2 | 0.496 | 0.0142 | 0.0001 | 0.0026 | 0.0012 | 0.0024 | 1.52 | 0.0256 | 0.0616 | 0.001 | 0.0005 | 0.014 | 0.336 | 0.0494 | 0.0001 | 0.0028 | 0.002 | 0.0032 | 1.72 | 0.112 | 0.0638 | 0.0012 | 0.0005 | 0.021 |
| | Median | 6.5 | 66 | 16 | 18 | 7 | 3.8 | 1.4 | 0.7 | 5.6 | 22 | 5 | 5 | 22 | 3 | 2 | 16 | 0.11 | 0.012 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.19 | 0.001 | 0.005 | 0.001 | 0.0005 | 0.007 | 0.16 | 0.017 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.73 | 0.001 | 0.012 | 0.001 | 0.0005 | 0.002 |
| | Sample Size | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | SSTV | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 95% | 0 | 0 | | 2 | | | | | | | | | | | | | | 2 | 0 | | 1 | 4 | | 0 | 2 | 0 | | 2 | | | | | | | | | | | | |
| | 90% | 0 | 0 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 4 | | 0 | 2 | 0 | | 1 | | | | | | | | | | | | |
| | 80% | 0 | 0 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 2 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW5 | Minimum | 6.3 | 13 | 15 | 7 | 5 | 0.6 | 0.9 | 0.5 | 0.6 | 5 | 5 | 5 | 5 | 1 | 1 | 3 | 0.01 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.08 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.002 | 0.003 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.43 | 0.002 | 0.001 | 0.001 | 0.0005 | 0.002 |
| | Maximum | 7.8 | 300 | 97 | 720 | 9 | 27 | 3.2 | 1.8 | 26 | 110 | 5 | 5 | 110 | 15 | 6 | 74 | 0.09 | 0.035 | 0.0001 | 0.001 | 0.001 | 0.004 | 0.47 | 0.18 | 0.005 | 0.001 | 0.0005 | 0.19 | 1.8 | 0.033 | 0.0001 | 0.002 | 0.003 | 0.006 | 2.2 | 0.33 | 0.028 | 0.001 | 0.0005 | 0.28 |
| | Average | 7.21 | 140.86 | 35 | 114.87 | 5.86 | 14.44 | 2.114 | 1.014 | 12.49 | 61.57 | 5 | 5 | 61.29 | 6.43 | 2.57 | 39.43 | 0.02 | 0.014 | 0.0001 | 0.001 | 0.001 | 0.00171 | 0.25 | 0.09 | 0.002 | 0.001 | 0.0005 | 0.0366 | 0.3 | 0.018 | 0.0001 | 0.00129 | 0.0013 | 0.004 | 1.169 | 0.1699 | 0.006 | 0.001 | 0.0005 | 0.0706 |
| | 80th | 7.78 | 208 | 33 | 22.6 | 6.6 | 22.8 | 3.08 | 1.56 | 22.8 | 95.2 | 5 | 5 | 95.2 | 11.4 | 3 | 62.8 | 0.026 | 0.0216 | 0.0001 | 0.001 | 0.001 | 0.0026 | 0.384 | 0.156 | 0.002 | 0.001 | 0.0005 | 0.0448 | 0.094 | 0.028 | 0.0001 | 0.0018 | 0.001 | 0.006 | 2.06 | 0.256 | 0.0036 | 0.001 | 0.0005 | 0.1352 |
| | Median | 7.6 | 140 | 24.5 | 14 | 5 | 16 | 2.3 | 0.9 | 9.6 | 67 | 5 | 5 | 67 | 5 | 2 | 42 | 0.01 | 0.011 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.26 | 0.12 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.07 | 0.018 | 0.0001 | 0.001 | 0.001 | 0.005 | 0.88 | 0.19 | 0.002 | 0.001 | 0.0005 | 0.009 |
| | Sample Size | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 95% | 0 | 2 | | 3 | | | | | | | | | | | | | | 2 | 0 | | 0 | 2 | | 0 | 0 | 0 | | 2 | | | | | | | | | | | | |
| | 90% | 0 | 2 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 2 | | 0 | 0 | 0 | | 2 | | | | | | | | | | | | |
| | 80% | 0 | 2 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 2 | | 0 | 0 | 0 | | 2 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW6 | Minimum | 5.6 | 10 | 5 | 3.9 | 5 | 0.5 | 0.5 | 0.5 | 0.7 | 5 | 5 | 5 | 5 | 1 | 1 | 3 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.16 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.05 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.38 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 |
| | Maximum | 6 | 25 | 17 | 30 | 10 | 0.6 | 2.1 | 0.6 | 2.3 | 5 | 5 | 5 | 5 | 3 | 1 | 4 | 0.11 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.32 | 0.033 | 0.015 | 0.001 | 0.0005 | 0.003 | 2 | 0.003 | 0.0001 | 0.001 | 0.001 | 0.002 | 2.2 | 0.043 | 0.018 | 0.001 | 0.0005 | 0.004 |
| | Average | 5.78 | 16.25 | 10.33 | 11.98 | 8.00 | 0.525 | 1 | 0.525 | 1.45 | 5 | 5 | 5 | 5 | 2 | 1 | 3.25 | 0.05 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.00125 | 0.22 | 0.02 | 0.005 | 0.001 | 0.0005 | 0.0015 | 0.585 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.00125 | 0.928 | 0.0283 | 0.006 | 0.001 | 0.0005 | 0.0023 |
| | 80th | 5.94 | 22 | 13.8 | 18 | 9.4 | 0.54 | 1.38 | 0.54 | 2.06 | 5 | 5 | 5 | 5 | 3 | 1 | 3.4 | 0.074 | 0.0014 | 0.0001 | 0.001 | 0.001 | 0.0014 | 0.254 | 0.03 | 0.0066 | 0.001 | 0.0005 | 0.0018 | 0.938 | 0.0024 | 0.0001 | 0.001 | 0.001 | 0.0014 | 1.222 | 0.0418 | 0.0084 | 0.001 | 0.0005 | 0.0034 |
| | Median | 5.75 | 15 | 9 | 7 | 8.5 | 0.5 | 0.7 | 0.5 | 1.4 | 5 | 5 | 5 | 5 | 2 | 1 | 3 | 0.03 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.2 | 0.014 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.145 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.565 | 0.0345 | 0.0015 | 0.001 | 0.0005 | 0.002 |
| | Sample Size | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 95% | 3 | 2 | | 1 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 90% | 3 | 2 | | 1 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 3 | 2 | | 1 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW7 | Minimum | 4.3 | 11 | 3 | 2.2 | 5 | 0.5 | 0.5 | 0.5 | 0.7 | 5 | 5 | 5 | 5 | 1 | 1 | 5 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.06 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.02 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.27 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 |
| | Maximum | 6.3 | 49 | 19 | 28 | 18 | 1 | 2.5 | 1.2 | 1.9 | 10 | 5 | 5 | 10 | 4 | 1 | 7 | 0.12 | 0.001 | 0.0001 | 0.003 | 0.001 | 0.001 | 0.41 | 0.64 | 0.094 | 0.001 | 0.0005 | 0.008 | 3 | 0.001 | 0.0001 | 0.003 | 0.005 | 0.002 | 1.7 | 0.69 | 0.14 | 0.001 | 0.0005 | 0.006 |
| | Average | 5.96 | 21.7 | 8 | 7.87 | 7.67 | 0.62 | 0.97 | 0.73 | 1.33 | 6.8 | 5 | 5 | 6.6 | 2 | 1 | 5.33 | 0.04 | 0.001 | 0.0001 | 0.002 | 0.001 | 0.001 | 0.146 | 0.35 | 0.011 | 0.001 | 0.0005 | 0.0023 | 0.371 | 0.001 | 0.0001 | 0.0018 | 0.0014 | 0.0011 | 0.797 | 0.3872 | 0.017 | 0.001 | 0.0005 | 0.0023 |
| | 80th | 6.22 | 26.8 | 10.4 | 9 | 9.2 | 0.64 | 1.48 | 0.84 | 1.5 | 7.6 | 5 | 5 | 7.6 | 3 | 1 | 5 | 0.09 | 0.001 | 0.0001 | 0.002 | 0.001 | 0.001 | 0.212 | 0.55 | 0.002 | 0.001 | 0.0005 | 0.0028 | 0.196 | 0.001 | 0.0001 | 0.0022 | 0.001 | 0.001 | 1.024 | 0.572 | 0.005 | 0.001 | 0.0005 | 0.003 |
| | Median | 6.2 | 18 | 6 | 4.2 | 6 | 0.6 | 0.55 | 0.7 | 1.35 | 7 | 5 | 5 | 6 | 2 | 1 | 5 | 0.01 | 0.001 | 0.0001 | 0.0015 | 0.001 | 0.001 | 0.11 | 0.4 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.04 | 0.001 | 0.0001 | 0.002 | 0.001 | 0.001 | 0.82 | 0.475 | 0.001 | 0.001 | 0.0005 | 0.002 |
| | Sample Size | 10 | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 95% | 2 | 6 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 90% | 2 | 6 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 2 | 6 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW10 | Minimum | 6.1 | 8 | 32 | 44 | 5 | 0.5 | 0.5 | 0.5 | 0.5 | 5 | 5 | 5 | 5 | 1 | 1 | 3 | 0.02 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.05 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.09 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.3 | 0.001 | 0.003 | 0.001 | 0.0005 | 0.006 |
| | Maximum | 7.1 | 55 | 250 | 860 | 6 | 6.8 | 2.1 | 1.1 | 1.9 | 27 | 5 | 5 | 27 | 2 | 1 | 21 | 0.05 | 0.008 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.21 | 0.005 | 0.005 | 0.002 | 0.0005 | 0.006 | 1.8 | 0.014 | 0.0001 | 0.002 | 0.004 | 0.008 | 4.9 | 0.23 | 0.11 | 0.001 | 0.0005 | 0.02 |
| | Average | 6.60 | 29 | 141 | 325.7 | 5.33 | 2.9 | 1.3 | 0.7 | 1.33 | 13.3 | 5 | 5 | 13.3 | 1 | 1 | 10 | 0.04 | 0.004 | 0.0001 | 0.001 | 0.001 | 0.00133 | 0.107 | 0.00 | 0.004 | 0.0013 | 0.0005 | 0.0027 | 0.70 | 0.006 | 0.0001 | 0.00133 | 0.002 | 0.004 | 2.01 | 0.0773 | 0.074 | 0.001 | 0.0005 | 0.0147 |
| | 80th | 6.9 | 42.6 | 206.4 | 545.2 | 5.6 | 4.64 | 1.78 | 0.86 | 1.78 | 19.4 | 5 | 5 | 19.4 | 1.6 | 1 | 15 | 0.046 | 0.0056 | 0.0001 | 0.001 | 0.001 | 0.0016 | 0.15 | 0.0034 | 0.005 | 0.0016 | 0.0005 | 0.004 | 1.16 | 0.01 | 0.0001 | 0.0016 | 0.0028 | 0.0056 | 3.272 | 0.1384 | 0.11 | 0.001 | 0.0005 | 0.0192 |
| | Median | 6.6 | 24 | 141 | 73 | 5 | 1.4 | 1.3 | 0.5 | 1.6 | 8 | 5 | 5 | 8 | 1 | 1 | 6 | 0.04 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.06 | 0.001 | 0.005 | 0.001 | 0.0005 | 0.001 | 0.2 | 0.004 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.83 | 0.001 | 0.11 | 0.001 | 0.0005 | 0.018 |
| | Sample Size | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| | 95% | 0 | 1 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | 90% | 0 | 1 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 0 | 1 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW11 | Minimum | 6.2 | 21 | 6 | 2.8 | 5 | 0.5 | 0.9 | 0.5 | 1.3 | 7 | 5 | 5 | 5 | 1 | 1 | 3 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.04 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.01 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.06 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 |
| | Maximum | 7.3 | 82 | 490 | 610 | 11 | 11 | 2.2 | 1 | 2.5 | 38 | 5 | 5 | 38 | 3 | 7 | 32 | 0.51 | 0.016 | 0.0001 | 0.004 | 0.002 | 0.004 | 1.8 | 0.65 | 0.055 | 0.001 | 0.0005 | 0.004 | 0.89 | 0.014 | 0.0001 | 0.006 | 0.002 | 0.007 | 6.6 | 0.81 | 1.2 | 0.003 | 0.0005 | 0.027 |
| | Average | 6.62 | 46.333 | 125 | 215.30 | 7.00 | 4.95 | 1.567 | 0.683 | 1.85 | 20.0 | 5 | 5 | 19.5 | 2 | 2 | 15.33 | 0.11 | 0.006 | 0.0001 | 0.002 | 0.00117 | 0.00167 | 0.445 | 0.12 | 0.011 | 0.001 | 0.0005 | 0.002 | 0.357 | 0.008 | 0.0001 | 0.0025 | 0.0013 | 0.003 | 2.122 | 0.1602 | 0.216 | 0.00133 | 0.0005 | 0.0085 |
| | 80th | 6.8 | 81 | 158 | 300 | 10 | 11 | 1.7 | 0.8 | 2.4 | 37 | 5 | 5 | 37 | 2 | 1 | 32 | 0.08 | 0.009 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.36 | 0.038 | 0.005 | 0.001 | 0.0005 | 0.003 | 0.88 | 0.012 | 0.0001 | 0.004 | 0.002 | 0.004 | 3.2 | 0.092 | 0.071 | 0.001 | 0.0005 | 0.011 |
| | Median | 6.55 | 34 | 36 | 184 | 5.5 | 2.9 | 1.6 | 0.65 | 1.75 | 15 | 5 | 5 | 15 | 1 | 1 | 10.5 | 0.02 | 0.003 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.205 | 0.003 | 0.003 | 0.001 | 0.0005 | 0.0015 | 0.17 | 0.008 | 0.0001 | 0.0015 | 0.001 | 0.002 | 1.1 | 0.0285 | 0.0125 | 0.001 | 0.0005 | 0.0055 |
| | Sample Size | 6 | 6 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | SSTV | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 2 | | | | | | |
| | 95% | 0 | 0 | | 4 | | | | | | | | | | | | | | 1 | 0 | | 1 | 2 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 90% | 0 | 0 | | 4 | | | | | | | | | | | | | | 0 | 0 | | 0 | 2 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 0 | 0 | | 4 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 1 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW12 | Minimum | 5.4 | 10 | 5 | 24 | 6 | 0.5 | 0.5 | 0.5 | 1 | 5 | 5 | 5 | 5 | 1 | 1 | 3 | 0.07 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.05 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.27 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.29 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.002 |
| | Maximum | 6.1 | 14 | 7 | 47 | 9 | 0.5 | 1 | 0.5 | 1.8 | 5 | 5 | 5 | 5 | 2 | 1 | 3 | 0.14 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.15 | 0.018 | 0.018 | 0.001 | 0.0005 | 0.002 | 0.36 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.002 | 0.32 | 0.025 | 0.028 | 0.001 | 0.0005 | 0.003 |
| | Average | 5.70 | 12.333 | 6 | 37.7 | 7.33 | 0.5 | 0.667 | 0.5 | 1.30 | 5.0 | 5 | 5 | 5.0 | 2 | 1 | 3 | 0.12 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.11 | 0.01 | 0.008 | 0.001 | 0.0005 | 0.0017 | 0.32 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.00133 | 0.303 | 0.009 | 0.012 | 0.001 | 0.0005 | 0.0023 |
| | 80th | 5.9 | 13.6 | 6.6 | 45 | 8.2 | 0.5 | 0.8 | 0.5 | 1.52 | 5 | 5 | 5 | 5 | 2 | 1 | 3 | 0.14 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.142 | 0.0112 | 0.0128 | 0.001 | 0.0005 | 0.002 | 0.344 | 0.0016 | 0.0001 | 0.001 | 0.001 | 0.0016 | 0.312 | 0.0154 | 0.0196 | 0.001 | 0.0005 | 0.0026 |
| | Median | 5.6 | 13 | 6 | 42 | 7 | 0.5 | 0.5 | 0.5 | 1.1 | 5 | 5 | 5 | 5 | 2 | 1 | 3 | 0.14 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.13 | 0.001 | 0.005 | 0.001 | 0.0005 | 0.002 | 0.32 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.3 | 0.001 | 0.007 | 0.001 | 0.0005 | 0.002 |
| | Sample Size | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | 95% | 2 | 3 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 90% | 2 | 3 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 2 | 3 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW22 | Minimum | 6.2 | 21 | 5 | 0.7 | 5 | 0.5 | 1 | 0.5 | 1.7 | 5 | 5 | 5 | 5 | 2 | 1 | 3 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.01 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.03 | 0.001 | 0.001 | 0.001 | 0.0005 | 0.001 |
| | Maximum | 7.1 | 27 | 120 | 9.6 | 6 | 0.6 | 1.4 | 0.8 | 2.2 | 10 | 5 | 5 | 10 | 3 | 2 | 5 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.02 | 0.027 | 0.005 | 0.001 | 0.0005 | 0.027 | 0.04 | 0.003 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.67 | 0.17 | 0.022 | 0.001 | 0.0005 | 0.034 |
| | Average | 6.76 | 23.857 | 26.5 | 3.14 | 5.14 | 0.557 | 1.243 | 0.7 | 1.96 | 7.3 | 5 | 5 | 6.9 | 2 | 1 | 4 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.011 | 0.01 | 0.002 | 0.001 | 0.0005 | 0.0057 | 0.02 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.156 | 0.0621 | 0.004 | 0.001 | 0.0005 | 0.0073 |
| | 80th | 7.08 | 25 | 13 | 3.5 | 5 | 0.6 | 1.38 | 0.8 | 2.18 | 8.8 | 5 | 5 | 8.6 | 3 | 1 | 5 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.01 | 0.0122 | 0.001 | 0.001 | 0.0005 | 0.0046 | 0.028 | 0.0018 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.15 | 0.1294 | 0.001 | 0.001 | 0.0005 | 0.0056 |
| | Median | 6.9 | 24 | 8 | 2.4 | 5 | 0.6 | 1.3 | 0.7 | 1.9 | 7 | 5 | 5 | 7 | 2 | 1 | 4 | 0.01 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.01 | 0.005 | 0.001 | 0.001 | 0.0005 | 0.002 | 0.02 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.05 | 0.028 | 0.001 | 0.001 | 0.0005 | 0.002 |
| | Sample Size | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | 95% | 0 | 0 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 1 | | | | | | | | | | | | |
| | 90% | 0 | 0 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 1 | | | | | | | | | | | | |
| | 80% | 0 | 0 | | 3 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWQ2 | Minimum | 6.3 | 16 | 8 | 9.1 | 4 | 0.5 | 0.6 | 0.5 | 1.2 | 5 | 1 | 1 | 5 | 1 | 1 | 3 | 0.06 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.11 | 0.005 | 0.001 | 0.001 | 0.0005 | 0.001 | 0.1 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.31 | 0.008 | 0.001 | 0.001 | 0.00028 | 0.002 |
| | Maximum | 7.3 | 43 | 140 | 1500 | 7 | 1.7 | 1.5 | 1.7 | 4.2 | 17 | 5 | 5 | 17 | 3 | 3.6 | 11 | 0.19 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.00159 | 0.5 | 0.0152 | 0.001 | 0.001 | 0.0005 | 0.01 | 6.9 | 0.004 | 0.001 | 0.006 | 0.009 | 0.009 | 10 | 0.26 | 0.005 | 0.015 | 0.0022 | 0.035 |
| | Average | 6.64 | 29.857 | 64.17 | 249.30 | 5.29 | 0.829 | 1.157 | 0.886 | 3.16 | 10.6 | 4.43 | 4.43 | 10 | 2 | 1 | 6 | 0.12 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.00108 | 0.216 | 0.01 | 0.001 | 0.001 | 0.0005 | 0.0041 | 1.986 | 0.003 | 0.00027 | 0.00186 | 0.0025 | 0.00326 | 2.931 | 0.1197 | 0.002 | 0.00372 | 0.00071 | 0.0123 |
| | 80th | 6.7 | 36.6 | 120 | 61.8 | 5.8 | 0.96 | 1.46 | 0.98 | 4.08 | 13.8 | 5 | 5 | 13.8 | 2 | 1 | 6.72 | 0.164 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.218 | 0.0132 | 0.001 | 0.001 | 0.0005 | 0.008 | 3.64 | 0.003 | 0.00034 | 0.0018 | 0.0023 | 0.0038 | 3.44 | 0.232 | 0.00359 | 0.00281 | 0.0005 | 0.0174 |
| | Median | 6.6 | 32 | 44.5 | 52 | 5 | 0.6 | 1.3 | 0.8 | 3.7 | 9.9 | 5 | 5 | 8 | 2 | 1 | 5 | 0.11 | 0.001 | 0.0001 | 0.001 | 0.001 | 0.001 | 0.18 | 0.005 | 0.001 | 0.001 | 0.0005 | 0.002 | 0.72 | 0.002 | 0.0001 | 0.001 | 0.001 | 0.00283 | 1.9 | 0.11 | 0.001 | 0.002 | 0.0005 | 0.011 |
| | Sample Size | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | 2 | | | | | |
| | 95% | 0 | 1 | | 6 | | | | | | | | | | | | | | 0 | 0 | | 0 | 1 | | 0 | 0 | 0 | | 2 | | | | | | | | | | | | |
| | 90% | 0 | 1 | | 6 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | 80% | 0 | 1 | | 6 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | | 0 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

| | | pH | EC | TSS | Turbidity | Acidity | Ca | K | Mg | Na | Bicarbonate | Carbonate | Hydroxide | Alkalinity | Chloride | Sulphate | Hardness | Al-D | As-D | Cd-D | Co-D | Cr-D | Cu-D | Fe-D | Mn-D | Ni-D | Pb-D | U-D | Zn-D | Al-T | As-T | Cd-T | Co-T | Cr-T | Cu-T | Fe-T | Mn-T | Ni-T | Pb-T | U-T | Zn-T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MB01 | Minimum | 5.9 | 110 | 29 | 16 | 24 | 1 | 0.5 | 1.5 | 18 | 44 | 5 | 5 | 44 | 3 | 7 | 10 | 0.02 | 0.006 | 0.0001 | 0.005 | 0.001 | 0.001 | 0.32 | 0.001 | 0.003 | 0.001 | 0.0005 | 0.005 | 0.015 | 0.007 | 0.0001 | 0.005 | 0.001 | 0.002 | 0.49 | 0.001 | 0.004 | 0.001 | 0.0005 | 0.004 |
| | Maximum | 6.2 | 140 | 230 | 24 | 29 | 1.4 | 1 | 2 | 20 | 47 | 5 | 5 | 47 | 4 | 11 | 11 | 0.11 | 0.014 | 0.0001 | 0.007 | 0.001 | 0.001 | 2 | 0.065 | 0.031 | 0.001 | 0.0005 | 0.04 | 0.05 | 0.15 | 0.0001 | 0.008 | 0.001 | 0.003 | 2.4 | 0.069 | 0.032 | 0.002 | 0.0005 | 0.022 |
| | Average | 6.05 | 125 | 129.5 | 20 | 26.50 | 1.2 | 0.75 | 1.75 | 19 | 45.5 | 5 | 5 | 45.5 | 4 | 9 | 11 | 0.07 | 0.010 | 0.0001 | 0.006 | 0.001 | 0.001 | 1.16 | 0.03 | 0.017 | 0.001 | 0.0005 | 0.0225 | 0.033 | 0.079 | 0.0001 | 0.0065 | 0.001 | 0.0025 | 1.445 | 0.035 | 0.018 | 0.0015 | 0.0005 | 0.013 |
| | 80th | 6.14 | 134 | 189.8 | 22.4 | 28 | 1.32 | 0.9 | 1.9 | 19.6 | 46.4 | 5 | 5 | 46.4 | 3.8 | 10.2 | 10.8 | 0.092 | 0.0124 | 0.0001 | 0.0066 | 0.001 | 0.001 | 1.664 | 0.0522 | 0.0254 | 0.001 | 0.0005 | 0.033 | 0.043 | 0.1214 | 0.0001 | 0.0074 | 0.001 | 0.0028 | 2.018 | 0.0554 | 0.0264 | 0.0018 | 0.0005 | 0.0184 |
| | Median | 6.05 | 125 | 129.5 | 20 | 26.5 | 1.2 | 0.75 | 1.75 | 19 | 45.5 | 5 | 5 | 45.5 | 3.5 | 9 | 10.5 | 0.065 | 0.01 | 0.0001 | 0.006 | 0.001 | 0.001 | 1.16 | 0.033 | 0.017 | 0.001 | 0.0005 | 0.0225 | 0.033 | 0.0785 | 0.0001 | 0.0065 | 0.001 | 0.0025 | 1.445 | 0.035 | 0.018 | 0.0015 | 0.0005 | 0.013 |
| | Sample Size | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | SSTV | | | | | | | | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | 0 | | | | | |
| | 95% | 1 | 0 | | 2 | | | | | | | | | | | | | | 1 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 1 | | | | | | | | | | | | |
| | 90% | 1 | 0 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 1 | | | | | | | | | | | | |
| | 80% | 1 | 0 | | 2 | | | | | | | | | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 | | 1 | | | | | | | | | | | | |
| | SWG | | 0 | | | | 0 | | | | | | | | | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 |

## 10.8 Environmental Emergency Response Plan

# RUSTLERS ROOST PROJECT AREA ENVIRONMENTAL EMERGENCYPREPAREDNESS AND RESPONSE PLAN

## Introduction

This Environment Emergency Response Plan (EERP) has been developed to protect wildlife and reduce damage to the environment and Primary Gold Ltd (PGO) assets. . This plan is site specific to the Rustlers Roost Project Area (RRPA).

The RRPA is a care and maintenance site and there is no full time company representative onsite, however, the project area will be regularly monitored by a company appointed environmental officer based in Darwin. PGO will work collaboratively with local pastoralists and the appointed environmental service provider to manage the site.

## Aims

The Emergency Response Plan sets out the response protocol in the event of an environmental incident, detailing the required procedure for incident reporting, assessment, and response. This includes:

- The nature of potential on-site hazards;
- The most likely type and scale of emergency situation or accident;
- The most appropriate method(s) for responding to an accident or emergency situation;
- Internal and external communication plans;
- The action(s) required to minimise environmental damage;
- Mitigation and response action(s) for post-accident evaluation to establish and implement corrective and preventative actions;
- Periodic testing of emergency response procedure(s);
- A list of key personnel and aid agencies, including contact details;
- The possibility of mutual assistance from neighbouring operators;
- The location of on-site information on hazardous materials; and
- Location of emergency response equipment.

## Site Environmental Hazards and Management

Potential hazards/incidents required response and management are presented Table 1 below.

**Table 1 Environmental Hazards/Incidents, Response and Management**

| Environmental Hazards | Mitigation/Management | Response |
|---|---|---|
| Unscheduled release of mine site water | Review water balance model with updated dam and pit survey water levels to ensure sufficient capacity is available, monitor and instigate pumping strategy as required. Detailed plan of water movement will be included in the next EERP.. | Assess situation, turn pump on to transfer excess water to BHS pit Notify the appropriate people (PGO Management), Monitoring/Remediation and Follow-up. |

| Environmental Hazards | Mitigation/Management | Response |
|---|---|---|
| Chemical spill or toxic release E.g. from equipment working in the project area. | *Note, there are currently no active working areas in the PA or chemicals stored on site.*<br><br>Review policy, procedures, and Inductions. Ensure adequate training where appropriate, conduct regular pre-start checks to track maintenance issues. | Senior PGO company representative or appointed Environmental officer is to assess the situation. Protect personal safety, safety of personnel, prevent further spillage and contain the spill. Notify the relevant emergency response personnel, remediation and follow-up. |
| Pipeline Emergency | Carry out pre wet season pipeline inspections, replace any damaged or weak areas identified to prevent pipeline failure. | Senior PGO company representative or appointed Environmental officer is to assess the situation. Prevent further spillage and contain the spill through shutting off valve/pump and or bunding. Notify the relevant emergency response personnel, monitoring/ remediation and follow-up. |
| Equipment failure | *Note, there are currently no active working areas in the PA or equipment used or stored on site.*<br><br>Conduct regular (monthly) equipment inspections, tag out if any defects detected and remedy. | Senior PGO company representative or appointed Environmental officer is to assess the situation. Protect the people, turn on battery isolator Notify the relevant emergency response personnel, remediation and follow-up. |
| Wildfire | Ensure all fire breaks are re-established prior to the onset of the wet season. Liaise with pastoralist to manage and protect infrastructure during back burns. Liaise with pastoralist to monitor local fire conditions. | Notify environmental personnel, pastoralist and the local Fire and Emergency Response Group (FERGS) /volunteers bush fire brigade for assistance if required. Protect people and assets, extinguish fire and back-burn where necessary. |

| Environmental Hazards | Mitigation/Management | Response |
|---|---|---|
| Severe weather conditions | Regularly check the Bureau of Meteorology (BoM) website for cyclone advice issued. | Q29 PA is a care and maintenance site, in the event of cyclone watch or warning advice issued by BOM, PGO staff are required to vacate site. |
| Vehicle emergency | Daily LV Inspections. | Notify Emergency Services and PGO Senior management. Assess situation/dangers, isolate battery, assist where necessary until help arrives. |
| Damage to a protected heritage or archaeological site | Inspections of known heritage & archaeological sites. Surveys and reports commissioned to an archaeologist as required (e.g. in the event exploration work was to take place in a previously unsurveyed area) | Notify PGO Management. PGO Management to notify Government external bodies (DME, DLPE) |

# Procedures

## *Incident Reporting*

The Q29 PA is a legacy care and maintenance site and the company does not maintain a presence onsite. Whilst inactivity will not mitigate an environmental incident the cause of any such incident is likely to be attributable to a natural event such as wildfire, or high rainfall event. PGO will work closely with a Darwin based environmental consultant and local pastoralist to monitor and assess the site on a regular basis or as natural events dictate. Measurable environmental events and other incidents will be required to be promptly reported within 24 hours of discovery and investigated to identify and evaluate the immediate and contributory causes to enable prompt and effective corrective actions to be implemented.

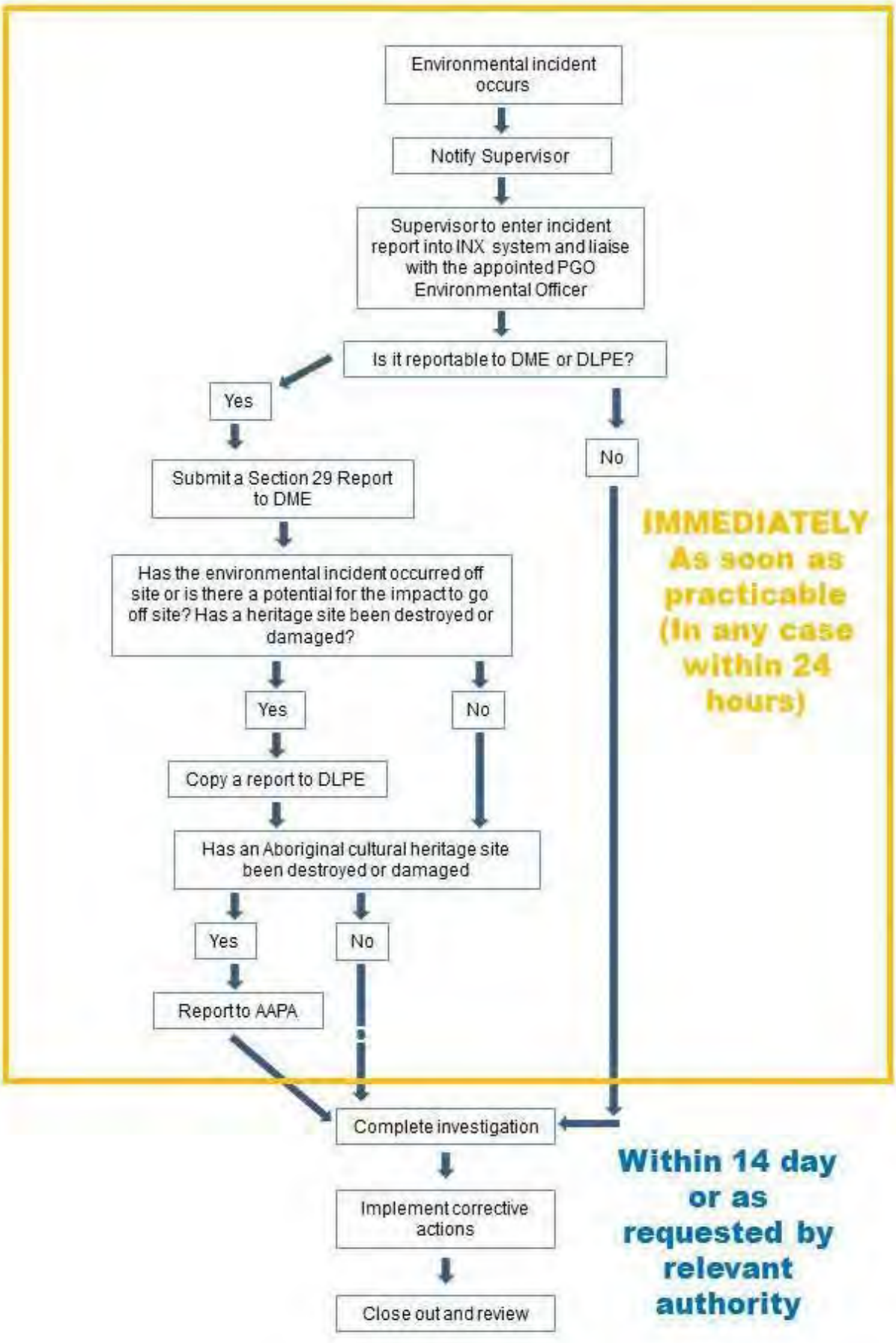
All events, incidents and injuries will be reported and assessed and appropriately recorded where required using the PGO Event, Incident Reporting Procedure, as set out in Figure 1.

This procedure requires:

- All hazards and incidents are to be reported to PGO Senior Management as soon as the hazard or incident is identified;
- All significant safety incidents will be recorded and reported to NT WorkSafe under the *Workplace Health and Safety Act*;
- All significant environmental incidents will be recorded and reported to:
    - Department of Mines and Energy (DME) as required under section 29 of the *Mining Management Act*;
    - Environment Protection Authority (EPA) under the *Waste Management and Pollution Control Act* (if the incident causes impact and is offsite).
- Incidents will be investigated to improve systems and prevent recurrence.

Reportable incidents include events with potential and / or actual environmental impact. Checks

by Senior Managers and routine inspections by the Environmental Officers will ensure prompt reporting of any problems. In the event of a major environmental or safety incident, the matter will be reported to the Managing Director who will coordinate any necessary response in consultation with the PGO Environment Officer. It is the responsibility of the PGO Managing Director to report the occurrence of a serious accident or critical incident to the Chief Executive Officer of the Department of Mines and Energy in accordance with Section 29 of the *Mining Management Act.* If an investigation is required the responsible management of the Department is responsible to ensure the investigation is completed and submitted to the relevant NT Government Department.




DME = Department of Mines and Energy
DLPE = Department of Lands, Planning and Environment AAPA = Aboriginal Areas Protection Authority

## Communications

### *Emergency Contact*

.

### *Internal*

PGO Emergency Contact Clay Gordon 0427 491 680 or 08 9364 9009

PGO Management to be notified:

- Managing Director

### *External*

Regulatory authority and emergency service contact details are presented in Table 2.

**Table 2 - Regulatory Authority and Emergency Services**

| Organisation | Name (if applicable) | Position(if applicable) | Telephone | Mobile |
|---|---|---|---|---|
| Dept of Mines and Energy (DME), NT Gov | | Director Mining Performance | 08 8999 6470 | AH 0401 110 356 |
| NTEPA, NT Gov (only notified if incident occurs outside mine site) | Chair of the NTEPA | Delegate for the Controller of Water Resources | Pollution Hot Line 1800 064 567 | |
| NT Worksafe, NT Gov | | | 1800 019 115 | |
| DLPE , NT Gov | | Heritage | 08 8999 5039 | |
| NT Bush Fire Council | | Darwin head office & Arnhem Region contact | 08 8922 0844 | |
| Fire & Emergency Response Group (FERGS)<br>Humpty Doo Brigade | | | 000<br><br>08 8988 4333 | |
| St Johns Ambulance | | | 000 | |
| NT Volunteer Bushfire Brigades | | | | |
| Spillage Clean Up | | | | |

## Emergency Equipment

The RRPA is a care and maintenance site with no equipment available onsite. All company vehicles visiting the site will be fitted with two way radios, personal mobile telephones, satellite telephone, first aid kits and vehicle mounted fire extinguishers. Additional emergency, firefighting and earth moving equipment is available at Mt Bundy Station.

## Training and Competence

As the RRPA is an inactive legacy care and maintenance site, training programs will focus on familiarisation of personnel and contractors with the company Emergency Response Plan. If the project status changes from care and maintenance the company will, as appropriate to the level of activity, review and institute a program of training and competence testing.

## Audit and Review

The current Environmental Emergency Response Plan is based on the project continuing on a care and maintenance basis. Any increase in site activity, be that on a campaign or permanent basis will require an audit and review of the EERP to reflect;

- Increased interaction and potential for an environmental emergency
- Increased access to appropriate resources and emergency equipment / personnel commensurate with the level of work being undertaken.

As part of the review process, all credible event scenarios and the associated response requirements must be identified, this includes:

- Maintain and develop the site Environment Emergency Response Plan;
- In line with the proposed work, conduct sufficient exercises to test the site's capability against the above Plans;
- Increase the frequency of environmental site audits in line with the nature of the work being undertaken and the associated increased potential for an incident occurring ;
- Develop a training plan as appropriate for the work being undertaken and report progress on this plan to PGO Senior Management.
- If appropriate to the work being undertaken develop an Emergency Response Team
- Ensure that all credible scenarios and the associated response requirements are identified during the review process.

## 10.9 Environmental Management Plans

# Rustlers Roost Project Area

# Environmental Management System and Plans

**Authorisation Number 0738-01**

**Version 1.0**
**June 2020**

# Distribution List

| Stakeholder | Organisation |
|---|---|
| Internal | Primary Gold RRPA Employees and Contractors |
| External | Department of Primary Industry and Resources (DPIR) |

# Document Control

| Version | Date | Author | Reviewer | Approved |
|---|---|---|---|---|
| 1.0 | 15/06/2020 | **Michelle Berryman**<br>Botanica Consulting – Senior Environmental Consultant | **Charles Hastie**<br>Hanking Australia – Chief Mining Engineer | **Mark Qiu**<br>Hanking Australia – Managing Director |

# Amendments

| Version | Key Changes |
|---|---|
| 1.0 | This document reflects the first collated version of the Primary Gold Environmental Management System and Plans for the RRPA. |

# Table of Contents



# List of Tables

# 1 Introduction

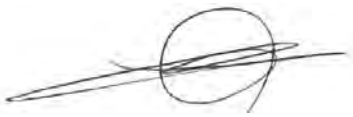
Welcome to the Primary Gold Rustlers Roost Project Area (RRPA). Primary Gold aims for a relationship with our Employees, Contractors and Stakeholders based on cooperation and a mutual desire to achieve the best possible results. The Primary Gold Environmental Management System (EMS) outlines the conditions and expected work practices at the RRPA to minimise physical harm or impact on the environment from our operation.

All Primary Gold Employees and Contractors are required to understand their roles and responsibilities with regards to Occupational Health, Safety, Environment and Social Responsibility. This includes following procedures, understanding legal requirements or the potential impact of their work, and identifying and controlling risks. Risks must be identified and controlled in accordance with documented processes.

Primary Gold considers that it is the duty of our Employees and Contractors to:

- Work safely, protecting people, environment, and community;
- Comply with all Laws, conditions of any Permits, Licences and Authorisations or any Primary Gold standards and procedures applicable to their activities;
- Identify any hazards or risks associated with their work and implement appropriate controls; and
- Report and rectify any observed unsafe acts, incidents, or hazards.

Primary Gold expects all Employees and Contractors to work safely, considerately, and remember that effective health, safety, environment, and community management programs will benefit us all.



**Dr Mark Qiu**

**Managing Director**

**15 June 2020**

# 2 Environmental Management System Overview

The Primary Gold Environmental Management System (EMS) includes an Environment Policy, Environmental Risk Assessment, Environmental Management Plans (EMPs) and Standard Operating Procedures (SOPs), which enable the systematic review and management of site environmental aspects.

The EMS outlines a process to manage and minimise environmental risks; comply with legislation and other requirements, and is designed to deliver:

- Site wide awareness and accountability of environmental issues;
- All Employees and Contractors effectively managing operations with a goal to reduce environmental impacts; and
- A continuous improvement framework and culture to be leaders in environmental performance.

The EMS covers all activities undertaken at the RRPA that have the potential to impact on environmental performance. Communication and participation across all site levels is vital to ensure the EMS is effective and success is dependent on active involvement by all Employees and Contractors.

## 2.1 Policy

All Employees and Contractors must comply with the Primary Gold Environmental Policy. Primary Gold believes that effective environmental management is paramount to a successful future. The company is committed to compliance with legal and other requirements, developing an effective EMS, continuous improvement, and minimising environmental impacts. The Primary Gold Environmental Policy outlines these commitments and is provided in Figure 2-1.

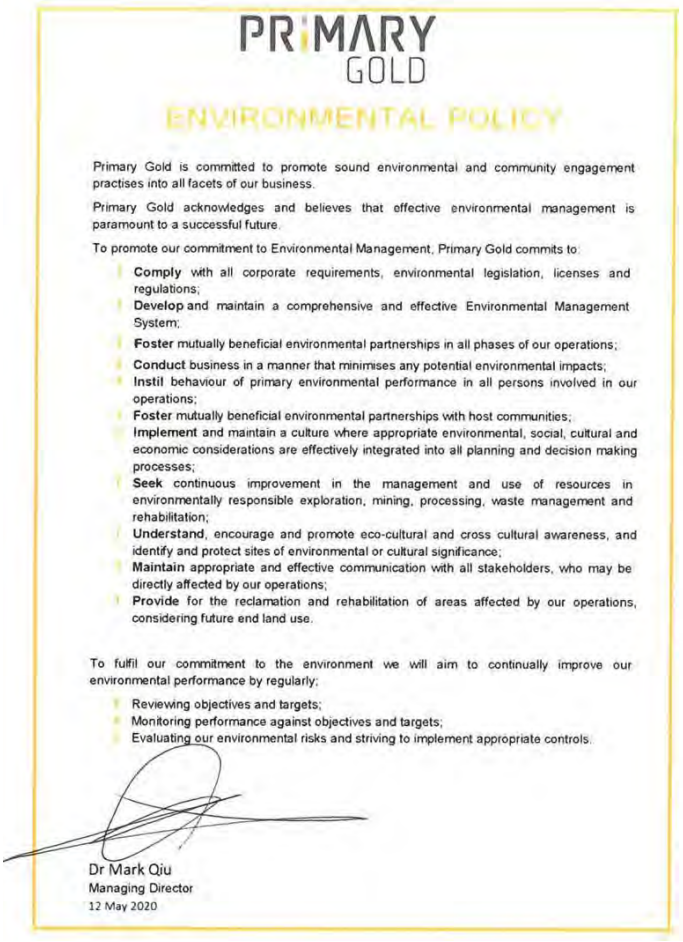
## 2.2 Environmental Aspects and Risks

Primary Gold has a risk assessment process to identify environmental aspects and risks to ensure that appropriate management strategies (treatments or controls) are implemented to reduce potential impacts to people, the environment or community. The risk assessment process identifies the hazards associated with site activities, the likelihood of it happening and the consequence of the potential impact.

Primary Gold will ensure that all environmental aspects that may pose significant impacts to the environment have appropriate controls implemented and are prioritised for improvement. The Environmental Risk Register is kept up to date and it will be reviewed as part of the Management Review (Section 2.5). Table 2-1 summarises the identified key care and maintenance aspects and associated risks for the RRPA.

**Table 2-1: Key Care and Maintenance Aspects and Associated Risk**

| Aspect | Associated Risk |
|---|---|
| **Erosion and Sediment** | Erosion of materials increasing sediment in natural drainage channels. |
| **Fire** | Uncontrolled fire. |
| **Flora and Fauna** | Fauna or Livestock illness, injury, or death due to inadequate barriers. |
| **Water** | Contamination of surface water from mine impacted areas. |
| **Weeds** | Introduction and/or spread of weed species. |



PRIMARY GOLD

ENVIRONMENTAL POLICY

Primary Gold is committed to promote sound environmental and community engagement practises into all facets of our business.

Primary Gold acknowledges and believes that effective environmental management is paramount to a successful future.

To promote our commitment to Environmental Management, Primary Gold commits to:

- **Comply** with all corporate requirements, environmental legislation, licenses and regulations;
- **Develop** and maintain a comprehensive and effective Environmental Management System;
- **Foster** mutually beneficial environmental partnerships in all phases of our operations;
- **Conduct** business in a manner that minimises any potential environmental impacts;
- **Instil** behaviour of primary environmental performance in all persons involved in our operations;
- **Foster** mutually beneficial environmental partnerships with host communities;
- **Implement** and maintain a culture where appropriate environmental, social, cultural and economic considerations are effectively integrated into all planning and decision making processes;
- **Seek** continuous improvement in the management and use of resources in environmentally responsible exploration, mining, processing, waste management and rehabilitation;
- **Understand**, encourage and promote eco-cultural and cross cultural awareness, and identify and protect sites of environmental or cultural significance;
- **Maintain** appropriate and effective communication with all stakeholders, who may be directly affected by our operations;
- **Provide** for the reclamation and rehabilitation of areas affected by our operations, considering future end land use.

To fulfil our commitment to the environment we will aim to continually improve our environmental performance by regularly;

- Reviewing objectives and targets;
- Monitoring performance against objectives and targets;
- Evaluating our environmental risks and striving to implement appropriate controls.

Dr Mark Qiu
Managing Director
12 May 2020

**Figure 2-1: Primary Gold Environmental Policy**

## 2.3 Environmental Management Plans

Primary Gold manages significant environmental aspects at the RRPA through a series of EMPs which are a compilation of the work required to:

- Meet the requirements of the Primary Gold Environment Policy;
- Comply with all applicable regulatory requirements;
- Achieve objectives and targets; and
- Manage and reduce the impact of higher risk environmental aspects.

The EMPs set key objectives and targets and management and mitigation measures which are aimed to prevent or minimise higher risk impacts identified during the site risk assessments. Primary Gold regularly reviews and assesses performance against these EMPs and aims for continuous improvement. Performance against the objectives and targets is reported annually in the RRPA Mining Management Plan (MMP) submitted to the Northern Territory (NT) Department of Primary Industry and Resources (DPIR).

Primary Gold uses the SMART (Specific, Measurable, Achievable, Relevant and Timely) method when developing EMP management strategies. This method requires that strategies are:

**Specific** - and unambiguous, with set targets;

- *Strategies (What)*: Plan of action(s) to achieve targets.
- *Actions (How)*: Specific tasks to accomplish the strategy.
- *Explanation (Why)*: Justification for the actions.

**Measurable** - so performance can be measured against targets;

- *Responsibility (Who)*: Person(s) responsible to undertake the task.
- *Deliverable (Outcome)*: End product of action.

**Achievable** - ensuring adequate resources and capability to meet targets;

- *Target: (When)*: Primary Gold commitment to meet and achieve the set action.

**Relevant** – review of the effectiveness of the management and mitigation strategies;

- *Key Performance Indicator (KPI)*: Analysis and interpretation of results and determination as to whether targets are being met.
- *Non-Conformance and Corrective Action*: Procedures for implementing corrective actions should an undesirable impact result.

**Timely** - targets met within a certain time frame.

- *Time frame (When)*: Time frame for completion or frequency.

## 2.4 Standard Operating Procedures

A series of SOPs have been developed by Primary Gold to guide Employees and Contractors when carrying out some activities outlined in the EMPs. The SOPs include step by step instructions and aim to achieve efficiency, quality output and uniform performance. The SOPs are not included in this document but are referenced and available from Primary Gold as required.

## 2.5 Incident Reporting

All Employees and Contractors must promptly report any emergency, incident, hazard, complaint, or non-compliance to Primary Gold as soon as reasonably practicable, or within 24 hours of any incident or occurrence. Reported events are investigated to identify and evaluate the immediate and contributory causes to enable prompt and effective corrective actions to be implemented.

## 2.6 Management System Review

Primary Gold regularly reviews its performance against the EMPs to determine the effectiveness of control strategies and whether the objectives and targets are being met within the RRPA MMP submitted to the DPIR. Any non-conformances are discussed and analysed with appropriate corrective and preventative actions identified.

The Primary Gold EMS is reviewed annually to ensure that the system is functional and to identify any areas requiring improvement. During the EMS review the following information is considered:

- Results of audits and the status of legal compliance;
- Communication from external parties;
- Environmental performance;
- Relevance of objectives and targets;
- Incident or complaint trends and resulting corrective and preventative actions; and
- Any changes in activity or risk.

# 3 Environmental Management Plans

It is the responsibility of Primary Gold Employees and Contractors to ensure that they are familiar and compliant with the EMPs and SOPs applicable to their activities. Primary Gold Employees and Contractors must always comply with applicable Laws and Conditions of Site Permits, Licences and Authorisations issued by various Governmental Agencies.

The EMPs applicable to the RRPA include:

- Fire;
- Flora and Fauna;
- Landform, Erosion and Sediment Control;
- Water; and
- Weed and Pest.

## 3.1 Fire Management Plan

### 3.1.1 Purpose and Objectives

The purpose of the Fire Management Plan is to ensure the safety of people, natural, archaeological, and built assets at the RRPA and surrounding properties. Through implementation of this EMP, Primary Gold aims to meet the following objectives and targets:

- Effectively manage fuel loads in the RRPA and mitigate potential impacts from uncontrolled wildfires.
    - Fire breaks are installed and maintained.
    - Controlled burning completed in accordance with a Permit to Burn.
    - No incidents of vehicle ignited fires.

### 3.1.2 Legal and Other Requirements

Legal requirements applicable to the Fire Management Plan include:

- *Bushfires Management Act* – Requires the prevention and control of bushfires including fire breaks, fire management plans and permits for lighting fires (Permit to Burn).
- *Fire and Emergency Act* - The owner is required to maintain the building's essential services, which include required fire detection and alarm systems.
- *Mining Management Act* - MMPs require technical studies, data and management plans based on the risk assessment of proposed activities.
- *Territory Parks and Wildlife Conservation Act* - Regulates or prohibits the use of fire in parks and reserves.

Primary Gold SOPs applicable to the Fire Management Plan include:

- Weed Spraying;
- Weed Control;
- Incident and Notification Reporting; and
- Controlled Burning.

### 3.1.3 General Management and Mitigation Strategies

The following general fire mitigation and management measures will be implemented as applicable:

- Grading of fire breaks and associated tracks prior to the commencement of the dry season;
- Fire detection and suppression systems, and firefighting equipment will be routinely inspected, maintained, and tested. Dedicated firefighting equipment and trained personnel for fire management;
- Identify areas with high fuel loads requiring controlled burns. Implement patchy burns of low scorch height wherever practicable. Liaise with local Pastoralists and Bushfires NT prior to burning including required Permits to Burn prior to conducting controlled burns;
- Hot work to be permitted and restricted to designated hot work areas. Smoking only in designated areas;
- Vehicles will be regularly serviced and will carry fire extinguishers and VHF/UHF radios. No vehicles will be left running unattended;
- Inspections of waste management areas to identify potential accumulation of combustible materials and associated risks;
- Monitor the fire Danger Rating and no fires lit during designated fire bans;
- Open flame or other ignition sources are prohibited within 20m of bulk flammable storage areas, fuel dispensing vehicles or refuelling operations and activities in hazardous atmospheres;
- Employees and Contractors are educated in fire management, their responsibilities and environmental emergency preparedness and response during inductions;
- Active working areas, fire breaks and fuel storage locations will be regularly inspected to determine if there are any developing fire risks;
- Vegetation growth around assets controlled during the wet season through the application of herbicides and then removal. Weed spraying to reduce fuel loads surrounding infrastructure (pipelines, buildings, bores etc) and hazardous storage areas; and
- Monitor and record the occurrences of controlled and wildfires. Implement firefighting strategies as required in accordance with the Emergency Response Plan.

### 3.1.4 Monitoring and Measurement

The specific strategies and actions designed to achieve the Fire Management Plan objectives and targets are outlined in Table 3-1.

## Table 3-1: RRPA Fire Management Strategies

| Specific | | | Measurable | | Achievable | Timely | Relevant | |
|---|---|---|---|---|---|---|---|---|
| **Strategies (What)** | **Actions (How)** | **Explanation (Why)** | **Responsibility (Who)** | **Deliverable (Outcome)** | **Targets (When)** | **Time frame (When)** | **Key Performance Indicators** | **Non-Conformance and Corrective Action** |
| Monitor and record the occurrences of fires. | Create a fire incident register and log uncontrolled fires and controlled burning events. | To obtain information regarding fire occurrences. | Environmental Manager (or delegated person) | Fire incident register. | Documented fire incidences across the RRPA. | Annual | Fire occurrences register and log of entries. | Northern Australian Fire Information (NAFI) data will be utilised to retrospectively create a log of fire occurrences. |
| Ensure compliance with NT Bushfires Permitting requirements. | Liaise with Bushfires NT. | To reduce risk to surrounding properties from local controlled burning of the project area. | Environmental Manager (or delegated person) | Approved Permit to Burn. | Obtain applicable permits to undertake controlled burning (Bushfires NT – Permit to Burn). | Annual | Ability to install internal fire breaks and undertake controlled burning. | If compliance with Bushfires NT requirements are not met, then incident reporting will be undertaken in accordance with Incident and Notification Reporting SOP. |
| Conduct controlled burning, install fire breaks, and manage weeds. | Undertake control burning within the project area. | To mitigate potential wildfire impacts to personnel, infrastructure and adjacent properties and manage weed spread. | Environmental Manager (or delegated person) | Completed controlled burning of high-risk areas. | Controlled burning completed. | Annual | Documentation confirming the task was completed. | Review resources and operating requirements to determine why action was not completed. Develop and implement an action plan to ensure the action is achieved. |
| Maintain installed fire breaks. | Slash or grade fire breaks when access is permits following wet season. | To contain controlled burning of the site. | Environmental Manager (or delegated person) | Fire breaks are slashed or graded. | Fire breaks installed. | Annual | No controlled burning will be undertaken unless adequate fire breaks are in place. | |
| Manage access within the project area. | Restrict vehicle access to existing roads and tracks. | To reduce risk of vehicular initiated grass fires. | Environmental Manager (or delegated person) | No incidents of vehicle ignited fires. | No incidents of vehicle ignited fires and no new access tracks. | As Required | Site inspection records.<br><br>No observed new tracks created in the project area from the previous inspection. | Review of site security infrastructure.<br><br>Liaise with surrounding land managers on trespassing and unauthorised access issues. |

## 3.2 Flora and Fauna Management Plan

### 3.2.1 Purpose and Objectives

The purpose of the Flora and Fauna Management Plan is to ensure that appropriate controls are developed and implemented to effectively protect flora and fauna at the RRPA. Through implementation of this EMP, Primary Gold aims to meet the following objectives and targets:

- Protect and appropriately manage threatened species that occur within the RRPA and prevent the disturbance of flora and fauna outside of the RRPA.
    - Logging and review of site fauna sightings.
    - No incidents of adverse impact to flora and fauna of significance.

### 3.2.2 Legal and Other Requirements

Legal requirements applicable to the Flora and Fauna Management Plan include:

- *Environment Protection and Biodiversity Conservation Act 1999* – Any activity that will have or is likely to have a significant impact on a matter of national environmental significance requires Commonwealth Government approval. This includes nationally threatened animal and plant species and ecological communities.
- *Bushfires Management Act* – Requires the prevention and control of bushfires including fire breaks, fire management plans and permits for lighting fires (Permit to Burn).
- *Mining Management Act* – MMPs require technical studies, data and management plans based on the risk assessment of proposed activities.
- *Territory Parks and Wildlife Conservation Act* – Lists plants and animals that are protected in the NT and requires management plans for impacts on protected species. Permits may be required to undertake studies for approvals or to remove or relocated problem animals during development or operations (Permit to Take or Interfere with Wildlife and / or Permit to Undertake Scientific Research).
- *Weed Management Act* – Duties of landowners to manage and prevent the spread of weeds into and out of the NT in accordance with a Weed Management Plan.

Guidelines applicable to the Flora and Fauna Management Plan include:

- *DENR Advisory Note: Native Vegetation Buffers and Corridors* – Buffers and corridors support natural processes that occur in a healthy environment, including the movement of species.

Primary Gold SOPs applicable to the Flora and Fauna Management Plan include:

- Fauna Monitoring;
- Weed Spraying;
- Snake Capture and Relocation;
- Ground Disturbance;
- Weed Control;
- Incident and Notification Reporting;
- Pest and Vector Management;
- Fauna Injury and Death Management; and
- Feral Animal Management.

### 3.2.3 General Management and Mitigation Strategies

The following general flora and fauna mitigation and management measures will be implemented as applicable:

- Implement the Primary Gold Ground Disturbance SOP, which includes threatened flora and fauna checks, prior to undertaking any ground disturbance activities and issue of a Primary Gold Permit to Clear;
- Minimise areas of disturbance and vegetation clearing. Staged clearing of vegetation as required to minimise areas of bare ground, particularly on any steep slopes. Avoid land clearing where possible during the Wet Season (Dec-May). Revegetate disturbed areas as soon as possible after disturbance;
- Reduce the potential impact of soil and vegetation disturbance in accordance with the *DENR Fact Sheet for Native Vegetation Buffers and Corridors*;
- Weed control to be implemented as detailed in the Weed and Pest Management Plan;
- Driving speed restrictions are in place and off-road driving is restricted or prohibited to avoid accidental disturbance to flora and fauna;
- Appropriate approvals will be obtained prior to the disturbance of any protected flora and fauna site because of the RRPA operations;
- Conduct flora and fauna surveys prior to activities within previously undisturbed areas and implement any identified site-specific mitigation and management measures (i.e. fencing of threatened flora);
- Ensure the induction includes a flora and fauna awareness module;
- Fauna sightings to be recorded in the fauna register to assess presence of threatened fauna and assessment of mitigation and management measure effectiveness;
- Identify key flora species and collect seeds (where possible and appropriate) for revegetation programs;
- Ensure appropriate fauna egress is available for any ponds or dams;
- Assess water quality in the pit void and ponds for suitability for fauna during care and maintenance and after mine closure. Fence off or bund access points to water bodies to minimise livestock and fauna access if unsuitable; and
- Manage general site wastes to prevent/reduce interaction with fauna and introduction of vermin.

### 3.2.4 Monitoring and Measurement

The specific strategies and actions designed to achieve the Flora and Fauna Management Plan objectives and targets are outlined in Table 3-2.

## Table 3-2: RRPA Flora and Fauna Management Strategies

| Specific | | | Measurable | | Achievable | Timely | Relevant | |
|---|---|---|---|---|---|---|---|---|
| **Strategies (What)** | **Actions (How)** | **Explanation (Why)** | **Responsibility (Who)** | **Deliverable (Outcome)** | **Targets (When)** | **Time frame (When)** | **Key Performance Indicators** | **Non-Conformance and Corrective Action** |
| Gather information on the flora and fauna that inhabit the project area. | Register and review fauna sightings. | To effectively manage of fauna species at the project site. | Environmental Manager (or delegated person) | Fauna sightings recorded and review of register. | Undertake a review of the register and ensure fauna sightings are recorded. | Annual | Fauna sightings recorded and review of register. | Conduct a retrospective review of fauna register to identify any trends or changes in fauna populations. |
| | Engage a specialist consultant to undertake flora and fauna surveys in any new areas prior to any disturbance. | To identify and prevent potential impacts to threatened flora and fauna. | Environmental Manager (or delegated person) | Flora and Fauna Survey Report. | Complete flora and fauna surveys prior to activities within previously undisturbed areas. | As Required | Completed flora and fauna survey prior to new disturbance.<br><br>Implement any recommended actions. | If a threatened flora or fauna is impacted, an incident will be logged and the appropriate authority will be notified. Investigation will be undertaken with and corrective actions identified. |
| Manage disturbance to flora and fauna. | Obtain Permit to Clear approval prior to any ground disturbance activities and rehabilitate areas once available. | To minimise impact to native flora and fauna. | Environmental Manager (or delegated person) | Approved Permit to Clear. | No adverse impact to threatened flora and fauna identified. | As Required | Permit to Clear obtained.<br><br>No incidents of impacts to threatened flora or fauna. | If threatened flora and fauna are impacted an assessment will be undertaken to determine the level of impact and Identified remediation activities undertaken. |
| Minimise adverse impacts on flora and fauna. | Implement any identified measures to protect and appropriately manage any threatened species. | To ensure adequate protection of threatened species. | Environmental Manager (or delegated person) | To be determined based upon any sightings of threatened species. | Develop appropriate strategies to protect species if identified to be at risk of impact from RRPA operations. | Annual | Review of fauna register and flora and fauna surveys and implement protection methods if identified to be a risk of impact from operations. | Review of protection measures or implementation methods.<br><br>Develop alternative solutions. |
| Promote awareness of the protection of flora and fauna. | Conduct flora and fauna awareness as part of the induction. | To promote employee protection of fauna and flora. | Environmental Manager (or delegated person) | Induction completed by Employees and Contractors. | Induction includes flora and fauna management. | Prior to Site Access | Induction completed by Employees and Contractors. | Review resources and operating requirements to determine why action was not completed. |

## 3.3 Landform, Erosion and Sediment Control Management Plan

### 3.3.1 Purpose and Objectives

The purpose of the Landform, Erosion and Sediment Control Management Plan is to ensure the ongoing management of erosion risks and to minimise the potential for environmental impacts from erosion and sedimentation from RRPA activities. Through implementation of this EMP, Primary Gold aims to meet the following objectives and targets:

- Minimise areas of disturbance and implement appropriate erosion control measures in mine impacted areas.
    - Any planned disturbance is undertaken in accordance with a Permit to Clear.
    - All roads and tracks are inspected, and a maintenance and repair action plan is developed and implemented.
    - All constructed landforms maintain structural integrity and functionality.
    - All areas with erosion and sediment control issues identified, documented and a maintenance and repair action plan is developed and implemented.

### 3.3.2 Legal and Other Requirements

Legal requirements applicable to the Landform, Erosion and Sediment Control Management Plan include:

- *Mining Management Act* - MMPs require technical studies, data and management plans based on the risk assessment of proposed activities.
- *Soil Conservation and Land Utilisation Act* - Areas of land that are subject to soil erosion or that are likely to become subject to soil erosion may be declared Areas of Erosion Hazard.

Guidelines applicable to the Landform, Erosion and Sediment Control Management Plan include:

- *DPIR Advisory Note: Construction and Rehabilitation of Exploration Drill Sites* - A guide to constructing and rehabilitating drill pads, benches, and drill holes.
- *DPIR Advisory Note: Clearing and Rehabilitation of Grid Lines and Tracks* - A guide to clearing and rehabilitating grid lines and tracks during exploration.
- *DENR Advisory Note: Native Vegetation Buffers and Corridors* – Buffers and corridors support natural processes that occur in a healthy environment, including the movement of species.
- *DENR Technical Notes for Soil Management, Erosion and Sediment Control* - https://nt.gov.au/environment/soil-land-vegetation/soil-management-erosion-sediment-control
- *International Erosion Control Association (IECA): Best Practice Erosion and Sediment Control* - BPESC is an essential reference for all erosion and sediment control practitioners.

Primary Gold SOPs applicable to the Landform, Erosion and Sediment Control Management Plan include:

- Construction and Rehabilitation of Drill Pads and Benches;
- Ground Disturbances; and
- Incident and Notification Reporting.

### 3.3.3 General Management and Mitigation Strategies

The following general landform, erosion and sediment control mitigation and management measures will be implemented as applicable:

- Manage earthworks to minimise disturbance to drainage channels and reduce potential erosion. Various strategies will be used on site, depending on the exact location, the proximity to watercourses or other sensitive receiving environments and the slope of the land;
- Implement the Primary Gold Ground Disturbance SOP, which includes a check of the nearest watercourse and any potential sedimentation and erosion issues, prior to undertaking any ground disturbance activities and issue of a Primary Gold Permit to Clear;
- Minimise areas of disturbance and vegetation clearing, utilise existing cleared areas where possible. Staged clearing of vegetation as required to minimise areas of bare ground, particularly on any steep slopes;
- Avoid land clearing where possible during the Wet Season (Dec-May). Revegetate areas as soon as possible after disturbance;
- All temporary exploration tracks and associated disturbed areas will be scarified, ameliorated, and seeded when no longer required for use. Stockpiled topsoil will be re-spread before sowing. On steeper slopes the seeded areas will be protected where necessary;
- Reduce the potential impact of soil and vegetation disturbance in accordance with the *DENR Fact Sheet for Native Vegetation Buffers and Corridors*;
- Understand soil profiles and structures to enable vegetation establishment and resistance to erosion. Stockpiling of topsoil for replacement prior to rehabilitation;
- Topsoil and subsoil will be stripped and stockpiled in accordance with the following:
    - Separate stripping and stockpiles to prevent mixing and contamination;
    - Stockpiles retained for more than 1 month will be stabilised with a soil polymer or revegetated to minimise erosion and weed infestation;
    - Stockpiles will be no more than 2.5m high (allowing settlement to 2m) with 3(h):1(v) batter slopes; and
    - Stockpiles will be protected from run-on water by installing water diversion structures upslope.
- Appropriate drainage control measures installed to prevent or reduce soil erosion caused by concentrated flows including the management of rill and gully erosion, and to appropriately manage the movement of “clean” and “dirty” water through the site;
- Where applicable, any slope lengths shall be reduced via the use of catch or diversion drains at regular intervals down the slope and drains must be appropriately stabilised as soon as they are constructed to ensure erosion and sediment transportation does not occur;
- Access tracks/roads will be maintained to minimise storm wash out;
- Drainage, erosion, and sediment controls for temporary watercourse crossings to minimise the potential for sediment inflow into the watercourses include:
    - Directing sediment laden water to off-line sediment traps. In-stream sediment traps shall be utilised only for dry watercourse crossings; and
    - In high erosion areas, it may be necessary to protect the banks of watercourses from short-term erosion with the aid of an erosion control blanket, mat, or soil binder. The use of synthetic mesh is not suggested along waterways containing ground-dwelling wildlife.

- Other erosion controls may include (as appropriate):
    - Matting, slope design, and contour ripping;
    - Silt fencing around potentially affected area;
    - Sediment retention basin or dams;
    - Rock armoured drains;
    - Rock filters/rock check dams;
    - Water diversion drains around disturbed areas; and
    - Bunds or berms where applicable.

### 3.3.4 Monitoring and Measurement

The specific strategies and actions designed to achieve the Landform, Erosion and Sediment Control Management Plan objectives and targets are outlined in Table 3-3.

## Table 3-3: RRPA Landform, Erosion and Sediment Control Management Strategies

| Specific | | | Measurable | | Achievable | Timely | Relevant | |
|---|---|---|---|---|---|---|---|---|
| **Strategies (What)** | **Actions (How)** | **Explanation (Why)** | **Responsibility (Who)** | **Deliverable (Outcome)** | **Targets (When)** | **Time frame (When)** | **Key Performance Indicators** | **Non-Conformance and Corrective Action** |
| Minimise areas of disturbance and implement appropriate erosion control measures. | Obtain Permit to Clear approval prior to any ground disturbance activities and rehabilitate areas once available. | To minimise disturbance to the environment, including buffer zones and protected areas. | Environmental Manager (or delegated person) | Approved Permit to Clear.<br><br>Documented before and after rehabilitation photographs. | Area of disturbance minimised, and no protected areas or buffer zones are disturbed.<br><br>Disturbance progressively rehabilitated. | As Required | Permit to Clear obtained.<br><br>Documented before and after rehabilitation photographs. | If erosion and sedimentation observed an assessment will be undertaken to determine the level of impact and remediation undertaken, as required. |
| | Install identified erosion controls as part of ground disturbance activities. | To prevent potential erosion and sedimentation from clearing. | Environmental Manager (or delegated person) | Approved Clearing/Ground Disturbance Permits.<br><br>The requirement for erosion controls assessed during inspections. | Develop appropriate plans to implement erosion controls in high risk areas.<br><br>Controls implemented as identified. | As Required | Controls implemented as identified.<br><br>No evidence of significant erosion or sedimentation. | |
| Manage access within the project area. | Restrict vehicle access to existing roads and tracks. | To minimise erosion from vehicle activities. | Environmental Manager (or delegated person) | No evidence of erosion from unauthorised off-road vehicle access. | No unauthorised access tracks. | As Required | Site inspection records.<br><br>No observed new tracks created in the project area from the previous inspection. | Review of site security infrastructure.<br><br>Liaise with surrounding land managers on trespassing and unauthorised access issues. |
| Monitor and manage erosion in mine impacted areas. | Conduct inspections of mining landforms, cleared and rehabilitated areas and prioritise actions based on risk. | To identify any erosion and sedimentation risks that may require additional control measures. | Environmental Manager (or delegated person) | Identification of mining areas requiring remediation or additional controls.<br><br>Documented inspections and photographs (as required). | Develop appropriate plans to implement erosion controls in high risk areas. | Quarterly | Documented notes from inspections and follow up assessments and actions required. | Item to remain on action list until appropriate action items are identified and implemented. |
| | Maintain tracks and roads to prevent washout during storm events. | To ensure roads and tracks at risk of erosion are repaired or controls installed to allow access prior to wet season. | Environmental Manager (or delegated person) | An assessment of roads and tracks in disrepair and requiring action for remediation. | All roads and tracks to be inspected and assessed and maintenance and repairs scheduled. | Quarterly | Priority tracks and roads are accessible during wet season. | Develop and implement an action plan to ensure the action is achieved. |

## 3.4 Water Management Plan

### 3.4.1 Purpose and Objectives

The purpose of the Water Management Plan is to protect the beneficial use of water ecosystems from the release of low quality mine impacted water from the RRPA. Through implementation of this EMP, Primary Gold aims to meet the following objectives and targets:

- Water quality generally reflects the background levels and water use by stakeholders is not compromised.
    - Passively discharged surface water meets the applicable 95% species protection Guideline Values (GVs), Site Specific Trigger Values (SSTV) and Livestock Water Guidelines (SWGs) (outside of seasonal or natural fluctuations).
    - Groundwater and the pit lake meet the applicable 80% ecosystem protection GVs, SSTV and SWGs (outside of seasonal or natural fluctuations).

### 3.4.2 Legal and Other Requirements

Legal requirements applicable to the Water Management Plan include:

- *Mining Management Act* – MMPs require technical studies, data and management plans based on the risk assessment of proposed activities.
- *Waste Management and Pollution Control Act* – Provides a general framework for protecting the environment from pollution and waste, including offence provisions and enforcement tools; and licensing and approvals for specified activities. In general terms, for mining activities the Act does not apply to any contaminants and wastes that are confined on mining tenure.
- *Water Act* – Any person conducting an activity that includes a discharge to water must apply for a Waste Discharge Licence (WDL) noting that it is an offence under the Act to allow waste to come into contact with water or to pollute water without authorisation. A WDL is an authorisation that allows waste to be discharged or come into contact with water.

Guidelines applicable to the Water Management Plan include:

- *Australian and New Zealand Environmental and Conservation Council (ANZECC) Water Quality Guidelines 2000* – Provide authoritative guidance on fresh and marine water quality management issues.
- *NT EPA Environmental Assessment Guidelines: Acid and Metalliferous Drainage (AMD)* – Defines the information requirements of an Environmental Impact Statement (EIS) relating to assessment of potential AMD from mining and mineral processing materials.

Primary Gold SOPs applicable to the Water Management Plan include:

- Water Monitoring; and
- Incident and Notification Reporting.

### 3.4.3 General Management and Mitigation Strategies

The following general water mitigation and management measures will be implemented as applicable:

- Placement of waste rock or ore within landforms so that long-term generation of potential AMD is controlled to a level that does not adversely impact on downstream water quality;
- Segregation and selective placement of potential AMD waste rock types to minimise the exposure of Potentially Acid Forming (PAF) rock to atmospheric oxygen and leaching including the backfill of PAF material into mine voids (where practicable);
- Appropriate drainage control measures installed to manage the segregation and movement of “clean” and “dirty” water through the site;

- Appropriately qualified and experienced professionals will be used to develop the final landform designs of major landforms which will be incorporated into the Mine Closure Plan;
- Implement a surface and groundwater monitoring program;
- Conduct regular inspections of site water bodies including water levels to ensure adequate freeboard (storage capacity) to contain high rainfall events and prevent overtopping;
- Investigate options for the active treatment and discharge of water to reduce the site water inventory (if required) and ensure that any active discharge is undertaken in accordance with an approved WDL;
- Routine checks of the Bureau of Meteorology (BoM) forecast of predicted rainfall, tropical cyclone tracking and weather warnings;
- Implement the Landform, Sediment and Erosion Control EMP;
- Ensure that the integrity of any installed pond liners is maintained;
- Operate and maintain any pipelines or pumping infrastructure;
- Maintain berms, bunding, sumps, and ponds designed to contain mine impacted water or water runoff; and
- Assess water quality in the pit void and ponds for suitability for fauna during care and maintenance and after mine closure. Fence off or bund access points to water bodies to minimise livestock and fauna access if unsuitable.

### 3.4.4 Monitoring and Measurement

The specific strategies and actions designed to achieve the Water Management Plan objectives and targets are outlined in Table 3-4.

## Table 3-4: RRPA Water Management Strategies

| Specific | | | Measurable | | Achievable | Timely | Relevant | |
|---|---|---|---|---|---|---|---|---|
| **Strategies (What)** | **Actions (How)** | **Explanation (Why)** | **Responsibility (Who)** | **Deliverable (Outcome)** | **Targets (When)** | **Time frame (When)** | **Key Performance Indicators** | **Non-Conformance and Corrective Action** |
| Assess the AMD potential of mined material. | Geochemical characterisation of mined material. | To determine the risk of AMD generation from stockpiled mined material. | Environmental Manager (or delegated person) | Laboratory analytical results. | Geochemical characterisation during exploration drilling. | As Required | Laboratory analytical results received for drill holes identified for test work. | Review resources and operating requirements to determine why action was not completed.<br><br>Develop and implement an action plan to ensure the action is achieved.<br><br>Inspections or report outcomes documented and discussed at team meetings.<br><br>A risk assessment will be conducted where required to determine the level of significance and action required.<br><br>Assess the need for the action to be included in the budget. |
| Effectively manage AMD discharge or erosion from constructed landforms. | Conduct inspections and record any erosion and potential discharge areas from constructed landforms. | To identify and understand any potential AMD sources influencing surface or groundwater quality. | Environmental Manager (or delegated person) | Recorded locations of potentially problematic areas on the ore or waste stockpiles. | Documented inspection records of any erosion and potential seepage areas from ore or waste stockpiles. | Annual | Follow up risk assessments and priorities for any required actions. | |
| | Develop final closure / rehabilitation designs. | Ensure appropriate final landform designs are developed to minimise any potential long-term surface and groundwater quality impacts. | Environmental Manager (or delegated person) | RRPA Mine Closure Plan | Final landform designs developed and constructed. | As Required | Final landform designs developed and incorporated into Mine Closure Plan. | |
| Gather information on the water quality in the project area. | Surface and groundwater quality monitoring around the project area. | To determine the risk of discharges from the disturbed mining area impacting on surface and groundwater quality. | Environmental Manager (or delegated person) | Field and laboratory analytical results. | Water quality monitoring data and interpretation. | In accordance with MMP | Water monitoring completed as per the approved MMP. | |
| Minimise adverse impacts on the beneficial use of water. | Implement any identified measures to protect and appropriately manage surface and groundwater quality. | To ensure adequate protection of the beneficial use of water ecosystems. | Environmental Manager (or delegated person) | To be determined based upon the analysis of water monitoring data and interpretation. | Develop appropriate strategies to protect water resources if identified to be at risk of impact from the RRPA operations. | Annual. | Review of water monitoring data and implement control measures where a high risk is identified. | |

## 3.5 Weed and Pest Management Plan

### 3.5.1 Purpose and Objectives

The purpose of the Weed and Pest Management Plan is to is to limit and reduce the spread of weed and pest populations; to minimise adverse impacts to native flora and fauna; and to manage weed growth to reduce the risk of wildfires. Through implementation of this EMP, Primary Gold aims to meet the following objectives and targets:

- Minimise adverse impacts to native flora and fauna and to manage weed growth to reduce the risk of uncontrolled wildfire impacts.
    - No increase in weed spatial distribution and no new weed species identified.
    - No increase in pest populations or species and no observed detrimental effects.

### 3.5.2 Legal and Other Requirements

Legal requirements applicable to the Weed and Pest Management Plan include:

- *Environment Protection and Biodiversity Conservation Act 1999* - Protects natural, Indigenous, and historic places that are of outstanding heritage value to the nation or are owned or controlled by the Australian Government.
- *Biological Control Act* - Protects the agricultural industry from pests and diseases.
- *Bushfires Management Act* – Requires the prevention and control of bushfires including fire breaks, fire management plans and permits for lighting fires (Permit to Burn).
- *Heritage Act* - Provides protection to nominated areas, places, sites, buildings, and heritage objects on the NT Heritage Register from accidental and deliberate damage or harm.
- *Mining Management Act* - MMPs require technical studies, data and management plans based on the risk assessment of proposed activities.
- *Soil Conservation and Land Utilisation Act* - Areas of land that are subject to soil erosion or that are likely to become subject to soil erosion may be declared Areas of Erosion Hazard.
- *Territory Parks and Wildlife Conservation Act* - Lists plants and animals that are protected in the NT and requires management plans for impacts on protected species.
- *Weed Management Act* - Duties of landowners to manage and prevent the spread of weeds into and out of the NT in accordance with a Weed Management Plan.

Guidelines applicable to the Weed and Pest Management Plan include:

- *DENR Northern Territory Weed Management Handbook* - Provides information on strategic and planned approaches to weed management, including integrated weed control methods.
- *DENR Weed Data Collection Field Guide* - Provides step-by-step instructions on how to collect weed data in the field and then process it for use in weed management.

Primary Gold SOPs applicable to the Weed and Pest Management Plan include:

- Weed Spraying;
- Weed Control;
- Incident and Notification Reporting;
- Pest and Vector Management; and
- Feral Animal Management.

### 3.5.3 General Management and Mitigation Strategies

The following general weed and pest mitigation and management measures will be implemented as applicable:

- Monitor and map sites with declared weeds and weeds of concern;
- Liaison with Key Stakeholders regarding weed or pest control;
- Weed controls implemented including spraying and controlled burns;
- All vehicles and mobile machinery restricted to designated access tracks;
- Mobile equipment entering site will be inspected to ensure it is clean of high-risk indicators such as caked dirt and residual vegetative materials;
- Plant and/or equipment and vehicles are to be washed prior to vacating areas known to contain Weeds of National Significance (WoNS) or Class A, B or C weeds;
- Imported fill to be certified weed-free prior to being utilised on site;
- Implement the Primary Gold Ground Disturbance SOP, which includes a weeds check, prior to undertaking any ground disturbance activities and issue of a Primary Gold Permit to Clear;
- Weeds are removed as required prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site;
- Vegetation and soil stockpiled from clearing activities will be monitored and chemical control undertaken should weeds be identified; and
- Employees and Contractors are educated in weed and pest management during inductions.

### 3.5.4 Monitoring and Measurement

The specific strategies and actions designed to achieve the Weed and Pest Management Plan objectives and targets are outlined in Table 3-5.

## Table 3-5: RRPA Weed and Pest Management Strategies

| Specific | | | Measurable | | Achievable | Timely | Relevant | |
|---|---|---|---|---|---|---|---|---|
| **Strategies (What)** | **Actions (How)** | **Explanation (Why)** | **Responsibility (Who)** | **Deliverable (Outcome)** | **Targets (When)** | **Time frame (When)** | **Key Performance Indicators** | **Non-Conformance and Corrective Action** |
| Monitor occurrences of weed species. | Map weed infestations by density and spatial surveys. | To establish weed locations to target control strategies. | Environmental Manager (or delegated person) | Weed Map and details logged in database. | Up to date weed mapping available for project area. | Annual | Documented weed maps and database entries. No new weed species or infestations identified. | Review resources and operating requirements to determine why action was not completed. Develop and implement an action plan to ensure the action is achieved. |
| Prevent accidental introduction of weeds. | Prohibit off-road driving. | To prevent seed transfer by vehicles. | Environmental Manager (or delegated person) | Site awareness through inductions and meetings. | Site awareness through inductions and meetings. No new tracks identified. | Annual | Site inspection records. | Incident reporting will be undertaken in accordance with Incident and Notification Reporting SOP. |
| | Vehicles entering site are inspected and cleaned if leaving an area with declared weeds. | To prevent seed transfer and introduction by vehicles. | Environmental Manager (or delegated person) | Vehicles are clean prior to entering / exiting site. Inspection checklists completed. | Vehicles are inspected and clean prior to entering / exiting site. | As Required | Inspection checklists. | Review resources and operating requirements to determine why action was not completed. Develop and implement an action plan to ensure the action is achieved. |
| Implement effective weed management controls. | Liaison with Pastoral Lease Manager and adjacent landowners regarding weed or pest control. | To inform of site weed or pest issues, control methods and timeframes. | Environmental Manager (or delegated person) | Agreed weed and pest management projects that benefit the Pastoral Lease and meet Primary Gold commitments. | Liaison with the Pastoral Lease Managers and adjacent landowners regarding weed and pest control. | Annual Prior to weed control actions | Stakeholders are aware of RRPA weed and pest control programs and activities. | |
| | Undertake controlled burning or spraying of weeds. | To contain and minimise spread of weeds and to reduce potential impacts from wildfire. | Environmental Manager (or delegated person) | Record of weed control actions undertaken. | Undertake required controlled burning or spraying of weeds. | Annual | Record of weed control actions undertaken. | |
| Understand pest and feral animal populations and implement effective controls. | Register and review pest and feral animal sightings. | To obtain information regarding pest and feral animal species at the site. | Environmental Manager (or delegated person) | Pest and feral animal sightings recorded and review of register. | Undertake a review of the register and ensure that pest and feral animal sightings are recorded. | Annual | Pest and feral animal sightings recorded and review of register. | Conduct a retrospective review of register to identify any trends or changes in populations. |
| | Undertake pest or feral animal control. | To minimise pest or feral animal populations. | Environmental Manager (or delegated person) | Record of pest or feral animal control actions undertaken. | Undertake required pest or feral animal controls. | Annual | Record of pest or feral animal control actions undertaken. | Review resources and operating requirements to determine why action was not completed. |

## 10.10 Security Calculation

# Primary Gold Ltd

## Security Calculation

## Security Summary

| Details | | | |
|---|---|---|---|
| **Contact Name** | Charles Hastie | **Authorisation #** | 0738-01 |
| **Project** | Rustlers Roost Project Area (RRPA) | **Date** | May-19 |
| **MMP** | RRPA Care and Maintenance MMP | | |

**NOTE: Operators may use DPIR Cost per Unit Of Measure as a guide or insert their own cost and UOM - adjust form as necessary. Justification of changes to UOM and cost should be provided if DPIR units area not used**

| New Authorisation | MMP Renewal/amendment | Audit Finding | Client Request |
|---|---|---|---|
| | X | | |

| Domains | Calculated Cost |
|---|---|
| 1: Site Infrastructure | $0.00 |
| 2: Extractive Workings - Sand, Clay & Gravel | $0.00 |
| 3: Hard Rock Pits & Quarries | $0.00 |
| 4: Underground Workings | $0.00 |
| 5: Tailings Storage Facilities and Dams | $0.00 |
| 6: Stockpiles & Waste Rock Dumps | $0.00 |
| 7: Exploration | $8,499.00 |
| 8: Access and Haul Roads | $1,800.00 |
| 9: River Diversions | $0.00 |
| Decommissioning & Post Closure Management | $283,150.00 |
| | |
| Sub-Total - All Domains | $293,449.00 |
| | |
| CONTINGENCY @15% | $44,017.35 |
| | |
| TOTAL COST | $337,466.35 |
| 10% Discount | $33,747 |
| Amended amount | $303,720 |
| 1% levy | $3,037 |

| DISTURBANCE AREA INVENTORY | | | |
|---|---|---|---|
| | | | |
| **Whole of site summary** | **Total Area (ha)** | **Progressively rehabilitated area** | **Remaining area** |
| Lease surface area | 755 | | |
| Disturbed operational area | 101.3 | | |
| | | | |
| **Above grade landforms** | | | |
| Waste rock dump #1 | 40 | | |
| Waste rock dump #2 | | | |
| Waste rock dump #3 | | | |
| Waste rock dump #4 | | | |
| Waste rock dump #5 | | | |
| Tailings Dam #1 | | | |
| Tailings Dam #2 | | | |
| Tailings Dam #3 | | | |
| Tailings Dam #4 | | | |
| Mining area #1 - Open Pit | | | |
| Mining area #2 | | | |
| Mining area #3 | | | |
| Mining area #4 | | | |
| Mining area #5 | | | |
| Mining area #6 | | | |
| Extractive areas | | | 2 |
| haul roads | | | |
| access roads | | | |
| water ponds/dams | 2.9 | | |
| Area of infrastructure | | | |
| camp area | | | |
| area of drill pads and sumps | | | |
| costeans/pits | | | |
| tracks/roads | | | |
| Heap Leach | | | 25 |
| **TOTAL** | **42.9** | | |

## Domain 7: Exploration

| Management Area | Technique | Unit of Measure (UOM) | Range per UOM ($) | Cost per UOM ($) | Estimated Quantity | Sub Total ($) | Technique Notes |
|---|---|---|---|---|---|---|---|
| Drillholes, Pads, sumps, costeans | capping drillholes 30cm below ground | @ | 80-275 | 150.00 | 37 | 5550.00 | Cut collar, insert plug and backfill. Assume using, concrete or plastic cone plugs or bridge (no 'occy' plugs) Depends on number of holes |
| | grout w ith concrete | @ | 1250 | 1250.00 | | 0.00 | Assume total grouting of drillhole |
| | empty and remove plastic sample bags | hole | 25-235 | 100.00 | | 0.00 | return cuttings to hole and remove plastic bags to a w aste disposal facility. Bags cannot be disposed of on site. |
| | ripping/scarifying pads | ha | 440-2500 | 1000.00 | 2 | 1850.00 | Minor ripping/scarifying of pads to depth of 0.3m to assist vegetation in areas of flat/gentle terrain, includes sump infilling. Sumps should not remain open for extended periods of time. |
| | reshape drill pads | @ | 320 | 320.00 | | 0.00 | Required in steep terrain w here earthw orks required w ith excavator/dozer to return pad to slope and establish erosion control, includes sump infilling. Using PC650 excavator or equivalent assumes one pad per hour @$320/hr. |
| | infilling costeans | $m^3$ | 2.00-3.00 | 3.00 | | 0.00 | Backfilling of all costeans/trenches. Assumes material does not have to be carted. |
| | bulk sample pits | $m^3$ | 2.00-8.00 | 2.00 | | 0.00 | dependent on depth of pit and if battering of w alls required to form to 18° slope |
| | contouring for erosion control | ha | 700-1540 | 1500.00 | | 0.00 | minor pushing to construct w ater management structures such as contour banks and diversion drains as required. |
| | topsoil replacementif applicable | $m^3$ | 2.50-5.50 | 5.50 | | 0.00 | includes min of 10cm of topsoil to assist revegetation program. **this may be carried out w hen reshaping pads |
| | revegetation by tube stock | ha | 6000/ha (or 5/ea) | 6000.00 | | 0.00 | includes acquisition of tubestock, fertiliser and guarding as necessary |
| | revegetation by direct seeding | ha | 1200-2000 | 2000.00 | | 0.00 | includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha if required. Required w here area of disturbance is significant. |
| | fertiliser applicataion | ha | 140-744 | 140.00 | | 0.00 | includes a single application of fertiliser during the initial seeding program |
| | | | | | | 7400.00 | |
| Tracks and Gridlines | ripping/scarifying minor tracks and gridlines | km | 120-500 | 350.00 | 3 | 1099.00 | assume using grader or equivalent to rip to 0.3m and no w indrow s, establishing erosion control measures (eg bunds) as required |
| | ripping major tracks and roads | km | 550-1000 | 1000.00 | | 0.00 | pushing in w indrow s and ripping track and establishing erosion control measures (ie bunds) across tracks as required |
| | removal of gridpegs | item | 1500 | 1500.00 | | 0.00 | includes removal offsite of all grid pegs in exploration area |
| | topsoil replacementif applicable | $m^3$ | 2.50-5.50 | 5.50 | | 0.00 | includes min of 10cm of topsoil to assist revegetation program if required |
| | revegetation by tube stock | ha | 6000/ha (or 5/ea) | 6000.00 | | 0.00 | includes acquisition of tubestock, fertiliser and guarding as necessary |
| | revegetation by direct seeding | ha | 1200-2000 | 2000.00 | | 0.00 | includes acquiring and spreading a range of native seed by direct broadcast at a rate of 4-10kg/ha. |
| | fertiliser applicataion | ha | 140-744 | 140.00 | | 0.00 | includes a single application of fertiliser during the initial seeding program |
| | | | | | | 1099.00 | |
| **DOMAIN 7 TOTAL** | | | | | | $8,499.00 | |

## Domain 8: Access and Haul Roads

| Management Area | Technique | Unit of Measure (UOM) | Range per UOM ($) | Cost per UOM ($) | Estimated Quantity | Sub Total ($) | Technique Notes |
|---|---|---|---|---|---|---|---|
| Haul Roads | remove ARD material from road | m3/bcm | 2.50-5.50 | 5.50 | | 0.00 | w here haul road has been constructed w ith w aste rock material that is leaching ARD removal and disposal in pit or similar w ill be required |
| | reshape and deep rip | ha | 2000-5000 | 5000.00 | | 0.00 | w indrow s are pulled back and edges battered, area is deep ripped (road 12mw ide) |
| | structural w orks for drainage | ha | 700-1540 | 1500.00 | | 0.00 | pushing to construct w ater management structures such as contour banks and diversion drains as required. |
| | | | | | | 0.00 | |
| Access Roads | breaking and removal of bitumen | m3 | 12.00-17.00 | 17.00 | | 0.00 | Includes area of bitument in roads car parks etc w hich needs to be removed and disposed of appropriately |
| | reshape and deep rip | ha | 2000-5000 | 2500.00 | | 0.00 | w indrow s are pulled back and edges battered, area is deep ripped |
| | structural w orks for drainage | ha | 700-1540 | 900.00 | 2 | 1800.00 | pushing to construct w ater management structures such as contour banks and diversion drains as required. |
| | | | | | | 1800.00 | |
| Revegetation activities - all roads | source cart and spread topsoil | $m^3$ | 2.50-5.50 | 5.50 | | 0.00 | assume minimum of 10cm depth |
| | revegetation by tubestock | ha | 6000/ha (or 5/ea) | 6000.00 | | 0.00 | enter total area for revegetation by tubestock. (or enter quantity of tubestock required (<15cm), and density/ha) |
| | revegetation by direct seeding | ha | 1200-2000 | 2000.00 | | 0.00 | this rate includes acquiring a mix of native tree and shrub species appropriate for the area, mixing and treating the seed and applying by hand at a rate of 4-10kg/ha |
| | feriliser application | ha | 140-744 | 140.00 | | 0.00 | includes a single application of fertiliser during the initial seeding program - see assumptions |
| | | | | | | 0.00 | |
| **DOMAIN 8 TOTAL** | | | | | | $1,800.00 | |

## Decommissioning & Post Closure Management

| Management Area | Technique | Unit of Measure (UOM) | Range per UOM ($) | Cost per UOM ($) | Estimated Quantity | Sub Total ($) | Technique Notes |
|---|---|---|---|---|---|---|---|
| Decommissioning and Closure | mobilisation/demobilisation | km | 10.00-15.00 | 15.00 | | 0.00 | determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherw ise stipulated & supported by the operator. Calculation assumes 5 pieces of machinery required per site. Adjust formula if necessary. |
| | Contaminated site assessment | @ | 35000 | 35000.00 | | 0.00 | has a contaminated site assessment been undertaken? If not this should be included for large metalliferous mines. |
| | Pest and w eed management, monitoring & assessment | ha | 200 - 250 | 200.00 | 86 | 17,160.00 | Include total disturbed area , consider for minimum of 2 years during closure for larger sites only. Entry automated form 'Key Information' tab. |
| | Contractor accommodation, messing and travel costs | man day | 210-320 | 320.00 | | 0.00 | Assume 5-9 people required for 2-10 w eeks (or more) depending on size of site *quantity = number of days X number of people (eg 9 persons for 50 days = 450 man days) |
| | Closure management | yr | 110,000 - 300,000 | 110000.00 | | 27,500.00 | This includes project manaement team assuming 1 - 3 persons based on the magnitude of the process salaries, oncosts, tender preparation and closure report and coordination of w orks. Consider part of year only for small sites. |
| Post Closure | mobilisation/demobilisation | km | 10.00-15.00 | 15.00 | | 0.00 | Determined based on distance to the mine and machinery used ($/km) Assume mob/demob from largest centre unless otherw ise stipulated & supported by the operator. Calculation assumes 1 piece of machinery required per site. |
| | Post closure w ater monitoring | yr | adjust post closure w orksheet - no entry required | | | 152,700.00 | Monitoring and measurement requirements that may be needed follow ing the closure of the project - use the 'post closure w orksheet' Estimated quanity refers to number of years required post closure |
| | Pest and w eed management, monitoring & assessment | ha | 200 - 250 | 200.00 | 129 | 25,740.00 | Include total rehabilitated area , assumed for minimum of 3 years post closure Entry automated form 'Key Information' tab. |
| | Earthw ork maintenance | ha | 1,100 | 1100.00 | 16 | 17,600.00 | Assume 20% failure rate for the total areas of contructed landforms (eg WRDS, TSF etc) for a period of 2 years (if not stipulated otherw ise) Entry automated form 'Key Information' tab. |
| | Revegetation maintenance, monitoring & assessment | ha | 1,250 - 2,500 | 1250.00 | 17 | 21,450.00 | Assume a 20% failure rate for all disturbed areas for a period of 2 years. (if not stipulated otherw ise) Entry automated form 'Key Information' tab. |
| | Project management | yr | 20,000 | 20000.00 | 1 | 20,000.00 | This includes tender preparation, financial reporting procurement, contractor management etc. Time frame assumed is 1-10 years depending upon the site & the complexity of the issues present |
| | fire break maintenance | km | 50-75 | 50.00 | 20 | 1,000.00 | Grading of firebreaks during and after closure for a period of 1-10 years depending on site size *quantity = number km x number years |
| | | | | | | 283,150.00 | |
| **POST CLOSURE TOTAL** | | | | | | 283,150.00 | |

# POST CLOSURE WATER QUALITY MONITORING WORKSHEET

**NOTE:**
**Operators must enter numbers in the blue boxes, to the appropriate timeframes and reflecting the structures present on individual sites.**

## SUMMARY

| Item | Component | Cost ($) |
|---|---|---|
| 1 | Groundwater monitoring - Analytical | $65,000 |
| 2 | Surface water monitoring - Analytical | $10,000 |
| 3 | Field sampling and Expenses | $35,200 |
| 4 | Water quality interpretation & reporting | $42,500 |
| | **TOTAL** | **$152,700** |

## 1 GROUNDWATER MONITORING - ANALYTICAL

**Analytical & consumables**
***Assumptions: ICPMS, fields & laboratory consumables @ $250/sample***

| Mine site structures | Size (ha) | Enter the number of structures | Sampling points | Sampling per year | Enter the number of years 0-10 | Subtotal cost ($) |
|---|---|---|---|---|---|---|
| Whole of site | All | | 3 | 2 | 10 | 0 |
| Extraction bores for use after closure | | | 1 | 2 | 10 | 0 |
| Discrete infrastructure areas | | | 3 | 2 | 10 | 0 |
| Underground fuel storage areas | | | 1 | 2 | 10 | 0 |
| Pit voids/declines | All | 1 | 3 | 2 | 10 | 15,000 |
| Waste rock dump - oxide | <5 | | 2 | 1 | 10 | 0 |
| | 5 - 20 | | 3 | 2 | 10 | 0 |
| | >20 | 1 | 4 | 2 | 10 | 20,000 |
| Waste rock dump - mixed or sulfide | <5 | | 2 | 2 | 10 | 0 |
| | 5 - 20 | | 4 | 2 | 10 | 0 |
| | >20 | | 6 | 2 | 10 | 0 |
| Tailings dam / residue disposal ponds | 0 -20 | | 3 | 2 | 10 | 0 |
| | 21 - 100 | | 4 | 2 | 10 | 0 |
| | 100 - 150 | | 6 | 2 | 10 | 0 |
| | >150 | | 10 | 2 | 10 | 0 |
| Heap leach pad | <10 | | 3 | 2 | 10 | 0 |
| | >10 | 1 | 5 | 2 | 10 | 25,000 |
| Water containment/retention ponds (water not suitable for passive release) | <10 | 1 | 2 | 1 | 10 | 5,000 |
| | 10 - 20 | | 3 | 2 | 10 | 0 |
| | >20 | | 4 | 2 | 10 | 0 |
| Waste disposal areas | | | 2 | 1 | 10 | 0 |
| Other | | | | | | 0 |
| Other | | | | | | 0 |
| Other | | | | | | 0 |
| | | | | | ***sub total*** | ***$65,000*** |

*Denotes sampling of*

## 2 SURFACE WATER MONITORING - ANALYTICAL

**Analytical & consumables**
***Assumptions: ICPMS, fields & laboratory consumables @ $250/sample***

| Mine site features | Number of features | Sampling points | Sampling per year | Enter No. of years 1-10 | Subtotal cost ($) |
|---|---|---|---|---|---|
| Water retaining structures with no discharge | 1 | 1 | 1 | 10 | 2,500 |
| Water retaining structures with possible discharge | 1 | 1 | 2 | 10 | 5,000 |
| Bioremediation structures | | 1 | 1 | 10 | 0 |

**PLUS**

| Mine site features | Number of features | Sampling points | Sampling per year | Enter No. of years 0-10 | Subtotal cost ($) |
|---|---|---|---|---|---|
| Perenial streams discharging from site | | 2 | 4 | 10 | 0 |
| Ephemeral streams discharging from site | 1 | 2 | 2 | 10 | 10,000 |

**OR Please note: Fill out either the streams or the site operational complexity, size and climate section, but not both**

| Site operation complexity & size and climate | Default sampling sites | Sampling per year | Enter No. of years 0-10 | Subtotal cost ($) |
|---|---|---|---|---|
| Arid zone site - small to medium | 5 | 1 | | 0 |
| Arid zone site - large | 10 | 2 | | 0 |
| Wet/dry tropics site - small size, simple issues | 10 | 2 | | 0 |
| Wet/dry tropics site - small size, moderate -complex issues | 10 | 4 | | 0 |
| Wet/dry tropics site - medium size, simple issues | 15 | 2 | | 0 |
| Wet/dry tropics site - medium size, moderate-complex issues | 15 | 4 | | 0 |
| Wet/dry topics site - large size, moderate -simple issues | 25 | 4 | | 0 |
| Wet/dry topics site - large size, moderate -complex issues | 30 | 4 | | 0 |
| | | | ***sub total*** | ***$10,000*** |

## 3 FIELD SAMPLING & EXPENSES

***Assumptions:***
*Road travel <200km = day trip , 2 people, no accommodation, fuel (300km return) & expenses*
*Road travel 200 - 500km = minimum of 1 nights accom , 1 day travel + 1 night for each additional sampling day, 2 people , fuel (av 800km return)*
*Road travel >500km = minimum of 2 nights accom, 2 days travel + 1 night for each additional sampling day, 2 people, fuel (av 1600km return)*
*Fuel = $1.20/L @ 6km/L Accommodation & meals = $130 per person /per night Personnel = $800 per person per day Air travel = $2000 per person return Ex*

| Travel and expenses | Enter No. of years 0-10 | Distance from nearest centre eg Darwin | Quantity | Enter est. days each sampling trip | Subtotal cost ($) |
|---|---|---|---|---|---|
| Field trips - Road travel | 5 | <200km | 4 | 1 | 35,200 |
| | | 200 - 500km | 4 | 1 | 0 |
| | | > 500km | 4 | 1 | 0 |
| Field trip - Air travel (Proof of availability & suitability required) | | | 4 | 1 | 0 |
| | | | | ***sub total*** | ***$35,200*** |

## 4 WATER QUALITY INTERPRETATION AND REPORTING

| Item | Site size& water mgmt challenges | Quantity | Enter No. of yrs 0-10 | Unit cost ($) | Subtotal cost ($) |
|---|---|---|---|---|---|
| Quaterly data collation & interpretation | small | 3 | 5 | 2,500 | 37,500 |
| | medium | 3 | | 5,000 | 0 |
| | large | 3 | | 10,000 | 0 |
| Annual data collation & interpretation | small | 1 | 5 | 1,000 | 5,000 |
| | medium | 1 | | 5,000 | 0 |
| | large | 1 | | 20,000 | 0 |
| Other reporting | | 1 | | 5,000 | 0 |
| | | | | ***sub total*** | ***$42,500*** |