

Appendix O - Updated Groundwater Modelling Report



Rustlers Roost and Quest 29 Open-Cut Mine Redevelopment

Supplement to the Draft Environmental Impact Statement (EIS)

Appendix O – Updated Groundwater Modelling Report

Prepared pursuant to the Environment Protection Act 2019

October 2021

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Key Project Terms

Term	Definition
Carbon in Leach	This process uses a dilute alkaline cyanide solution to leach (dissolve) gold from the ore material. Activated carbon removes gold out of dilute cyanide solution by adsorption (sticking). The leaching agent and activated carbon are added together in a slurry of ore and water.
Development Envelope	Defined as the maximum area within which the Project footprint could occur. The development envelope for the Project encompasses 790 ha, inclusive of Rustlers Roost, Quest 29, the accommodation camp and haul road.
Environmental Impact	Change to the environment whether adverse or beneficial, wholly or partially resulting from the Primary Gold's environmental aspects. Environmental impacts can be caused directly or indirectly from a Project activity or cumulatively with other non-Project related activities in a set area.
Heap Leach Pad	Existing areas where historic mining placed ore for processing via a leaching solution to dissolve and capture the mineral. The pads contain the remaining material.
Waste Rock Dump	An engineered and constructed impoundment into which overburden from the mining process is placed for safe storage in perpetuity.
Project	The Project includes the expansion of existing pits, waste rock landforms, water storage dams and internal roads in both the Rustlers Roost and Quest 29 MLs. Two new pits will be constructed at Rustlers Roost and new infrastructure includes an onsite processing plant, a tailings storage facility, a landfill, laydown area, magazine, administration office, accommodation camp and groundwater bores for water supply. The Project is inclusive of an expanded connecting haul road between the non-contiguous extraction areas and an accommodation camp.
Project Area	The Project area is defined as wholly including ML1083 (Rustlers Roost), ML 29783 (Quest 29), ML 29814 (accommodation camp) and the connecting haul road. The entire Project area covers 1,143.25 ha.
Significant Impact	A significant impact of an action is an impact of major consequence having regard to: (a) the context and intensity of the impact; and (b) the sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact.
Modelled area	Refers to the area included within the boundary for the groundwater model.
Tailings Storage Facility	A specially engineered and constructed impoundment into which tailings (residue) from the ore processing plant is deposited for placement in perpetuity. The storage facility is constructed with confining embankments consisting of earthen material (e.g. rock and soil) and capped following closure.

Glossary/Acronyms

Term	Definition
AHD	Australian Height Datum
AMD	Acid and Metalliferous Drainage
ANZG	Australia and New Zealand Government
BGL	Below Ground Level
BoM	Bureau of Meteorology
BUD	Beneficial Use Declaration
CIL	Carbon in Leach
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	Digital Elevation Model
DGV	Default Guideline Value
DITT	Department of Industry, Tourism and Trade (NT) (current)
DO	Dissolved Oxygen
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
ET	Evapotranspiration
GDE	Groundwater Dependent Ecosystem
GHB	General Head Boundary
GL	Gigalitre
GV	Guideline Value
HSU	Hydro-Stratigraphic unit.
kL	Kilolitre
LOM	Life of Mine
MCP	Mine Closure Plan
ML	Mining Lease
MMP	Mine Management Plan
Mt	Million Tonnes
Mtpa	Million Tonnes Per Annum
NAF	Non-Acid Forming
NT	Northern Territory
NTU	Nephelometric Turbidity Unit
NWQMS	National Water Quality Management System
PAF	Potentially Acid Forming
PCO	Pine Creek Orogen
PGO	Primary Gold Limited
PPL	Perpetual Pastoral Lease
PWD	Process Water Dam
RCP	Representative Concentration Pathway
ROM	Run Of Mine
RMSE	Root Mean Squared Error
RSWL	Reduced Standing Water Level

Term	Definition
SRMSE	Scaled Root Mean Squared Error
SRTM	Shuttle Radar Topography Mission
SSTV	Site-Specific Trigger Values
SWL	Standing Water Level
TDS	Total Dissolved Solids
TOC	Top Of Casing
ToR	Terms of Reference
TSF	Tailings Storage Facility
WRD	Waste Rock Deposit

1. Introduction

1.1 Project Overview

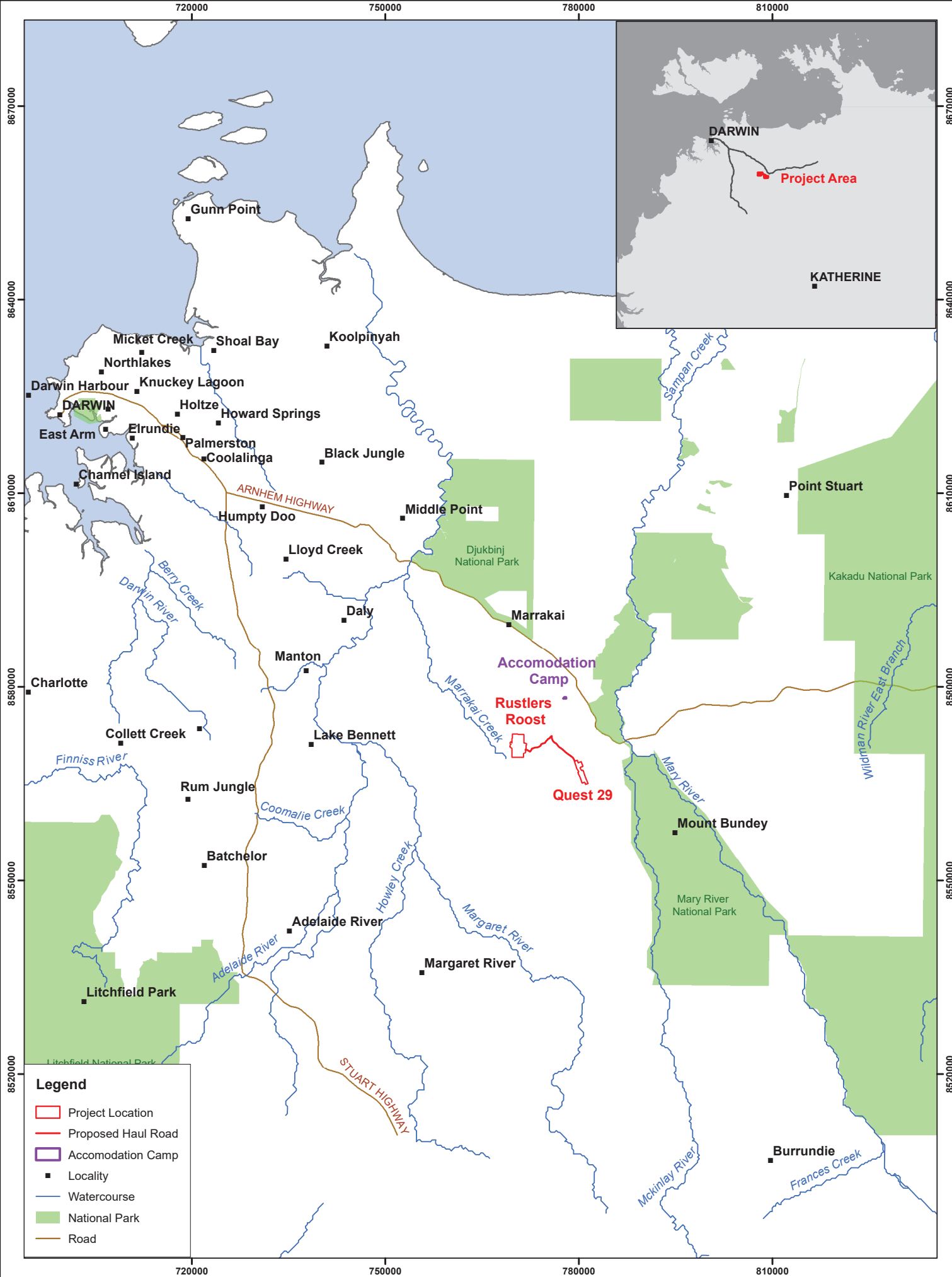
Rustlers Roost and Quest 29 are brownfield sites on Mineral Leases (ML) located in the Mount Bunday region, approximately 85 km south-east of Darwin in the Northern Territory (NT). These sites are proposed to be redeveloped for open-cut mining operations, including connection of the existing areas by a haul road and the construction of an accommodation camp (the Project). The sites have a history of gold mining activity with first gold being discovered in the 1940s and mining activities occurring over intermittent periods during the past 70 years. Primary Gold Limited (PGO) (the Proponent) is proposing to redevelop the existing mine by expanding open-cut gold mining operations and connecting the two non-contiguous sites with the proposed haul road.

The mine sites are located approximately 11 km apart, connected by an existing unsealed access track which will be upgraded to accommodate haulage of ore from the Quest 29 satellite pits to a proposed processing facility at Rustlers Roost. Ore mined at both sites will be processed at a new purpose-built processing facility located at the Rustlers Roost site to produce gold bullion which will then be trucked offsite for sale. The rate of production will be up to 5 million tonnes per annum (Mtpa) over an approximately 10-year life of mine (LOM). Following completion of mining activities the Project area will be closed and rehabilitated in accordance with an approved Mine Closure Plan (MCP).

The main Project areas of Rustlers Roost and Quest 29 are located between 5 km and 12 km directly south-west of the Arnhem Highway on Old Mount Bunday Station, Perpetual Pastoral Lease (PPL) 1163 and McKinlay River Pastoral Station (PPL 1184) (Figure 1-1).

The Project includes the expansion of existing pits, waste rock landforms, water storage dams and internal roads. Two new pits will be constructed at Rustlers Roost and new infrastructure includes an onsite processing plant, a tailings storage facility (TSF), a landfill, laydown area, magazine, administration office, accommodation camp and groundwater bores for water supply. The Project includes an entire development envelope of 790 ha which is taken to be the maximum extent within which disturbance may occur. However, a large portion of the additional Project footprint is within historically disturbed areas.

This model report has been reviewed comprehensively by an independent external reviewer, Hugh Middlemis from HydroGeoLogic. The review concludes that "... as additional data has been used in the 2022 modelling and the model calibration conforms to the AGMG performance criteria, including level and flux constraints, the RR/Q29 model is considered fit for the Class 2 investigative modelling purpose". In addition, the review states that "the groundwater modelling and related impact assessment has been competently conducted and documented and it meets best practice criteria for modelling and uncertainty analysis". The review is included in Appendix D of this report.



1.2 Report Purpose

These groundwater investigations and groundwater modelling works have been undertaken as part of the Supplement to the Draft Environmental Impact Statement (SEIS) prepared for the proposed Project by PGO.

The primary purpose of the investigations and modelling scope is to address groundwater-related requirements of the Terms of Reference (ToR) for the Project Draft EIS, as issued by the Northern Territory Environment Protection Agency (NT EPA) in May 2021 and revised in September 2021 (ToR version 1.1, TRM number NTEPA2021/0038-006~0004). Refer to Appendix C of the Draft EIS for a listing of the ToR. Additionally, further groundwater modelling was undertaken to address relevant comments received during the public consultation period of the Draft EIS finishing on 13 January 2022. The public exhibition period resulted in 9 submissions on the Draft EIS which generally provided several comments and addressing multiple themes. Section 3 of the SEIS provides a summary of the submission received and Section 4 of the SEIS provides all comments received as well as PGO's responses to each comment.

1.3 Project Areas

The Project comprises two main extraction areas, being Rustlers Roost (Figure 1-2) and the Quest 29 portions of the Project area (Figure 1-3). The mine sites are located approximately 11 km apart, and are currently connected by an unsealed access track that will be upgraded to accommodate haulage of ore from the Quest 29 satellite pits to a processing facility to be located at Rustlers Roost.

1.3.1 Rustlers Roost

The Rustlers Roost portion of the Project area is located on ML 1083 which covers approximately 756 ha. The current infrastructure and landforms at the Rustlers Roost mine area comprise the following (Figure 1-2):

- Associated historic open pits that have flooded and have become a single pit (approximate dimensions 50 m depth, 1,000 m length and 300 m width). The pit lake currently holds approximately 3.16 Gigalitres (GL) of water based on post mining pit shell bathymetry and current water level of 56.90 mAHD (surveyed on 3 November 2020);
- Remnants of an old processing plant and ROM. In 1997 most of the plant, buildings and other mining infrastructure were removed, apart from three large tanks and some concrete footings;
- Annie's Dam (included within the NTSF WSD area for the redevelopment) covering approximately 11.4 ha and with an estimated capacity of 200,000 kilolitres (kL);
- Existing waste rock dump (WRD), with approximate dimensions of 30 m high, 1,000 m long and 400 m wide; and
- Two heap leach pads (total approximate dimensions 20 m in height, 600 m in length and 450 m width) and associated heap leach ponds.

The proposed redevelopment at Rustlers Roost includes the following key components:

- Processing plant and Run of Mine (ROM) - The new processing facility will be constructed in the northern portion of Rustlers Roost, immediately north of the WRD and will be contained in an area approximately 1000 m long and 400 m wide;
- Expanded existing main pit and two minor pits - The Rustlers Roost main pit is proposed to be expanded by approximately 57% to the east and west and increased in depth to -125 m AHD. Dewatering of the pits will be undertaken with diesel powered in-pit sumps. Dewatering will occur as required, as a result of direct precipitation from rain events and groundwater in-flow. To access ore that has been recently identified through drilling and to prevent future sterilisation through placement of the TSF over and immediately adjacent these areas, PGO is proposing to also mine two small additional pits (Annie's Okaley and Annie's Dam Pits);

- Tailings storage facility - The TSF will be located in the southern section of ML 1083 and will occupy 243.0 ha of land. The TSF size is based on a nominal tailings disposal volume of 4 Mtpa for a total of 40 Mt capacity (i.e. 10 years production). The TSF will be raised in height progressively over a 10-year period to reach storage capacity for the LOM. The entire TSF basin is proposed to be covered by composite liner of HDPE and compacted soil liner (CSL). Appendix G of the SEIS provides detailed information on the TSF design;
- Waste rock dumps – The area including and to the north of the existing U-shaped WRD will be the designated location for the disposal of waste rock from Rustlers Roost pit. Waste rock will be placed in two separate WRDs termed the northern WRD and the southern WRD. A total of 50.9 Mt of waste material will be produced from the main Rustlers Roost pit. Approximately 45.6 Mt will be placed within the surface WRDs and 5.36 Mt of fresh waste backfilled into the pits;
- Mine laydown area – A compacted earth mine laydown area covering approximately 6.0 ha will be constructed in the Rustlers Roost portion of the Project area;
- Administration facility – An administration facility covering approximately 0.42 ha will be constructed in proximity of the laydown area and processing facility in the north of Rustlers Roost;
- Landfill – A landfill is proposed to be constructed at Rustlers Roost encompassing largely disturbed land to the west of the main pit and east of the TSF. The landfill will be constructed over 4.0 ha to a depth of 5 m and be utilised for the 10-year Project period; and
- The final post-mining landform is anticipated to predominantly contain the mined main pit shells, with the Annie's Oakley pit backfilled and Annie's Dam pit consumed within the TSF. The elevated WRD, landfill and TSF will be surrounded by water diversion berms and capped. It is anticipated refilling of the main pit shell will result in one remaining pit lake.

1.3.2 Quest 29

Quest 29 is located 10 km south-east of Rustlers Roost; and is located across five MLs (i.e. ML 29781, ML 29782, ML29783, ML 29785 and ML 29786), which collectively cover approximately 658 ha. There are currently no proposed activities, other than exploration, on Quest 29 ML 29781, ML 29785 or ML 29786. Therefore, the Quest 29 portion of the Project area only includes mining lease ML 29783.

The current infrastructure and landforms at the Quest 29 mine area comprise the following (Figure 1-3):

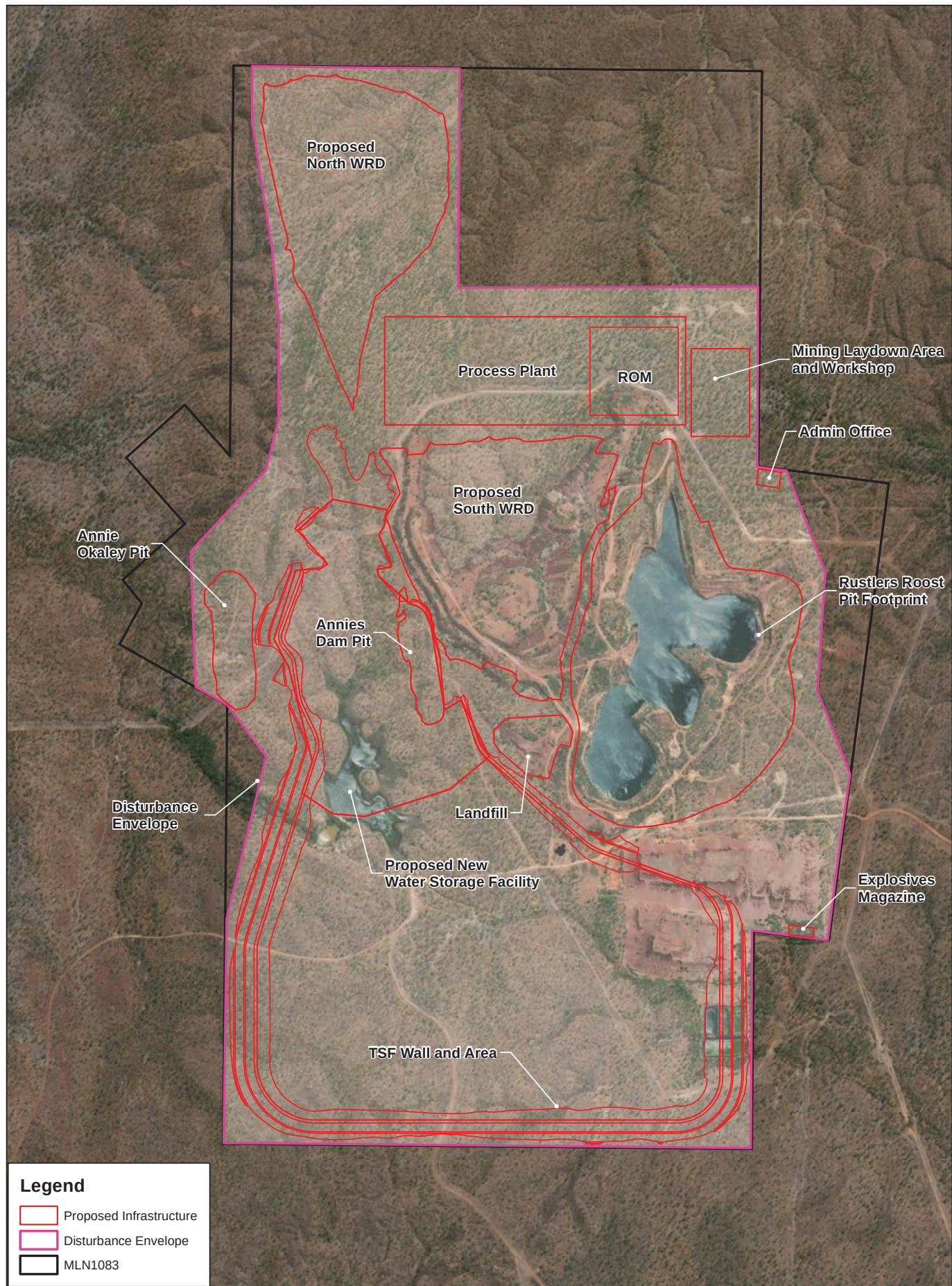
- Five open-cut pits, being the BHS Pit, North Koolpin Pit, West Koolpin Pit (South Koolpin Pit), Zamu Pit and Taipan Pit, with dimensions of the largest of the pits approximately 25 m depth, 280 m length and 50 m width);
- Five WRDs (largest of the WRDs approximately 10 m height, 280 m length and 80 m width);
- One heap leach pad (approximate dimensions 20 m in height, 200 m length and 200 m width);
- Heap leach pond; and
- Remaining infrastructure associated with the Carbon in Leach (CIL) tanks.

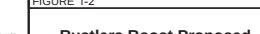
The proposed development at Quest 29 includes the following:

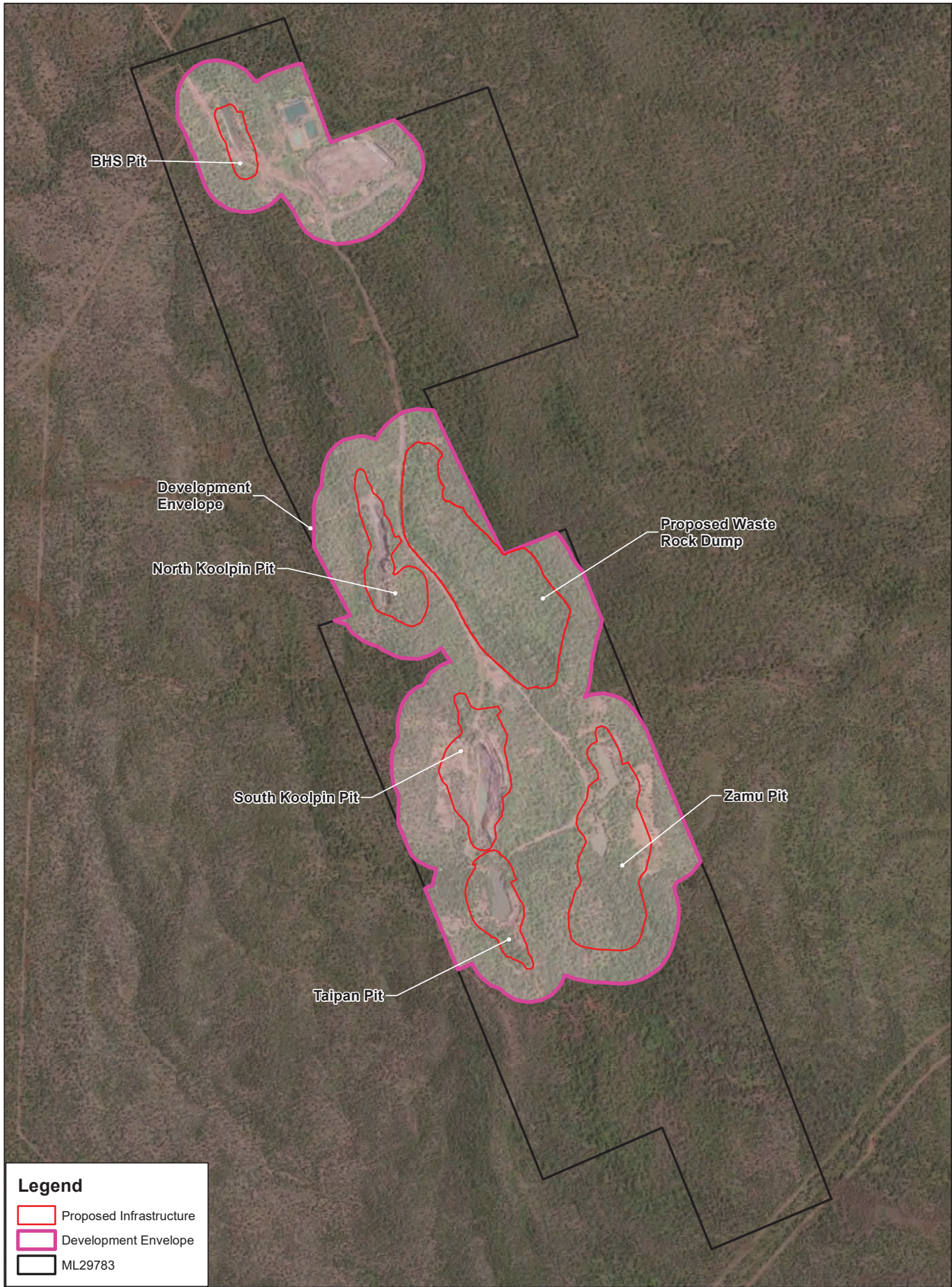
- Expanded existing pits – The five existing pits at Quest 29 are proposed to be expanded and mined to a depth of 75 m from the current depth of 25 m. On completion of mining Zamu pit, the pit will be backfilled with waste material from mining of the remaining Quest 29 pits;
- Waste rock dump - The proposed surface WRD at Quest 29 will be developed in the area north of Zamu Pit. This was selected to minimise haulage distances for the initial stage of mining Zamu pit. During construction the WRD face angle will be 37°, with a berm width of 19.5 m and 4 x 10 m lifts. The WRD construction will commence with the placement of non-acid forming (NAF) material for the base and outer annulus.

Potential acid forming (PAF) material encountered will be placed onto of the NAF base and encapsulated within the centre of the WRD. No PAF material will be placed on outer perimeter, slopes, toe, surface or base of the dump; and

- The final post-mining landform is anticipated to contain the mined pit shells, with Zamu pit predominately backfilled using waste rock material, surrounded by water diversion berms and the capped WRD. It is anticipated refilling of the pit shells will result in five remaining pit lakes.



R Details		Date	©COPYRIGHT CDM SMITH				DISCLAIMER		DESIGNER	CLIENT	FIGURE 1-2
1	First Draft	30/06/21	This drawing is confidential and shall only be used for the purpose of this project.				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.				
2	Second Draft	27/07/21	DESIGNED	SS	CHECKED	JM	DATA SOURCE				
3	Third Draft	30/06/22	DRAWN	SS	CHECKED	JM	QLD Government Open Source Data				
			APPROVED	-	DATE	30/06/22					
			Notes:								



2. Scope of Work and Methodology

2.1 Scope of Work

The scope of work for the groundwater investigations and groundwater modelling was based on the ToR for the Project (refer to Appendix C in the Draft EIS). Additionally, further groundwater modelling was undertaken to address relevant comments received during the public consultation period of the Draft EIS (refer to Section 4 of the SEIS).

The revised groundwater investigation and modelling scope included the following:

- A desktop review of currently available data, information and reports relevant to the Project;
- Development of a numerical groundwater model to estimate the potential drawdown extents induced by the proposed mining pits;
- Development of a site water balance and mass balance model to assess the management of water and water quality from the water production to the water disposal during and beyond the life of mine until steady state conditions are established; and
- Preparation of this groundwater investigation and modelling report.

2.2 Methodology

2.2.1 Desktop Data Review

The data review included collation and review of:

- Historical groundwater investigations, studies and reports relevant to the Project;
- Publicly available data and information; and
- Regional climate and climate change projection.

Key historical studies/reports reviewed for the groundwater impact assessment included the following:

- CDM Smith 2019. Rustler's Roost Project – Desktop Groundwater assessment; and
- Primary Gold 2021. Rustlers Roost and Quest 29 Open-Cut mine redevelopment. Referral report.

Additional data sources included the following:

- Digital Elevation Model (DEM) of the Project area;
- SILO climate data (rainfall and pan evaporation);
- Historical and proposed pits shell geometry (and derived bathymetry curves); and
- Groundwater level records.

2.2.2 Field Investigations

Historical field investigations, including groundwater monitoring and sampling, have been undertaken by several entities since 1993, with results reported in the key historical studies/reports listed in Section 2.2.1.

As part of the technical studies for the EIS, the Proponent commissioned EcOz Environmental Consultants (EcOz) to undertake groundwater, surface water and open pit monitoring and sampling at Rustlers Roost and Quest 29 portions of the Project.

The results of the historical and current field investigations have been incorporated in this groundwater impact assessment report.

2.2.3 Groundwater Modelling

The objective of the numerical groundwater model, referred to as the Project groundwater model, was to estimate:

- The potential maximum drawdown extents induced by mining the proposed pits at the Rustlers Roost and Quest 29 portions of the Project.

2.2.4 Site Water Balance and Mass Balance Modelling

The objective of the site water balance and mass balance modelling was to estimate:

- The ability of the water management plan to prevent uncontrolled spill to the environment, and to keep a dry working environment during the mining phases;
- The Rustlers Roost and Quest 29 respective pit lake water balance and stabilisation level post-mining:
 - Evaluate the overflowing likelihood of all the pit lakes
 - The evolution of the water quality within pit lakes forming post-mining.
- The bore field production requirements to respond to the site demand.

3. Relevant Legislation

3.1 Environment Protection Act 2019

The EP Act (2019) and associated regulations has replaced the Environmental Assessment Act 1999 on 28 June 2020. The EP Act aims to protect the environment through sustainable development and manage significant disturbances through an environmental approval process. Under the Act, the NT EPA regulates the environment impact assessment process to identify potential environmental impacts of development proposals. This initial step is undertaken through a referral in which the NT EPA determines if further assessment is required (i.e. the tier of assessment).

A proponent-initiated EIS referral was submitted by PGO to the NT EPA on 3 February 2021 for consideration under the EP Act. The NT EPA determined a standard assessment by EIS to be an appropriate method of assessment for the proposed action to address the requirements of section 42 and section 43 of the EP Act. The NT EPA issued a formal Notice of Decision and Statement of Reasons on the assessment approach concurrently with the ToR for the EIS issued on 11 May 2021 and revised in September 2021 (ToR version 1.1, TRM number NTEPA2021/0038-006~0004).

3.2 Mining Management Act 2001

The *Mining Management Act 2001* and regulations enables authorisation of mining activities, management of mining sites, protection of the environment on mining sites and related purposes. The *Mining Management Act 2001* is administered by the DITT. The objectives of the *Mining Management Act 2001* are to:

- Ensure development of the NT's mineral resources in a manner consistent with best environmental practice for the mining industry:
 - Protect the environment by:
 - Requiring authorisation for and monitoring of mining activities
 - Requiring management of mine sites through implementation of management systems.
 - Foster consultation and cooperation between management and the mine workforce in implementing environment management systems
 - Implementing audits, inspections, investigations, monitoring and reporting to ensure compliance with agreed standards and criteria
 - Specifying personnel obligations on mine sites to protect the environment.
- Assist the mining industry to introduce continuous improvement initiatives to achieve best practice environmental management;
- Enable people connected with the mining industry to participate in implementation of the Act through establishment of a Mining Board to advise the Minister on:
 - Industry guidelines
 - Competencies required by persons involved in the industry
 - Best practice in mining activities
 - Minimising liability of the NT Government by having a system requiring payment of security to provide for rehabilitation of mining sites or rectify environmental harm caused by mining activities.

A MMP and Authorisation for the proposed work is required from the Minister of Mines and Energy before any mining activities (as defined in the *Mining Management Act 2001*) can commence. The environmental assessment process will allow the Minister to be informed of potential environmental impacts and proposed management to assist in the decision-making process.

4. Description of Environmental Values

4.1 Physical Environment

4.1.1 Climate

The climate of the 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, a summer wet season and winter dry season, with two subsidiary transitional periods between them. The dry season occurs from May to September and is characterised by prevailing south-easterly winds. The hot, "dry-wet" transition from October to November has high humidity and variable winds. The wet season occurs from December to March, with dominant northwest to westerly winds. The hot, "wet-dry" transition of April has variable winds, although predominantly from a westerly direction.

The Bureau of Meteorology (BoM) provide climate classification maps using three (3) methods of classifying the climate of Australia (Bureau of Meteorology, 2016). These different classification schemes are based on temperature/humidity, vegetation (Köppen) and seasonal rainfall. The climate classification for the Project, based on these maps, is as follows:

- Temperature/humidity zones map: The Project is located within the hot humid summer climate zone;
- Köppen map: The Project is located within the tropical classification group; and
- Seasonal rainfall map: The Project is located within a summer dominant climate class, with a marked wet summer and dry winter.

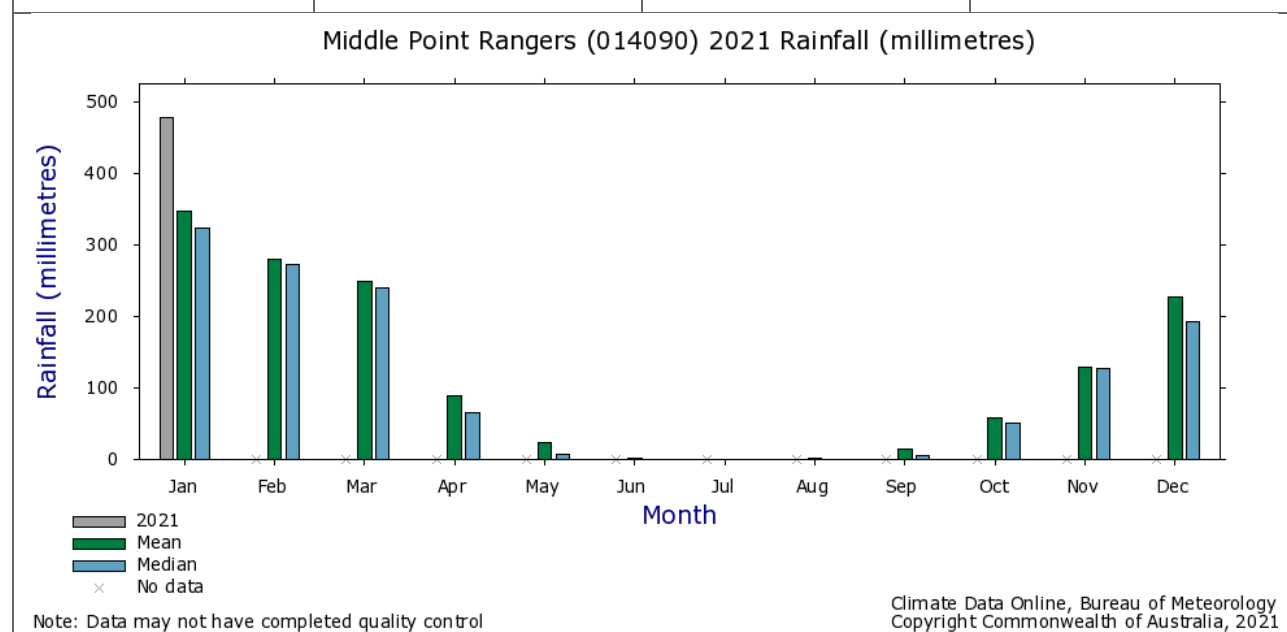
The long-term BoM weather station nearest to the Project area is the Middle Point Rangers Weather Station (BoM #14090), which is located approximately 42 km south of Rustlers Roost and approximately 40 km northwest of Quest 29.

Summary statistics of weather data from this station are provided in Table 4-1 to Table 4-3.

4 Description of Environmental Values

Table 4-1 Monthly Rainfall (mm) Statistics - Middle Point Rangers Weather Station (BoM #14090)

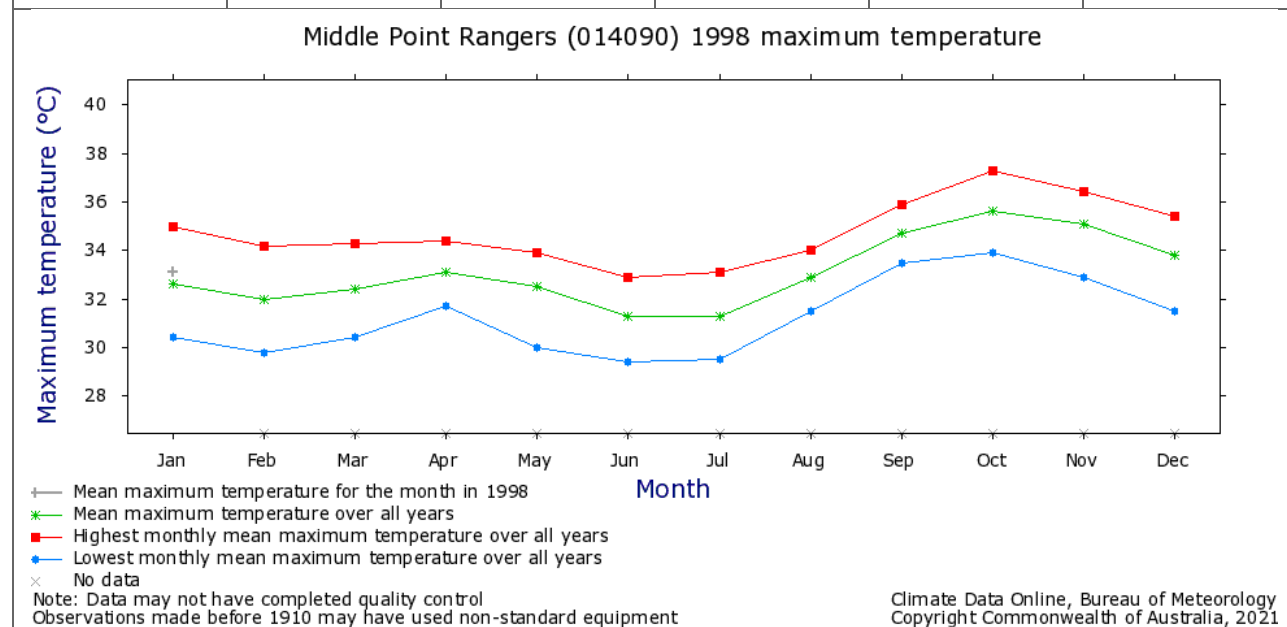
Month	Mean	Median	Highest Daily
Jan	347.4	322.4	210
Feb	280.1	271.9	134
Mar	249	240.4	158.8
Apr	89.1	64.8	112
May	23.5	6.6	91.4
Jun	1.4	0	30
Jul	0.7	0	7.4
Aug	2.2	0	38.4
Sep	14	5.8	65.6
Oct	57.7	51.7	60.6
Nov	128	127.2	97
Dec	226.8	193.2	242.3



4 Description of Environmental Values

Table 4-2 Daily Temperature (°C) Statistics - Middle Point Rangers Weather Station (BoM #14090)

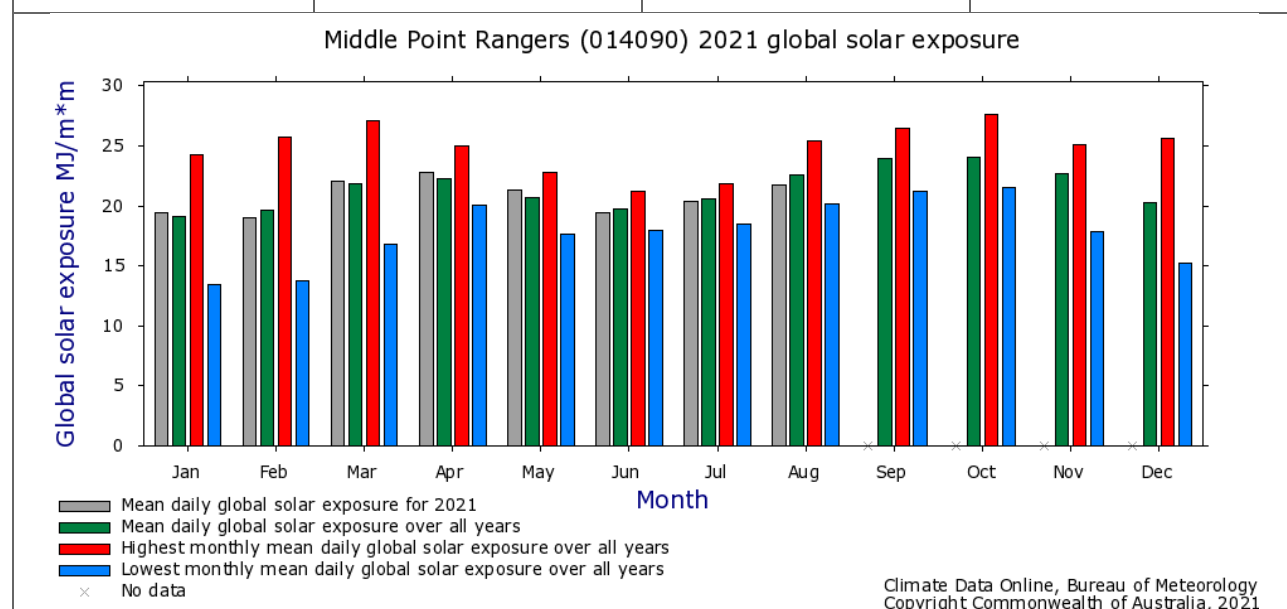
Month	Mean	Highest monthly mean	Lowest monthly mean	Highest Daily	Lowest Daily
Jan	32.6	35	30.4	38.2	25.2
Feb	32	34.2	29.8	36.2	24.5
Mar	32.4	34.3	30.4	37.5	26.1
Apr	33.1	34.4	31.7	39	25.8
May	32.5	33.9	30	35.9	22.2
Jun	31.3	32.9	29.4	34.9	25.3
Jul	31.3	33.1	29.5	35.5	19.9
Aug	32.9	34	31.5	37.1	18.6
Sep	34.7	35.9	33.5	38.8	27.6
Oct	35.6	37.3	33.9	40.3	24.5
Nov	35.1	36.4	32.9	40.2	26.5
Dec	33.8	35.4	31.5	38.7	25.4



4 Description of Environmental Values

Table 4-3 Daily Solar Exposure (MJ/m²) Statistics - Middle Point Rangers Weather Station (BoM #14090)

Month	Mean	Highest monthly mean	Lowest monthly mean
Jan	19.1	24.3	13.4
Feb	19.6	25.7	13.8
Mar	21.9	27.1	16.8
Apr	22.3	25	20.1
May	20.7	22.8	17.7
Jun	19.8	21.2	18
Jul	20.6	21.9	18.5
Aug	22.6	25.4	20.2
Sep	23.9	26.5	21.2
Oct	24.1	27.6	21.5
Nov	22.7	25.1	17.9
Dec	20.3	25.6	15.2



4.1.2 Climate Change Variability

The climate of the Northern Territory is expected to experience changes due to human induced climate change. The climate of the region is anticipated to become hotter, with longer fire seasons, more intense extreme rain events; however, with a projected decrease in cyclones and uncertain annual rainfall changes (CCA, 2021).

To inform climate change scenario selection for this project the representative concentration pathway (RCP) approach has been taken. This is a range of seven greenhouse gas concentration trajectories adopted by the International Panel on Climate Change. RCP 4.5 is considered an intermediate scenario under which there will be a mean sea level rise, with this rise resulting in the inability of some plants and animals to adapt (https://ar5-syr.ipcc.ch/topic_futurechanges.php). For the purposes of this groundwater assessment, and in line with the surface water assessment (Surface Water and Erosion Solutions, 2021), the RCP 4.5 climate model developed by Surface Water and Erosion Solutions for the hydrologic and hydraulic modelling was applied to the dewatering phase of the operation and the post-mining groundwater numerical model scenarios.

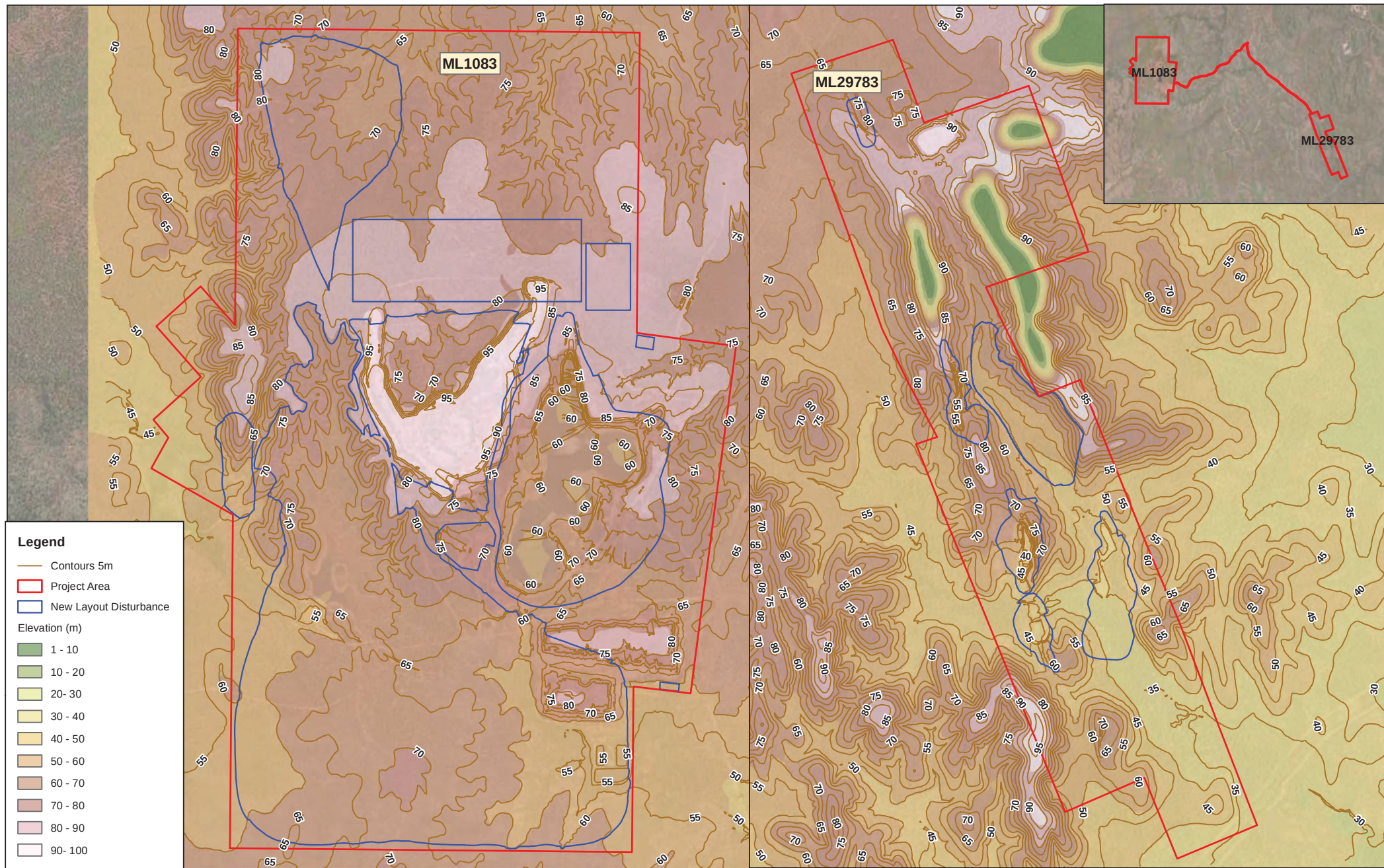
4.1.3 Topography and Drainage

The Rustlers Roost site is situated near a catchment divide at the headwaters of Mount Bunday Creek, which drains to the east. The Mount Bunday Creek catchment has a total area of approximately 150 km² and is a tributary catchment of the Mary River. The confluence of Mount Bunday Creek and Mary River is located roughly 5 km east of the Arnhem Highway crossing of Mount Bunday Creek. Like most creeks in the NT, Mount Bunday 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 channels, flowing to the west from Annie's Dam, and to the east from near the former ROM pad. The catchment upstream of Rustlers Roost operations covers around 2.2 km² and is characterised by outcropping rock. Runoff from the catchment is expected to occur rapidly following rainfall events.

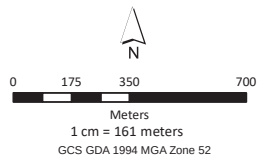
The landscape has been altered due to prior mining and processing operations in the Project area. Today, there are two permanent water bodies located on the Rustlers Roost site, the pit lake and Annie's Dam. Water store in the pit is likely a combination of stormwater runoff, incident rainfall and possibly groundwater, whilst Annie's Dam is likely a combination of stormwater runoff and incident rainfall.

The topography for the Rustlers Roost and Quest 29 portions of the Project area is illustrated in Figure 4-1.



R	Details	Date
1	First Draft	11/08/21
-	-	-
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DESIGNED	SS	CHECKED	TK
DRAWN	SS	CHECKED	TK
APPROVED	TK	DATE	11/08/21
Notes:			



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DATA SOURCE
NT Government Open Source Data

DESIGNER

CDM Smith

CLIENT

PRIMARY GOLD

FIGURE 4-1

**Rustlers Roost and Quest 29
Topography / Elevation**

DRG Ref: 1001087-EIS-07-7.4

4.1.4 Land Use

The Project area maintains two current active mining authorisations (0738-01 and 0739-01) for the purpose of care and maintenance activities. Rustlers Roost has been in care and maintenance since 1998, with exploration works conducted by PGO in 2003, 2017 to 2018 and more recently during 2020. At Quest 29, limited exploration activities have taken place intermittently, with the most recent activity occurring in 2020. No mining activities have been conducted at Quest 29 since 2004. Since its purchase in 2013, PGO has undertaken reconnaissance and desktop investigations and maintained site environmental monitoring, maintenance and reporting as detailed further in the supporting EIS documents.

The Project area is located in the Mount Bunday region and is remote from any communities. The closest major town is Humpty Doo, which is approximately 46 km north-west of the Project, with Darwin located approximately 85 km north-west. The Marrakai residential subdivision is located 14 km north-west.

The broader Mount Bunday locality includes the Mary River, the portion of the Mary River National Park south of the Arnhem Highway, the Mary River Wilderness Retreat and the Mount Bunday Military Training Area in the east. The Mary River National Park is utilised for environmental conservation, tourism and recreational purposes. The Mary River Wilderness Retreat is located 8.5 km north-east of the Project. The Mount Bunday Military Training area encompasses 117,300 ha east of the Mary River and is operated by the Commonwealth of Australia.

The most extensive land use in the vicinity of the Project area is pastoral, involving the grazing of beef cattle over the woodland terrain. There has been some improvement to pasture on Old Mount Bunday station. Under a state of care and maintenance, the pastoral landowner of Old Mount Bunday Station has been engaged by PGO to assist in monitoring and managing the mining tenements, in terms of weed, fire and water management compliance requirements.

Land use in the region includes agriculture (orchards and pastoral operations) and mining, with historic iron ore mining at Mount Bunday and gold mining at Toms Gully, Quest 29 and Rustlers Roost mines.

Tourism, including recreational fishing, is growing in the region. A number of conservation reserves and parks managed by the Parks and Wildlife Commission of the Northern Territory occur within a 50 km radius of the Project area. These include:

- Mary River Crossing Reserve (15 km);
- Mary River National Park (15 km);
- Leaning Tree Lagoon Nature Park (25 km);
- Wildman Reserve (40 km); and
- Fogg Dam Conservation Reserve (45 km).

The boundary of the Kakadu National Park, managed by the Australian National Parks and Wildlife Service, lies 60 km east of the Project area along the lowlands of the Wildman River. The Kakadu National Park currently covers 1.3 million ha, encompassing the drainage systems associated with the Wildman, West Alligator and South Alligator Rivers.

4.1.5 Hydrology

Rustlers Roost

The Rustlers Roost site is on the catchment divide and in the headwaters of Marrakai Creek and Mt Bunday Creeks and the mineral lease disturbance area is 9.35 km². Both creeks are ephemeral, flowing only through the wet season with the annual receding hydrograph continuing into the dry season.

The Rustlers Roost site has internally draining catchments reporting to the pit and the proposed TSF comprising 3.34 km² and externally draining catchments reporting to Marrakai and Mt Bunday Creeks comprising 6.01 km².

The local catchment is comprised of ridges and dissected hills that are drained by small step rivulets (CDM Smith 2019). Stream flows in these upper areas of the catchments are ephemeral, with flows occurring for only a few weeks-months each year throughout the wet season, in response to rainfall events (EcOz 2021).

Quest 29

The Quest 29 is predominantly located in the McKinley River sub-catchment, which also flows into the Mary River system. A minor northern portion of the Quest 29 is in the upper Mount Bunday Creek sub-catchment of the Mary River system.

The local catchment comprises ridges and dissected hills that are drained by small step rivulets (CDM Smith 2019). Stream flows in these upper areas of the catchments are ephemeral, with flows occurring for only a few weeks-months each year throughout the wet season, in response to rainfall events (EcOz 2021).

The Quest 29 site is split into a north catchment (Q29N), draining into Mount Bunday Creek, with a surface area of 96.06 ha, and a south catchment (Q29S), with a surface area of 492.68 ha, draining into the McKinley River.

4.2 Geology

4.2.1 Regional Geology

The Project area is located within the Pine Creek Orogen (PCO - the Pine Creek Inlier or the Pine Creek Geosyncline), which is a deformed and metamorphosed sedimentary basin that is exposed over 47,500 km² and comprises a thick (>4 km) succession of Palaeoproterozoic clastic, carbonate and carbonaceous sedimentary and volcanic rocks, unconformably overlying Neoproterozoic (ca 2670–2500 Ma) granitic and gneissic basement (Ahmad & Hollis, 2013). These depositions experienced regional metamorphism and deformation of varying grades and intensities in different part of the orogen in the period ca 1867-1850 Ma and syn- to post-tectonic granite emplacement at ca 1830-1800 Ma.

The Palaeoproterozoic strata of the PCO are extensively mineralised, hosting over 1,000 known mineral occurrences. It is a multi-commodity province with the major commodities including gold, uranium, lead-zinc-silver, platinum-group elements, copper-cobalt-nickel, iron, tin-tantalum-tungsten and phosphate.

The PCO is broadly correlated with other Palaeoproterozoic domains of Northern Australia (e.g. Tanami and Tennant regions, Arnhem and Murphy provinces and the Halls Creek Orogen). Younger strata conceal its margins, and the total extent is unknown (Figure 4-2). It is unconformably overlain by the Palaeo to Mesoproterozoic McArthur Basin to the east, the Palaeo to Neoproterozoic Victoria, Birrindudu and Fitzmaurice basins to the west, and Cambro–Ordovician and Mesozoic successions (Daly and Bonaparte basins) to the southwest and northwest. Mesozoic and Palaeozoic sediments of the Arafura and Money Shoal basins overlie parts of the PCO to the north and the Mesozoic onshore Carpentaria Basin overlies other parts to the south. Unconsolidated sand, silt and clay of Cenozoic age also cover much of the area. During the upper Cretaceous to mid Cenozoic, much of the land surface was subjected to intense chemical weathering, leading to laterite formation.

The PCO has been broadly subdivided into three domains (Needham *et al.*, 1988, Hollis *et al.*, 2009), i.e. the greenschist-facies Central Domain (including the Rum Jungle region and the South Alligator Valley), the amphibolite-facies Nimbuwah Domain to the east, and the amphibolite- to granulite-facies Litchfield Domain (formerly 'Litchfield Province') to the west (Figure 4-2). The greenschist-facies Central Domain is separated from amphibolite-facies Nimbuwah Domain to the east by the Jim Jim Fault Zone. The boundary with the amphibolite- to granulite-facies Litchfield Domain to the west is defined by the westernmost extent of the Finnis River Group.

In addition to differences in metamorphic grade and structural styles, these regions are also distinct in the timing and nature of metamorphism and the timing and chemistry of the main phases of magmatism.

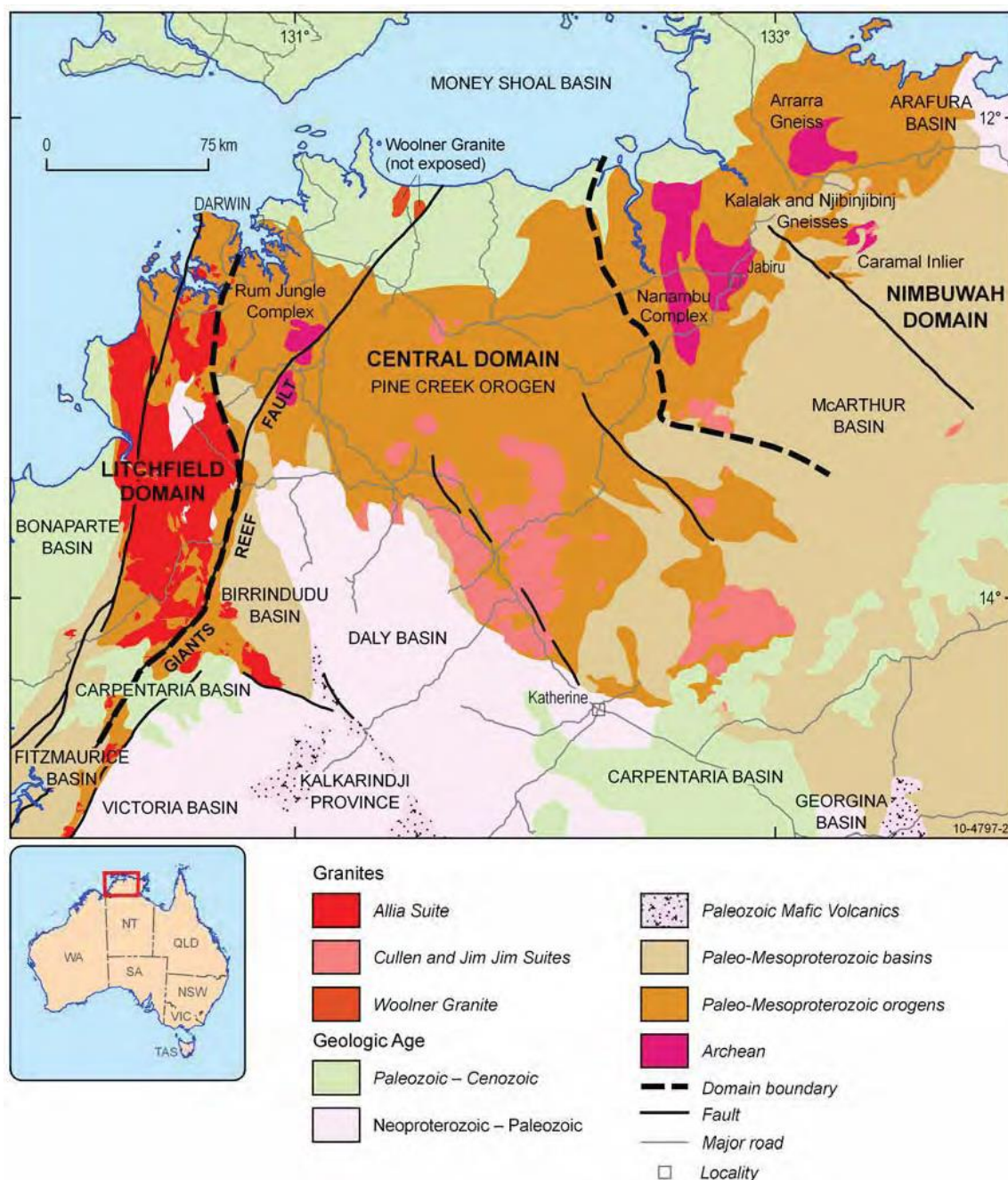


Figure 4-2 Geological Setting of PCO (Ahmad & Hollis, 2013)

The Palaeoproterozoic stratigraphic succession of the PCO (Figure 4-2 and Figure 4-3) comprises the Woodcutters and Cosmo supergroups. No strata of equivalent age to the Woodcutters Supergroup are recognised outside of the PCO in the Northern Territory. The succession is well constrained in the Central Domain with more tentative correlations into the Litchfield Domain and Nimbuwah Domain.

The Woodcutters Supergroup is represented by the Manton, Mount Partridge, and Namoon groups in the Central Domain and by the Kakadu Group in the Nimbuwah Domain.

The Cosmo Supergroup is more widespread than the underlying Woodcutters Supergroup and unconformably overlies the latter. The Cosmo Supergroup succession comprises the South Alligator Group and the regionally extensive Finnis River Group in the Central Domain, with the Hermit Creek and Welltree metamorphics representing probable equivalents of the Finnis River Group in the Litchfield Domain.

4 Description of Environmental Values

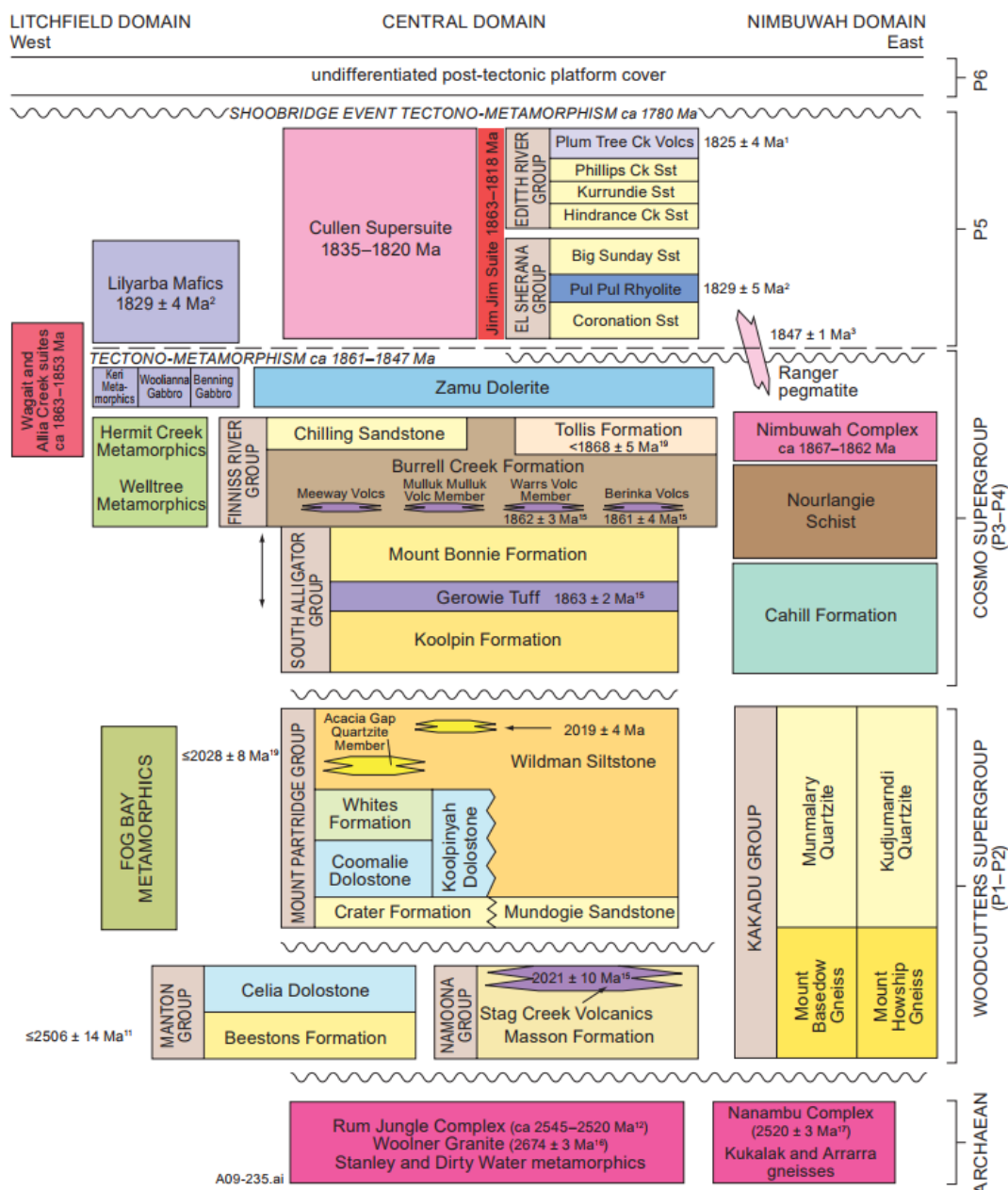


Figure 4-3 Simplified Palaeoproterozoic Stratigraphic Column of PCO (Ahmad & Hollis, 2013)

4.2.2 Rustlers Roost Geology

The Rustlers Roost site lies on the northern flank of the PCO within a transgressive marine sequence dominated by folded shallow marine sediments of the Early Proterozoic South Alligator Group. In general the PCO consists of an extensive but poorly exposed sequence of low to medium metamorphic grade, early Proterozoic sediments deposited in a shallow intra-cratonic geosyncline which overlies a late Archean granitic basement. The sediments were intruded and overlain by late early Proterozoic felsic volcanics and by later middle Proterozoic platform sequences.

The surface geology of the Rustlers Roost portion of the Project area is presented in Figure 4-4.

The Rustlers Roost site is underlain by shallow marine, iron rich and tuffaceous sediments of the South Alligator Group which are openly to tightly folded about gently south plunging axes (Environmental and Earth Sciences Pty Ltd, January 1993). The group includes the Koolpin Formation, Geowrie Tuff and Mount Bonnie Formation. The Koolpin Formation and Geowrie Tuff are exposed to the immediate north of the Rustlers Roost portion of the Project area.

- The Koolpin Formation consist of ferruginous siltstone and shale, with silicified haematite and chert breccias and minor silicified dolomite over an average thickness of 100 metres;
- The Geowrie Tuff (600 m thick) consists predominantly of thinly interbedded fine grain sediments, glassy crystal tuffs and tuffaceous cherts. Both the Koolpin Formation and Geowrie Tuff show extensive attenuation at fold hinges; and
- The Mount Bonnie Formation occupies the major portion of the Rustlers Roost Project area and consists of interbedded pelites, greywackes and tuffaceous sediments for an average thickness of 650 metres. The Mount Bonnie Formation shows little tectonically induced thickness variation.

Conformably overlying the Mount Bonnie Formation is the Burrell Creek Formation of the Finniss River Group. This formation consists of flysch style sediments consisting predominantly of interbedded shale, siltstone, phyllite and greywacke.

The South Alligator Group is unconformably underlain by fluvial sediments of the Mount Partridge Group.

All early Proterozoic rocks within the Rustlers Roost portion of the Project area have been regionally metamorphosed to lower greenschist facies. A 500-metre-wide aureole of contact metamorphic hornfels surrounds the Mount Bunday Granite to the east.

Early Proterozoic metasediments in the vicinity of the Rustlers Roost portion of the Project area 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 subhorizontal to shallow, plunge south and trend 180 to 200 degrees. The change in fold axis orientation is gradational from 180 in the south to 200 in the north and reflects a regional rotation about a west-northwest-trending flexure, the Marrakai-Coirwong Flexure Zone.

4 Description of Environmental Values

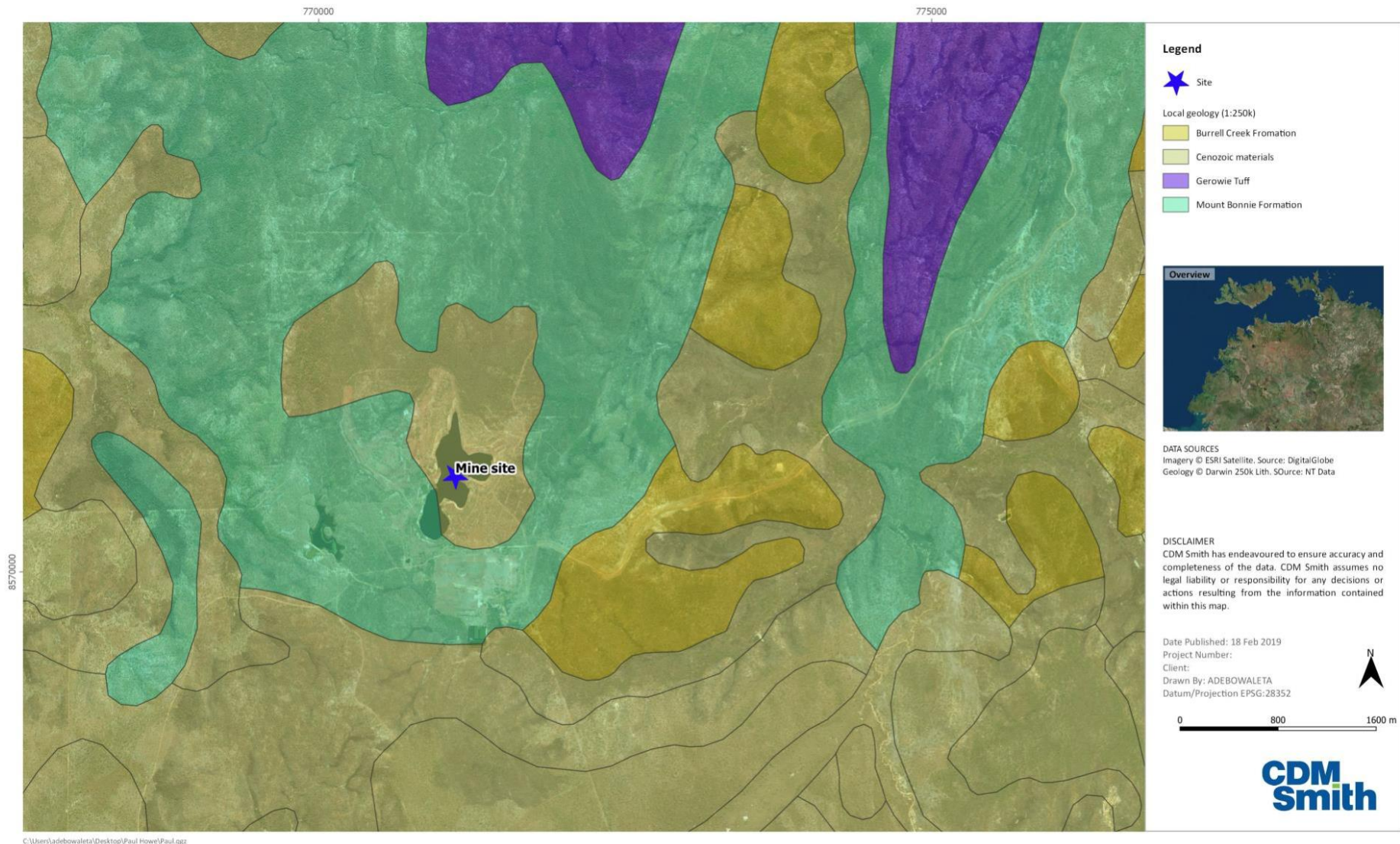


Figure 4-4 Surface Geology of Rustlers Roost Project Area.

The Rustlers Roost Gold Mine is predominantly underlain by folded greywacke and mudstone units. The greywacke units vary between 20 and 50 metres thick within individual beds and have upward fining sequences ranging from 0.5 to 10 metres. Individual beds are usually massive, weakly jointed, relatively soft and erode preferentially to form drainage features parallel to the bedding.

The mudstone units include varying amounts of chlorite, dolomitic carbonate, carbonaceous matter, chert, clastic quartz and accessory leucoxene. Chert nodules, surrounded by pyrite are common and occur preferentially in chlorite rich layers along with 1 - 10 mm thick pyrite rich zones. Disseminated pyrite euhedra up to 1mm diameter are common, often forming framboidal clusters. The oxidation of these sulphidic components gives rise to a pervasive haematisation within the oxidised zone.

Sediments are moderately folded about southwest plunging fold axes which have near vertical axial planes.

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).

4.2.3 Quest 29 Geology

Figure 4-5 shows the local geology of the Quest 29 portion of the Project area. The Quest 29 portion is underlain by shallow marine, iron rich and tuffaceous sediments of the South Alligator Group, which are open to tightly folded about gently south plunging axes.

The South Alligator Group includes the Koolpin Formation, Gerowie Tuff, Mount Bonnie Formation and the intrusive Zamu Dolerite. The Koolpin Formation consists of ferruginous siltstone and shale, with silicified hematite and chert breccias and minor silicified dolomite. The Gerowie Tuff consists predominantly of thinly interbedded fine grain sediments, glassy crystal tuffs and tuffaceous cherts. Both the Koolpin Formation and Gerowie Tuff show extensive attenuation at fold hinges. The Koolpin Formation and Zamu Dolerite occupy the majority of the Quest 29 portion of the Project area (Primary Gold, October 2020). Regionally, the Koolpin formation averages 100 m in thickness but ranges up to 200 m in fold hinges. The Koolpin formation is intruded in areas by the Zamu dolerite (massive quartz dolerite).

Two main auriferous trends have been identified along approximately north-south oriented shear structures. The main prospects occur on shear zones within the Koolpin Formation and Zamu Dolerite. Gold mineralisation at Quest 29 is related to a structurally prepared environment.

In the Koolpin Formation the gold is hosted by weakly sulphidic (pyrite-arsenopyrite) carbonaceous siltstone sequences with minor quantities of thin quartz veining. The dominant mineralised shear direction is 350°-020° (i.e. parallel to fold axes) dipping 20°-40° west.

In the Zamu Dolerite the gold is hosted by sulphidic (pyrite-arsenopyrite) shears within the dolerite and along the western contact between the dolerite and host sediments. The dominant mineralised shear direction is 350°-020° (i.e. parallel to fold axes) dipping 30°-50° west within the dolerite and steeply east along the eastern contact.

On the limbs of the anticline along the south-eastern and western edges of the lease exposures of Gerowie Tuff occur, comprising silicified siltstone, argillite, crystal tuff and chert with an average thickness of 600 m. In the north of the Quest 29 portion, the anticline is truncated by the Mount Bundy Granite which outcrops in an extensive batholith. North-east of the lease the contact between the meta-sediments and the granite is truncated by major fault with an offset of 100 m. There are no other major faults mapped on the mining lease.

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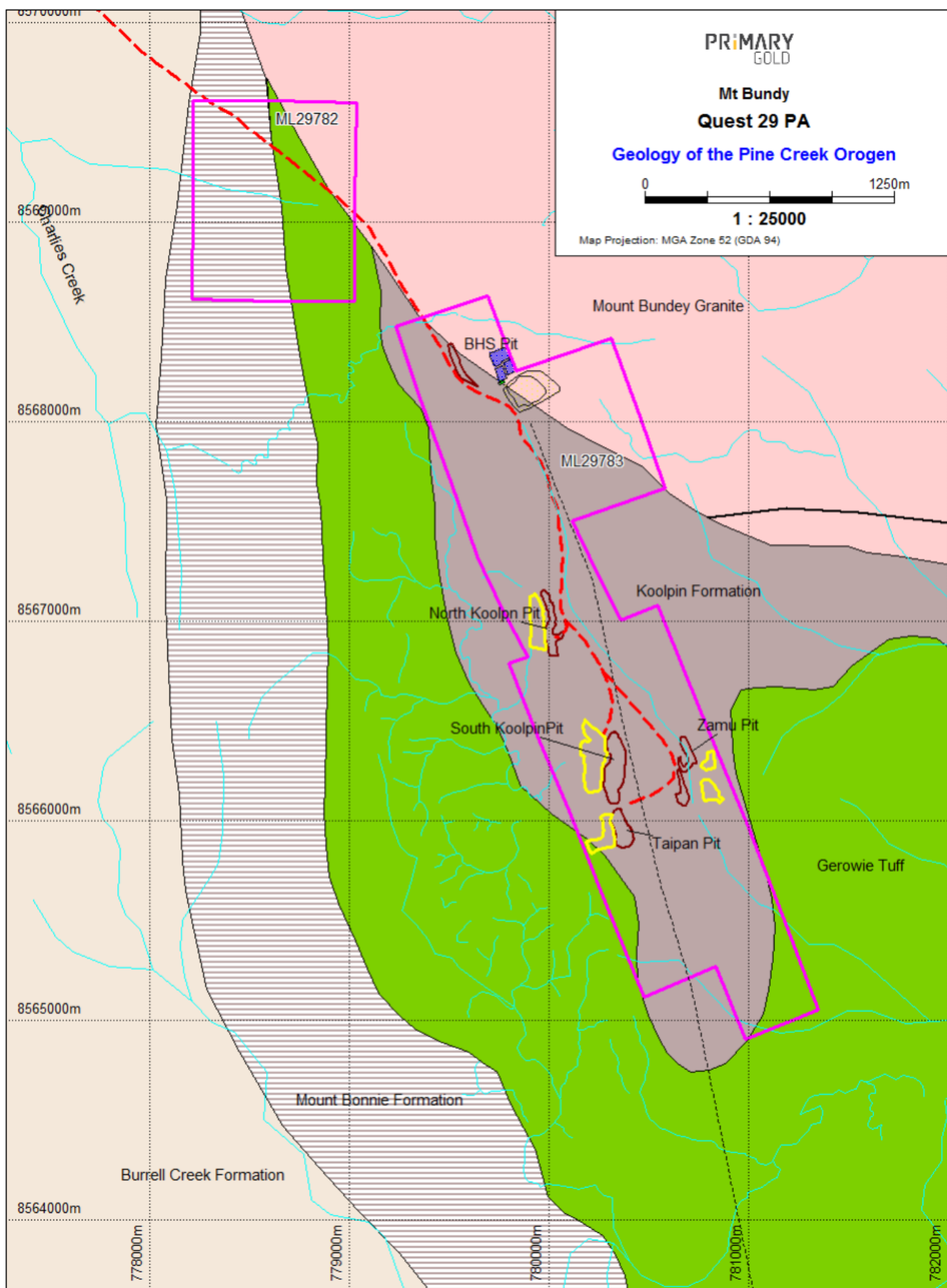


Figure 4-5 Surface Geology of Quest 29 Project Area

4.3 Beneficial Water Use and Environmental Values

4.3.1 Beneficial Water 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 ten 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. There is no BUD over the Adelaide River catchment to the east of the river, including Marrakai Creek and its tributaries. However, the Darwin Rural Water Control District includes the Adelaide River catchment to the west of the river and with defined beneficial uses for all surface water and groundwater being agriculture, aquaculture, public water supply, environment, cultural, industry, rural stock and domestic, mining and petroleum activities. The objectives that apply are specified in the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZG 2018). This BUD was gazetted on 13 February 2002 (Gazette G6). The Mary River Surface Water BUD transects the Rustlers Roost portion of the Project area and includes the historical mine area but not Annie's Dam (which forms part of the Adelaide River catchment).

There is also a BUD for the Mount Bunday Creek surface water which begins at the Arnhem Highway crossing of Mount Bunday Creek (approximately 16.5 km downstream of the Project area) and extends to just below the confluence with Coulter Creek. Beneficial uses are stock water supply for the defined part of the waterway and aquatic ecosystem protection for the remainder. This BUD was gazetted on 11 June 1997 (Gazette G23). The nearest location to the Project area is an aquatic ecosystem protection zone.

No BUD declarations are in place for McKinley River downstream of the Quest 29 portion of the Project (a declaration occurs on McKinley River upstream); however, the section of McKinley River between the Project area and Mary River is within the Mary River surface water BUD.

A BUD for the Mary River catchment groundwater has also been set with defined beneficial uses being environmental, riparian and agricultural.

Based on the BUD declarations for areas downstream of the Project, beneficial uses for the receiving environment include:

- Agricultural and stock water supply;
- Environmental and riparian; and
- Cultural.

These uses within the Project area, surrounds and downstream environment are discussed further below.

4.3.1.1 Agricultural and Stock Water Supply

The aim of the BUD is to maintain the productivity of the land and the water resource to ensure agricultural and stock water supply in accordance with the principle of ecologically and economically sustainable development.

Historically the Rustlers Roost and Quest 29 Project area has been used for pastoral activities like grazing of native vegetation by cattle as the mining leases are located on Old Mount Bunday Station and McKinlay River Pastoral Station.

Primary Gold currently holds an access agreement with the existing leaseholder of Old Mount Bunday Station. A separate agreement with the leaseholder of McKinlay River Station will be finalised prior to Project construction and is expected to align with the existing agreement. The agreements require that PGO, consistent with operational requirements and approval conditions, take reasonable measures to limit interference with surface and groundwater resources, to maintain water quality suitability for stock water supply in accordance with ANZG (2018) stock drinking water guidelines.

The predominant agricultural land use in the region includes pastoral stations and orchards, with the most extensive land use in the vicinity of the Project area being pastoral, involving low intensity grazing of beef cattle over the woodland terrain. Grazing is also widespread in neighbouring areas including Adelaide River, Jabiru, Pine Creek and further afield in the greater Darwin and Katherine regions. Smaller agricultural activities like orchards and aquaculture have been identified within the BUD areas.

4.3.1.2 Environmental and Riparian

Identified environmental values such as the wetland and permanent water bodies found in the Mary Floodplain related to surface water BUD and riparian vegetation associated with groundwater dependent ecosystems for groundwater are dependent on good water quality and reliable stream flows. The surface water in the lower Mount Bunday creek as a tributary to the larger Mary River Floodplain system is connected to the Project area and is of significance for the health of the aquatic ecosystems downstream of the Project area. Baseline and regular water monitoring will be undertaken to support the aquatic and riparian ecosystems of the Mary River Floodplain to confirm that water quality is in accordance with ANZG (2018) 95% species protection guidelines and Project related site specific trigger values (SSTV).

4.3.1.3 Cultural

The BUD also recognises that water resources have important cultural and spiritual values, particularly for indigenous peoples. While there were no recorded or registered sacred sites identified during an AAPA Certificates search, culturally significant areas relevant to the BUD and downstream of the Project area have been identified in the EIS.

Other cultural use may include recreational activities. For example, the Mary River floodplain is a major tourist and recreational fishing attraction for the region. Recreational fishing locations downstream within the Mary River system includes Hardies Creek (approximately 10 km downstream from the Arnhem Highway crossing), Corroboree Billabong (approximately 20 km downstream) and Shady Camp (approximately 60 km downstream). In addition, the Adelaide River floodplain is also a major tourist attraction for recreational fishing in the region.

While there is no specific guidance for protection of these values in the ANZG (2018) guidelines, consideration must be given to cultural issues in the planning and management of water resources. For example, to maintain water quality that supports cultural values the specific water quality objectives for the relevant environmental values are applied (e.g. ANZG (2018) 95% species protection) in the Project WMP.

4.3.2 Groundwater Environmental Values

Groundwater Dependent Ecosystems

Whilst regional groundwater systems provide water sources for pastoral and other anthropogenic uses, groundwater also supports surface (above ground) and subsurface (below ground) ecosystems that are likely to include habitat for threatened species. The Australian GDE toolbox (Richardson *et al.*, 2011) provides a framework to assist with the identification of GDEs and the management of their water requirements. The toolbox adopts the approach of Eamus *et al.*, (2006) and classifies GDEs based on the role groundwater plays in maintaining biodiversity and ecological condition.

Three types of GDEs are defined by the GDE toolbox:

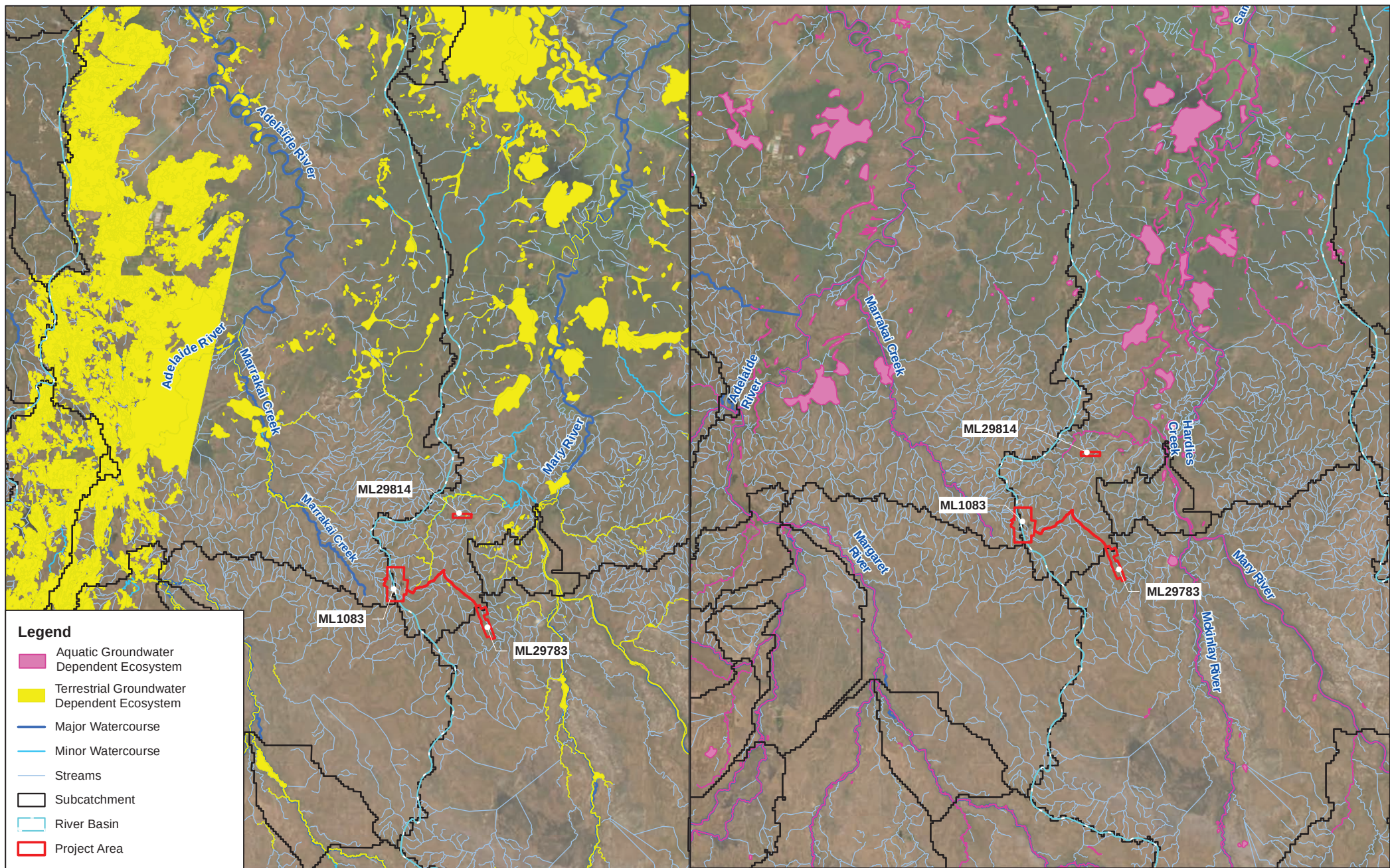
- Subterranean ecosystems dependent on water held in aquifers (e.g. stygofauna) or inundated caves (Type 1 GDEs). These ecosystems typically include karst aquifer systems and fractured rock groundwater environments;
- Ecosystems dependent on the surface expression of groundwater (Type 2 GDEs), including wetlands, lakes, seeps, springs, and river baseflow systems. In these cases, surface expression of groundwater exists, providing water that can support aquatic biodiversity through access to habitat (especially when surface run-off is low or non-existent) and regulation of water chemistry and temperature; and
- Ecosystems dependent on subsurface presence of groundwater (Type 3 GDEs), including terrestrial and riparian vegetation that depends on groundwater either seasonally, episodically or permanently to prevent water stress and avoid adverse impacts to their condition. Groundwater that Type 3 GDEs depend on is not visible from the surface. Type 3 GDEs can exist wherever the water table and capillary fringe is within the root zone of the plants, either permanently or episodically. The capillary fringe is the semi-saturated zone of soil above the water table.

For the Northern Territory, the National Atlas of GDEs (GDE Atlas) presents the best current knowledge of ecosystems that may depend on groundwater at a broadscale level. At the beginning of 2017, the GDE Atlas was updated with the latest information pertaining to GDEs and therefore the GDE Atlas can be considered as the primary data source.

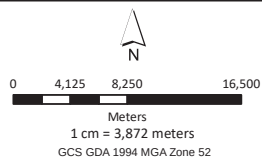
There are no mapped Type 1 GDEs within either the Project area (including the general region) or downstream (the Northern Territory has not been mapped for type 1). In addition, there are no type 2 GDEs mapped within the Project area; however, the lower reaches of Mount Bunday Creek, the McKinley River and lower reaches of Marrakai Creek are mapped as having a high potential for aquatic GDEs.

The GDE Atlas maps Type 2 GDEs (i.e. surface expressions) as potentially occurring consistently along the entire length of the downstream receiving watercourses including the Adelaide River and Mary River (Figure 4-6). Similarly, Type 3 terrestrial GDEs are mapped as potentially occurring along large portions of the downstream area, but at a much broader scale (i.e. greater width along the riparian corridor). However, Type 3 GDE mapping extends further upstream in both Marrakai Creek and Mount Bunday Creek, in proximity to the haul road. Potential GDE mapping covers areas mapped as potential habitat for threatened species. It is likely that swathes of the mapped downstream habitat access water through either surface expression of groundwater (Type 2) or subsurface groundwater (Type 3).

Further studies have been completed in relation to GDEs and are presented in Appendix P of this SEIS.



R	Details	Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.			
1	First Draft	20/08/21	DESIGNED	SS	CHECKED	TK
-	-	-	DRAWN	SS	CHECKED	TK
-	-	-	APPROVED	TK	DATE	20/08/21
-	-	-	Notes:			



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.

DATA SOURCE
NT Government Open Source Data

DESIGNER

CDM Smith

CLIENT

PRIMARY GOLD

FIGURE 4-6

Groundwater Dependent Ecosystem Mapping

DRG Ref: 1001087-EIS-07-7.26

Aquatic Vegetation

Aquatic habitat values that provide for aquatic plants in the Project area are limited by the ephemeral nature of flows in the higher order watercourses that drain the sites and the lack of natural permanent water bodies. No submerged aquatic plants were identified during the surveys. This underpins the highly ephemeral nature of the creeks and drainage lines (AES 2019). However, images from site inspections indicate the presence of aquatic vegetation at numerous locations related with previous mining and pastoral activities within the Project area (Annie's Dam, Rustlers Roost and Quest 29 pit lakes and leach ponds). These waterbodies, however, will be predominantly consumed by new and extended mining infrastructure.

4.3.3 Groundwater Environmental Values and Water Quality Objectives

In accordance with the surface water and groundwater beneficial use declarations, water quality objectives and indicators need to be considered within the Project area to protect the following beneficial uses/environmental values:

- Water use for agricultural purposes – irrigation water for primary production;
- Water use for farming purposes – livestock water supply;
- Health of aquatic ecosystems; and
- Cultural and spiritual environmental values.

The objectives of the National Water Quality Management Strategy (NWQMS) (Australian Government, 2018) is to enable effective water quality management for the delivery of fit-for-purpose water that supports community values. The NWQMS provides information that is applicable to all types of water in Australia, including fresh water, marine water, groundwater, estuarine water and recycled water; and that will support different purposes of the water, such as for drinking, the environment, primary industry, recreation, industry and cultural and spiritual values. The NWQMS provides a national framework for assessing and managing water quality issues and robust guidelines based upon best available science.

As per the NWQMS (Australian Government, 2018), water quality objectives are the locally specific guideline values for relevant indicators that will protect all the community values and management goals. These objectives can be numerical guideline values, a narrative statement and/or targets to be achieved over time. The guideline values are usually based on scientific or expert advice about what water quality is required to protect each community value or management goal.

Based on the identified beneficial uses, the following default guideline values have been adopted:

- The toxicant Default Guideline Values (DGVs) for the protection of freshwater ecosystems protection, as per the 2018 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018). DGVs have been developed for three categories of current or desired ecosystem conditions, i.e:
 - High conservation or ecological value systems. Where local biological or chemical data have not yet been gathered, the 99% species protection default guideline values (DGVs) apply, if they exist
 - slightly to moderately disturbed systems. For toxicants in water, apply 95% species protection DGVs, or 99% species protection for highly bioaccumulating toxicants, if local biological-effects data are unavailable
 - highly disturbed systems. For toxicants in water, the 90% or 80% species protection DGVs are considered acceptable.

It must be noted that the Mount Bunday catchment is classified as “tropical lowland rivers and streams” and is considered a highly disturbed ecosystem.

- The livestock (beef cattle) drinking water trigger values, as per the ANZECC 2000 Water Quality Guidelines (ANZECC/ARMCANZ, 2000); and

4 Description of Environmental Values

- The short- and long-term trigger values in irrigation water, as per the ANZECC 2000 Water Quality Guidelines (ANZECC/ARMCANZ, 2000).

As per the ANZG 2018 Water Quality Guidelines, ideally site-specific guideline values that are relevant to local conditions or situations should be used instead of default guideline values. Site-specific guideline values have not yet been developed for the Project area. However, in 2015 site-specific trigger levels (SSTVs) were developed for discharge of treated water into the Mount Bundy Creek from the Toms Gully Project Area, which is located about 10kms to the north of the Project area. In 2018, the CSIRO undertook a review of these SSTVs (Stauber & Batley, 2018) and proposed revised wet-season SSTV for the discharge point or compliance site at Toms Gully Mine (SWTG2) after dilution.

The guideline/trigger values adopted for the Project are presented in Table 4-4.

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Table 4-4 Water Quality Guidelines/Trigger Values for the Project

Parameter	Units	SSTV ^(a)	Tropical Australia Lowland Rivers ^(b)	Freshwater Aquatic Ecosystem 95% Protection Level 95%	Livestock Watering (Beef cattle)	Irrigation	
						Long Term	Short Term
Physico-chemical							
pH	-	5.8 – 8.0	6.0 – 8.0	-	-	-	-
Electrical Conductivity	µS/cm	41	20 - 250	-	-	-	-
Dissolved Oxygen	% sat	-	85 - 120	-	-	-	-
Total Dissolved Solids	mg/L	-	-	-	4,000	-	-
Total Suspended Solids	mg/L	54	-	-	-	-	-
Turbidity	NTU	87	2 - 15	-	-	-	-
Metals/metalloids							
Aluminium (pH <6.5)	mg/L	-	-	-	5	5	20
Aluminium (pH >6.5)	mg/L	0.295	-	0.055	5	5	20
Arsenic (As III)	mg/L	0.042	-	0.024	0.5	0.1	2.0
Arsenic (As VI)	mg/L		-	0.013	0.5	0.1	2.0
Cadmium	mg/L	0.0004	-	0.0002	0.01	0.01	0.05
Chromium (Cr III)	mg/L	0.006	-	-	1	0.1	1
Chromium (Cr VI)	mg/L		-	0.001	1	0.1	1
Cobalt	mg/L	-	-	-	1	0.05	0.1
Copper	mg/L	0.0018	-	0.0014	2	0.2	5
Iron	mg/L	2.7	-	-	-	0.2	10
Lead	mg/L	0.0056	-	0.0034	0.1	2	5
Manganese	mg/L	2.5	-	1.9	-	0.2	10
Nickel	mg/L	0.013	-	0.011	1	0.2	2
Selenium (total)	mg/L	-	-	0.011	0.02	0.02	0.05
Uranium	mg/L	-	-	-	0.2	0.01	0.1
Zinc	mg/L	0.015	-	0.008	20	2	5
Major Ions							
Calcium	mg/L	-	-	-	1,000	-	-
Magnesium	mg/L	-	-	-	2,000	-	-
Sulfate as SO4	mg/L	210	-	-	1,000	-	-
Nutrients							
Ammonia	mg/L	1.4	0.01	0.9	-	-	-
Nitrate	mg/L	-	-	-	400	-	-
Nitrite	mg/L	-	-	-	30	-	-
Nitrite + Nitrate as N	mg/L	-	0.01	-	-	-	-
Total Nitrogen as N	mg/L	-	0.2 – 0.3	-	-	5	25 - 125
Total Phosphorus as P	mg/L	-	0.01	-	-	0.05	0.8 - 12

^(a): Toms Gully Project SSTVs (Stauber & Batley, 2018)

^(b): As per Table 3.3.4 and Table 3.3.5 in ANZECC & ARMCANZ 2000 Water Quality Guidelines for lowland rivers.

4.4 Hydrogeology

4.4.1 Introduction

The description of the hydrogeology of the Project area is based on the following information sources:

- Publicly available data and information;
- Historical investigations undertaken by Environmental and Earth Sciences in 1993 (Environmental and Earth Sciences Pty Ltd, January 1993) at the Rustlers Roost portion of the Project area. These investigations comprised:
 - Measurements of standing water levels in existing exploration bores to establish regional groundwater flow direction
 - Aquifer pumping tests within one cased production bore (RN024143), to determine basic hydraulic aquifer parameters in the southern section of the “Backhoe” prospect
 - Groundwater sampling and analysis from exploration bores in the vicinity of the four proposed pits (Backhoe, Beef Bucket, Dolly Pot and Sweat Ridge) and from two background locations within the mining lease.
- Drilling logs, lithological logs and well construction details of registered bores, including bores installed at the Project area in September/October 2020;
- Groundwater monitoring and sampling undertaken by Primary Gold between 2016 and 2019; and
- Groundwater, surface water and open pit monitoring and sampling undertaken by EcOz in 2020-2021.

Location and well construction details of the monitoring wells at the Rustlers Roost portion of the Project area that were monitored/sampled during the above-listed investigations are provided in Table 4-5 and Table 4-6, respectively. Locations are provided on Figure 4-7.

Location and well construction details of the monitoring wells at the Quest 29 portion of the Project area that were monitored/sampled during the above-listed investigations are provided in Table 4-7 and Table 4-8, respectively. Locations are provided on Figure 4-8.

4 Description of Environmental Values

Table 4-5 Details of Historical and Current Groundwater Bores at Rustlers Roost Portion of Project Area

Monitoring Bore ID	Registered Bore Number	PGO Bore ID/ Old Name	Date Drilled	Z52 MGA EASTING	Z52 MGA NORTHING	Top of Casing (mAHD)	Ground level (mAHD)	Bore Depth (mbgl)
RRMB07	RN040084	RMB1	Sep-2020	771121.17	8571662.04	83.12	81.71	68
RRMB08	RN040085	RMB2	Sep-2020	770482.58	8572233.43	78.11	76.77	69.5
RRMB04	RN040086	RMB3	Sep-2020	769630.14	8570176.53	57.43	56.05	69.5
RRMB03	RN040087	RMB4	Sep-2020	770468.34	8569051.5	67.79	66.29	69.5
RRMB05	RN040088	RMB5	Sep-2020	770806.25	8570746.62	73.05	71.67	69.5
RRMB06	RN040089	RMB6	Oct-2020	771554.23	8570825.74	81.17	79.75	69.5
RRMB02	RN041890	RMB7	Oct-2020	771419.83	8569482.53	56.19	54.88	39
RRMB01	-	MB01/GW01	-	771334	8569626	-	-	-
-	RN024143	HALL B MT BUNDEY	Sep-1985	771680	8570061	-	-	61
-	RN029335	HENRY & WALKER CAMP 1	Apr-1994	772230	8569961	-	-	76
-	RN029345	RUSTLERS MINE NO2 MT. BUNDEY	Apr-1994	771680	8570511	-	-	71.5
-	RN029414	VALDORA MINING RUSTLERS ROOST 003 - MT. BUNDY	Aug-1994	771530	8570361	-	-	78
-	RN029415	VALDORA MINING RUSTLER'S ROOST 004 - MT. BUNDEY	Jul-1994	771730	8570261	-	-	74
-	RN029416	VALDORA MINING RUSTLER'S ROOST 005-MOUNT. BUNDEY	Aug-1994	771730	8570761	-	-	86
-	RN029417	VALDORA MINING RUSTLER'S ROOST 006 - MT. BUNDEY	Aug-1994	771830	8570061	-	-	83

4 Description of Environmental Values

Table 4-6 Well Construction Details of Groundwater Bores at Rustlers Roost Portion of Project Area

Monitoring Bore ID	Registered Bore Number	Date Drilled	Bore Depth (mbgl)	Water Bearing Beds (mbgl)	Screened Depth (mbgl)	Screened Lithology
RRMB07	RN040084	Sep-2020	68	57 – 58/64 - 65	56 - 65	Red-brown saprolite
RRMB08	RN040085	Sep-2020	69.5	55 – 56/60 - 64	60.5 – 66.5	Grey-brown saprolite
RRMB04	RN040086	Sep-2020	69.5	20 – 20.5/36 – 36.5/ 44 – 44.5/59 - 60	41 – 47	Grey-brown-black shale with some quartz
RRMB03	RN040087	Sep-2020	69.5	31 - 61	44 – 56	Brown-grey saprolite
RRMB05	RN040088	Sep-2020	69.5	46 - 69	54.5 – 66.5	Black shale
RRMB06	RN040089	Oct-2020	69.5	45 - 61	54.5 – 66.5	Black siltstone/shale
RRMB02	RN041890	Oct-2020	39	34 - 35	27 - 36	Brown-red saprolite with some quartz
RRMB01	??	-	-	-	-	-
-	RN024143	Sep-1985	61	3.6	49 - 61	Grey and black shales
-	RN029335	Apr-1994	76	60 - 64	64 - 76	Fresh grey shales
-	RN029345	Apr-1994	71.5	50.7 – 51/64 – 64.7	59.2 – 67.3	Fresh grey shales
-	RN029414	Aug-1994	78	?	?	Grey shales
-	RN029415	Jul-1994	74	34 - 42	59 - 61	Grey and brown shale
-	RN029416	Aug-1994	86	62 - 74	68 - 80	Fresh grey shale
-	RN029417	Aug-1994	83	63 - 78	59 - 80	Grey shale

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Table 4-7 Details of Historical and Current Groundwater Bores at Quest 29 Portion of Project Area

Monitoring Bore ID	Registered Bore Number	PGO Bore ID/ Old Name	Date Drilled	Z52 MGA EASTING	Z52 MGA NORTHING	Top of Casing (mAHD)	Ground level (mAHD)	Bore Depth (mbgl)
Q29MB01	RN32317	No 1	4/10/1999	779639.93	8568388.11			27
Q29MB02	?	-	-	779681.97	8568195.96	-	-	-
Q29MB03	RN41894	QMB3	25/10/2020	780710.69	8565612.63	50.36	48.92	54
Q29MB04	RN41895	QMB4	29/10/2020	780412.20	8566143.51	42.86	41.52	54
Q29MB05	RN41893	QMB2	23/10/2020	780525.43	8566473.66	46.68	45.55	54
Q29MB06	RN41896	QMB5/MB06	31/10/2020	779901.17	8566736.03	53.14	51.80	54
Q29MB07	RN41897	QMB6	4/11/2020	780100.99	8567019.96	57.28	55.88	54
Q29MB08	RN41898	QMB7	6/11/2020	780102.97	8568066.94	94.86	93.42	52.5
Q29MB09	RN41892	QMB1	8/10/2020	779410.88	8568472.57	68.04	66.66	54
-	RN008987	DDH QUEST 29/4 MT BUNDEY	22/12/1976	780130	8567361	-	-	153
-	RN008907	DDH QUEST 29/3 MT BUNDEY	3/09/1976	780480	8566811	-	-	22.5
-	RN008893	DDH QUEST 29/1 MT BUNDEY	23/07/1976	780630	8566311	-	-	17.8

4 Description of Environmental Values

Table 4-8 Well Construction Details of Groundwater Bores at Quest 29 Portion of Project Area

Monitoring Bore ID	Registered Bore Number	Date Drilled	Bore Depth (mbgl)	Water Bearing Beds (mbgl)	Screened Depth (mbgl)	Screened Lithology
Q29MB01	RN32317	4/10/1999	27	-	23 - 27	Fresh, broken, shattered dolerite
Q29MB02	?	-	-	-	-	-
Q29MB03	RN41894	25/10/2020	54	23 – 47	23.5 – 32.5 47.5 – 50.7	Shale and saprock
Q29MB04	RN41895	29/10/2020	54	37 – 38 40 – 44 50 - 52	40 – 52	Siltstone + dolerite + shale
Q29MB05	RN41893	23/10/2020	54	26 – 38	24 – 36	Shale
Q29MB06	RN41896	31/10/2020	54	18 – 19 24 – 25 33 – 37	19 – 25 31 – 37	Shale + dolerite + siltstone
Q29MB07	RN41897	4/11/2020	54	29 – 30 38 – 39 43 - 45	25 - 31	Sandstone
Q29MB08	RN41898	6/11/2020	52.5	49 – 49.5	45.5 – 51.5	Shale
Q29MB09	RN41892	8/10/2020	54	30 – 50	22 – 31	Siltstone
-	RN008987	22/12/1976	153	50	Not installed	Not installed
-	RN008907	3/09/1976	22.5	15?	11 - 17	Alluvium and weathered siltstone
-	RN008893	23/07/1976	17.8	15	10 - 17	Alluvium and granite wash

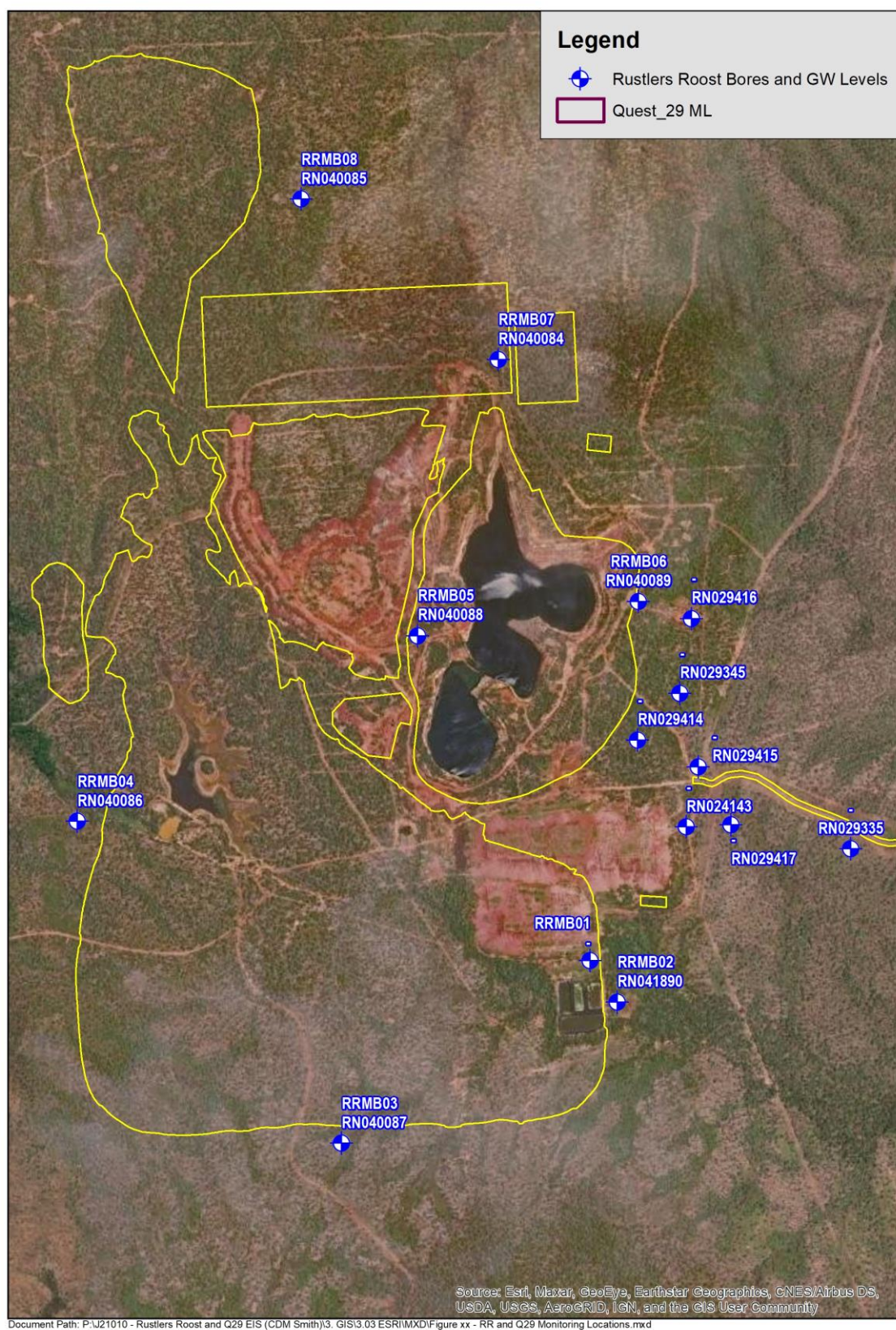


Figure 4-7 Location of Groundwater Monitoring Wells at Rustlers Roost

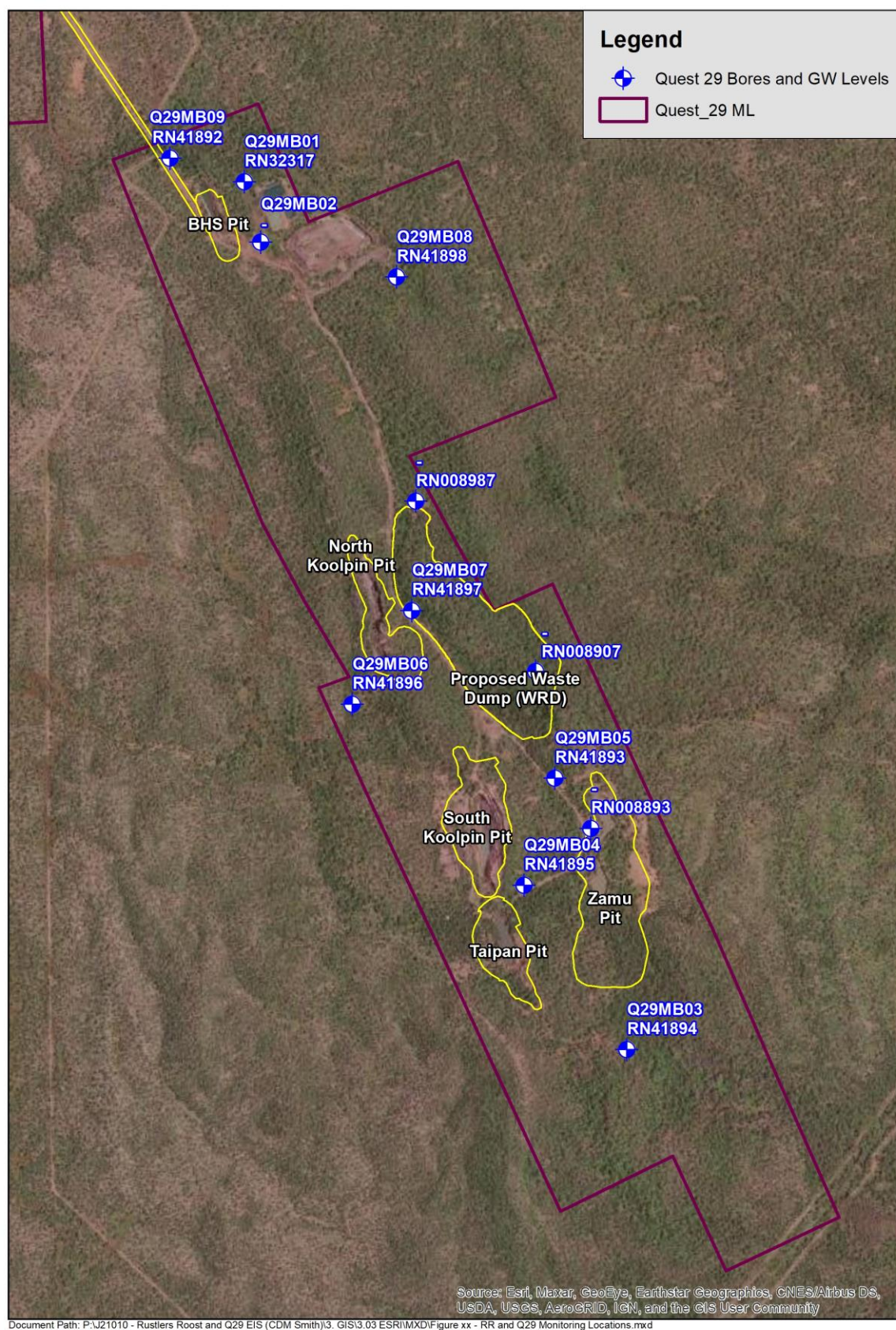


Figure 4-8 Location of Groundwater Monitoring Wells at Quest 29

4.4.2 Aquifer Systems

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2019). The Project 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.

At Rustlers Roost, 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 (Primary Gold, 2019).

At Quest 29, Groundwater Enterprises (2020) indicates that there is limited groundwater information available onsite or in the immediate vicinity of the lease. Regional scale mapping suggests aquifers across the lease are local scale systems in fractured and weathered rocks with expected bore yields of 1-3 L/s in the metasediments and <0.75 L/s in the Mt Bunday Granite (Tickell, 2019). Higher permeabilities are likely associated with structural deformation within the metasediments/dolerite (Sirocco, 1999) and at local scale.

4.4.3 Aquifer Hydraulic Properties

4.4.3.1 Rustlers Roost and Quest 29

The results of aquifer pumping test undertaken by EES at Rustlers Roost in 1993 (Environmental and Earth Sciences Pty Ltd, January 1993) in the vicinity of the Backhoe Prospect area can be summarised as follows:

- The 26-hour duration test comprised a constant discharge test with pumping at a rate of 1.76 litres/second from the then existing production bore (RN24143) and measured of standing water levels within the production bore and fifteen (15) surrounding, uncased exploration bores;
- During the test, the aquifer behaved in an infinite, isotropic, non-leaky artesian manner where no aquifer boundaries were intercepted. In practice, due to the aquifer's fracture nature, some long-term boundaries would be expected;
- Calculated transmissivity of the production bore was 93 m³/d/m. Assuming a saturated aquifer thickness of 30 to 80 m, calculated hydraulic conductivity would range from 1 to 3.3 m/day;
- Calculated storativity values range from 2x10⁻³ to 8x10⁻⁴; and
- Anisotropy of the groundwater flow was expected in the north/south direction which is parallel to the main strike of the surrounding lithologies. However, any anisotropy that may be present in this area was not noted, primarily as a result of the lack of observation wells monitored laterally.

Hydraulic testing has been undertaken by slug test in groundwater monitoring wells at Rustlers Roost and Quest 29 (Groundwater Enterprises 2021). Reported hydraulic conductivity at Rustlers Roost ranges from 0.8 — 12.5 m/day, with a geometric mean of 4.1 m/day. Reported hydraulic conductivity at Quest 29 ranges from 0.3 — 38.8 m/day with geometric mean of 5.2 m/day.

The Project monitoring bores were constructed across the highest yielding zone of the drilled sequence. The derived hydraulic conductivities are representative of the more permeable, heavily fractured intervals of the aquifer system. The screened interval of the tested Rustlers Roost bores ranged from 27 m to 67 m below ground level (mBGL) mainly within shale, siltstone and saprolite, and of the tested Quest 29 bores from 19 mBGL to 52 mBGL mainly within shale, dolerite, siltstone and sandstone.

4.4.3.2 Nearby Toms Gully Site

Pumping test for the nearby Toms Gully Mine revealed hydraulic conductivity estimation ranging from 0.1 to 1 m/d for the fractured and jointed siltstone basement (AGE 2019). The calibration of the Toms Gully groundwater model (AGE 2019) assumed value of hydraulic properties of 0.001 m/d for the bedrock and much higher hydraulic conductivity for the ore body (0.2 m/d to 20 m/d). The results of the tests suggest that the fractured rock aquifer has a high secondary permeability.

4.4.3.3 Summary

Table 4-9 summarises the hydraulic conductivity estimates from previous and current investigations, including studies related to the nearby Toms Gully Mine. The slug test estimates are relatively high, which may be influenced by the gravel pack surrounding the tested bores.

Table 4-9 Hydraulic Conductivity Estimates (m/d) from Previous Investigations

Location	Method	Formation	Geometric mean	Minimum	Maximum	Source
Rustlers Roost	Pump test	Not specified	1.2	0.8	1.8	Valdora (1994)
Rustlers Roost	Slug test	Not specified	4.1	0.8	12.5	Groundwater Enterprises (2021)
Quest 29	Slug test	Not specified	5.2	0.3	38.8	Groundwater Enterprises (2021)
Toms Gully	Pump test	Fractured and jointed Siltstone	0.5	0.1	1.0	AGE (2019)
Toms Gully	Pump test	Ore zone and Crabb Fault	323	220	915	AGE (2019)
Toms Gully	Model calibration	Wildman Siltstone	0.001	0.001	0.001	AGE (2019)
Toms Gully	Model calibration	Ore zone	NA	0.2	20	AGE (2019)
Toms Gully	Model calibration	Bedrock	0.001	0.001	0.001	AGE (2019)
Toms Gully	Model calibration	Bedrock	0.2	0.01	1.0	GHD (2018)

4.4.3.4 Additional Literature Review

A further literature review has been undertaken with the primary focus on increasing the knowledge base for hydraulic parameters for sites in similar geologic/hydrogeologic settings, especially the relationship between hydraulic conductivity and depth. In groundwater modelling of fractured rock aquifers it is important to conceptualise the bulk hydraulic parameters of a rock (i.e. large scale hydraulic parameters).

At RR and Q29 there has been limited testing to inform bulk hydraulic conductivity. Slug tests have been completed in all new monitoring wells, however, some wells indicate an underdamped response which is highly unlikely to represent bulk hydraulic conductivity and more likely to represent one or more fractures close to the wells.

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Groundwater Enterprises (2021) state that the monitoring bores were constructed across the highest yielding zone of the drilled sequence and therefore the derived hydraulic conductivities are representative of the more permeable, heavily fractured intervals of the aquifer system.

For fractured rock systems longer term hydraulic testing is generally required to understand the bulk hydraulic parameters, as fracture zones may have limited connectivity over the larger scale. The pumping test at Rustler Roost was conducted for 26 hours and provides some indication of the broader hydraulic conductivity. Based on test outcomes and assuming an aquifer thickness of 80 m, the hydraulic conductivity is reported at 1.2 m/day. Other mines within the Pine Creek Orogeny geology with published hydraulic tests include:

- Pumping test at Tom's Gully, a nearby site with similar geology, indicates a hydraulic conductivity of 0.1 to 1 m/day for a fractured siltstone (AGE, 2019);
- Airlift recovery tests (1 to 3 hours long) at Fountain Head mine site area (50 km south) indicate hydraulic conductivity of 0.2 to 3 m/day (CDM Smith, 2021);
- Pumping tests at Spring Hill (65 km south) of 1 to 4 hours at two production wells indicate a hydraulic conductivity of a heavily fractured shale of 3 to 5 m/day (although if the full saturated thickness of the aquifer is used in the calculation this would be 1 to 2.5 m/day) (Northern Resource Consultants, 2017); and
- Analysis of observed open pit groundwater inflows at Union Reefs Mine (70 km south) indicated hydraulic conductivity for the shallow aquifer of 0.3 m/day. This study also estimated a change in hydraulic conductivity with depth and modelled a two layer system in the one fractured aquifer (discussed further below) (GHD, 2019).

These field tests values are more likely to represent bulk hydraulic conductivity than the slug tests which only test a very small (<10s of centimetres) volume of aquifer close to the well. Calibrated groundwater models are another good source of bulk hydraulic conductivity values as these represent regional scale systems. As shown in Table 4-9, the Tom's Gully numerical model estimated hydraulic conductivity of the bedrock to be between 0.001 and 1 m/day (GHD, 2018; AGE, 2019).

It is generally accepted that in fractured rock the bulk hydraulic conductivity will decrease with increasing depths. This is mostly due to the closure of fractures and other rock defects as depth (and therefore overburden pressure) increases. Three international examples of this phenomenon are:

- Nastev et al (2004) carried out various aquifer tests across a groundwater flow system (limestone, dolostone, sandstone and crystalline rocks) in south west Quebec, Canada. The results indicate that the groundwater flow at a local scale is controlled by the fracture system and a decreasing trend of hydraulic conductivity with depth. The geometric mean of hydraulic conductivity decreased by two orders of magnitude over 80 m, although there was significant variation across all depths. Hydraulic conductivity was closely related to the frequency of fractures;
- DeRoches et al. (2014) conducted a hydrogeological study (including discrete interval constant head tests and packer testing) in New Brunswick, Canada, to improve the predictability of fracture-dominated groundwater flow in folded bedrock (fine grained). The study indicates that within individual boreholes, hydraulic conductivity decreased by about two orders of magnitude across a depth from 10 m (water table) to 70 m and a further two orders of magnitude from 70 m to 100 m. Hydraulic conductivity varied associated with changes in frequency and aperture widths of open fractures; and
- Chen et al (2018) completed a study to characterise hydraulic conductivity distribution for groundwater modelling in southwest China in basalt, crystalline rocks and metamorphic rocks including slate. It was deduced that the decreasing degree of weathering and unloading from ground surface to unaltered fresh rocks leads to reduction in the geometric mean of hydraulic conductivity by about 1–2 orders of magnitude over 600 m. Crystalline rocks showed a much more pronounced effect (3 orders of magnitude) reflecting the structural nature of these rocks.

The Union Reefs Mine (GHD, 2019) located 70 km south of Rustlers Roost analysed water level change in a historical pit along with inflow estimates in the Burrell Creek Formation. Although the pit was advanced into a single aquifer unit, the calibrated analytical model was represented as a two-layer system based on a previous study at the site which indicated a significant decrease in permeability with depth.

The analytical modelling set a transition depth of 30 m based on the site-specific information and varied the hydraulic conductivity of each layer. The calibration indicated a shallow hydraulic conductivity of 0.3 m/d and a deep (>30 m) hydraulic conductivity of 0.005 m/d reproduced the inflows and water levels observed at the site.

The Rustlers Roost pit is expected to be excavated to 187 m depth, and it is likely that a reduction in hydraulic conductivity would be seen through this horizon. At Rustlers Roost there are no specific studies that identify a decrease in hydraulic conductivity with depth, with only one longer term test completed (26 hour pumping test). The pumped interval of this test is 49 to 61 m depth which suggests that a transition zone at Rustlers Roost may be deeper than that seen at Union Reefs. As such a decrease in hydraulic conductivity of at least one order of magnitude would be expected across the depth of the Rustlers Roost pit.

4.4.4 Groundwater Levels and Flow Direction

4.4.4.1 Rustlers Roost Historical Investigations

Standing groundwater levels measured during the EES 1993 hydrogeological study (Environmental and Earth Sciences Pty Ltd, January 1993) were approximately 25 to 30 metres below ground level.

The groundwater gradient was flat, sloping gradually at 0.2 to 0.3% toward the Mary River (approximately 20 km) in the east. The groundwater level fell approximately 1.7m over 900m from west to east, (i.e. 0.2%) and 0.7 metres over 900 m from the north to the south. The measured depths indicated that the level fell 2.3m over 600m from south of the lateritic plateau (0.3%) to the north.

During the EES 1993 hydrogeological study, no wet and dry seasonal groundwater level variations had been measured within the mining lease. However, Power and Water Authority records indicated that the late wet season levels were approximately 6 to 8 metres higher than at the end of the dry season.

Groundwater monitoring undertaken by Valdora staff during November 1992 indicated water levels in the range of 0.5 to 0.9 m lower than in November 1993. This most likely reflected a drier than normal wet season, as well as different monitoring methods and annual rainfall variations.

4.4.4.2 Rustlers Roost 2020-2021 Groundwater Levels

Depth to groundwater measurements by EcOz during the 2020-2022 groundwater monitoring program are presented in Table 4-10, with corresponding reduced standing groundwater levels (relative to mAHD) presented in Table 4-11 and on Figure 4-9. An automatic level logger was installed in the Rustlers Roost pit lake and this data has been converted to elevation using survey levels provided by the client. The pit lake elevation is shown in Figure 4-9.

Groundwater levels generally rise during and immediately following the wet season, in response to increased rainfall and direct rainfall recharge to the aquifers. The response to the rainfall recharge is similar for all monitored bores. At the end of the wet season the groundwater levels fall. The pit water levels respond to rainfall events and are generally similar to the surrounding groundwater levels. After a rainfall even the pit levels appear to increase above the surrounding water levels.

The average groundwater levels vary by season and the lowest and highest observed groundwater levels are presented in Table 4-12.

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Table 4-10 Rustlers Roost Depth to Groundwater (mbTOC) 2020-2021

EcOz Bore ID	PGO ID	2020					2021					2022			
		09	10	11	12	01	02	03	04(16 th)	04(29 th)	05	07	09	12	03
RRMB01	MB01/GW01	4.06	4.29	4.65	2.5	2.21	2.27	2.18	2.24	2.3	-	2.58	3.3	2.59	2.18
RRMB02	RMB7	-	-	4.5	4.56	3.59	2.83	1.4	0.78	0.91	-	1.91	3.32	4.08	-
RRMB03	RMB4	-	-	14.99	15.18	14.42	13.37	11.33	10.31	-	10.57	11.68	13.01	14.05	11.16
RRMB04	RMB3	-	-	7.84	7.98	6.93	5.77	4.3	3.65	-	3.92	4.95	3.3	7.29	4.56
RRMB05	RMB5	-	-	16.08	16.19	15.43	15.16	12.42	11.98	12.16	-	12.97	-	15.94	16.38
RRMB06	RMB6	-	-	24.43	24.52	23.88	23.7	20.98	20.44	-	20.62	20.4	22.17	23.36	24.84
RRMB07	RMB1	-	-	26.51	26.65	26.11	25.82	23.02	22.22	-	22.37	23.23	23.93	25.23	26.27
RRMB08	RMB2	-	-	27.28	27.49	27.53	26.84	24.75	22.34	-	21.97	22.71	24	26.19	22.95

mbTOC: metres below top of casing

Table 4-11 Rustlers Roost Reduced Standing Groundwater Level (mAHD) 2020-2021

EcOz Bore ID	PGO ID	2020					2021					2022			
		09	10	11	12	01	02	03	04(16 th)	04(29 th)	05	07	09	12	03
RRMB02	RMB7	-	-	51.693	51.633	52.603	53.363	54.793	55.413	55.283	-	54.283	52.87	52.11	-
RRMB03	RMB4	-	-	52.803	52.613	53.373	54.423	56.463	57.483	-	57.223	56.113	54.78	53.74	56.63
RRMB04	RMB3	-	-	49.585	49.445	50.495	51.655	53.125	53.775	-	53.505	52.475	54.13	50.14	52.87
RRMB05	RMB5	-	-	56.971	56.861	57.621	57.891	60.631	61.071	60.891	-	60.081	-	57.11	56.67
RRMB06	RMB6	-	-	56.742	56.652	57.292	57.472	60.192	60.732	-	60.552	60.772	59.0	57.81	56.33
RRMB07	RMB1	-	-	56.613	56.473	57.013	57.303	60.103	60.903	-	60.753	59.893	59.19	57.89	56.85
RRMB08	RMB2	-	-	50.831	50.621	50.581	51.271	53.361	55.771	-	56.141	55.401	54.11	51.92	55.16

mAHD: metres Australian Height Datum

Note: Reduced standing groundwater levels relative to mAHD could not be calculated for bore RRMB01, as no survey data is available for this bore. Lidar elevation has been used to show the bore hydrograph.

4 Description of Environmental Values

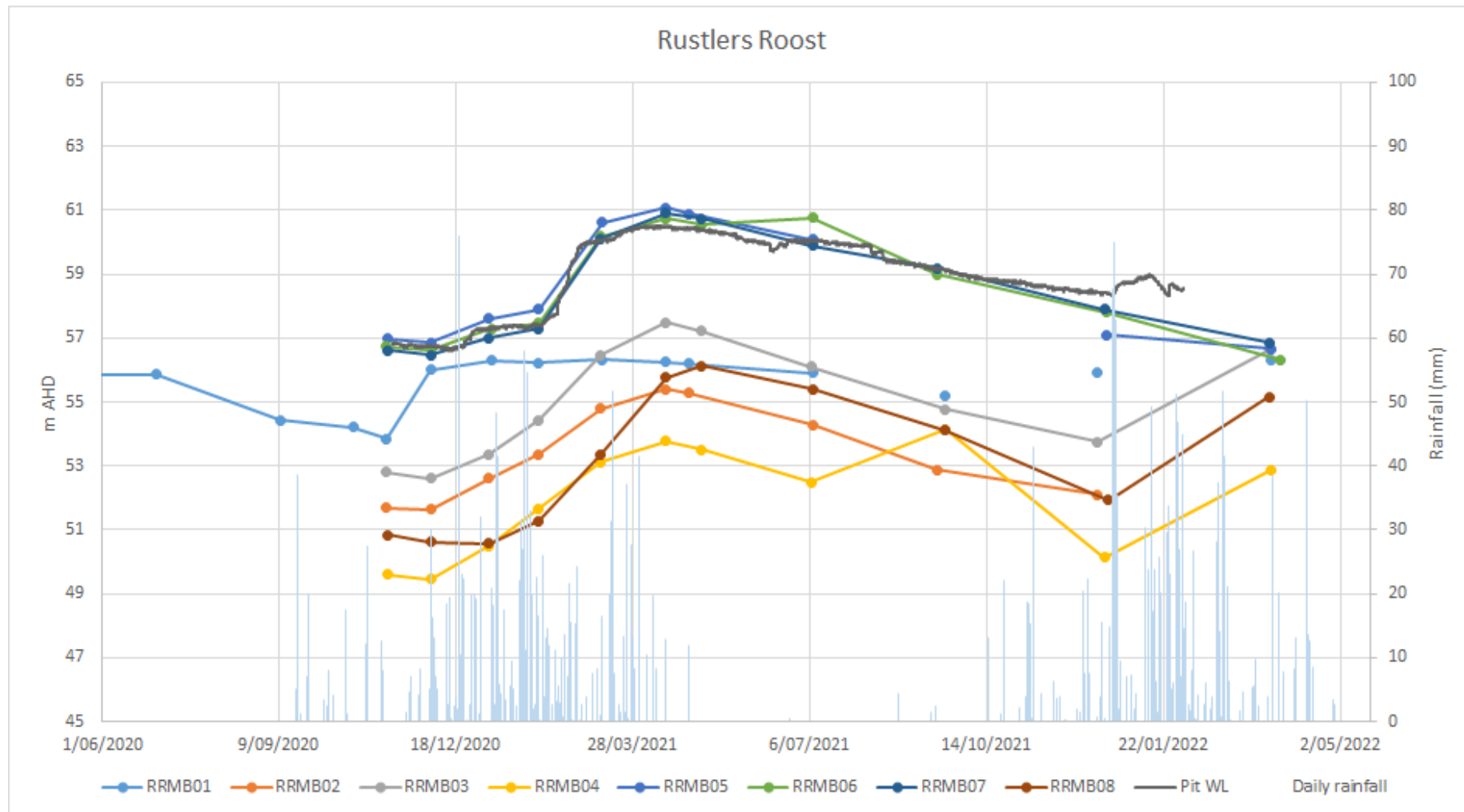


Figure 4-9 Rustlers Roost Reduced Standing Groundwater Levels (m AHD)

4 Description of Environmental Values

Table 4-12 Rustlers Roost Average Seasonal and Lowest and Highest Groundwater Levels (m AHD)

Bore ID	Winter, dry season	Hot, dry- wet transition	Summer, wet season	Hot, wet-dry transition	2020- 2021	Lowest (04/12/2020)	Highest (16/04/2021)
RRMB02	54.28	51.69	53.10	55.35	53.63	51.63	55.41
RRMB03	56.67	52.80	54.22	57.48	55.06	52.61	57.48
RRMB04	52.99	49.59	51.18	53.78	51.76	49.45	53.78
RRMB05	60.08	56.97	58.25	60.98	59.00	56.86	61.07
RRMB06	60.66	56.74	57.90	60.73	58.80	56.65	60.73
RRMB07	60.32	56.61	57.72	60.90	58.63	56.47	60.9
RRMB08	55.77	50.83	51.46	55.77	53.00	50.62	55.77

The regional groundwater flow and direction would be to the east/northeast of Rustlers Roost, towards the Mary River. However, the groundwater flow and direction are modified on a local scale by the local topography (e.g. the north-east trending hills) and, to a minor extent, by the open pit.

Groundwater level contour maps representing dry and wet season water level conditions are presented in Figure 4-10 and Figure 4-11. Groundwater flow direction that can be inferred from observations is consistent with topographic relief indicating that the water table resemble a subdued representation of ground surface elevation and groundwater flows from areas of higher ground to areas of lower ground. In the vicinity of Rustlers Roost this means groundwater flows to the east, south and west away from the higher elevation area around and to the north of the pit.

The pit lake level is closely aligned with the groundwater elevation at RRMB05, RRMB06 and RRMB07 which are located within 300 m of the pit lake. The pit logger hydrograph has been corrected to survey levels, however, there is some uncertainty around the later time data. It appears that the pit lake and groundwater levels are within 0.5 m of one another for the monitoring period, sometimes groundwater is above the pit lake (pit lake acting as a sink) and sometimes the pit lake is above the groundwater (pit lake acting as a recharge feature). The pit lake elevation is in line with the highest groundwater levels measured on site which suggests in general there is recharge from the pit lake to the local groundwater system. The pit lake is fed by groundwater recharge, rainfall and runoff, with evaporation only occurring across the pit lake surface. The balance of inflows is likely to be equal or slightly greater than the balance of outflows to maintain the pit lake level. The lake does not act as a throughflow feature, more a recharge feature with seasonal backflow into the pit during the dry season. The associated risk is considered low given the quality of source water as informed by the geochemical analysis (Section 4.4.5).

4 Description of Environmental Values

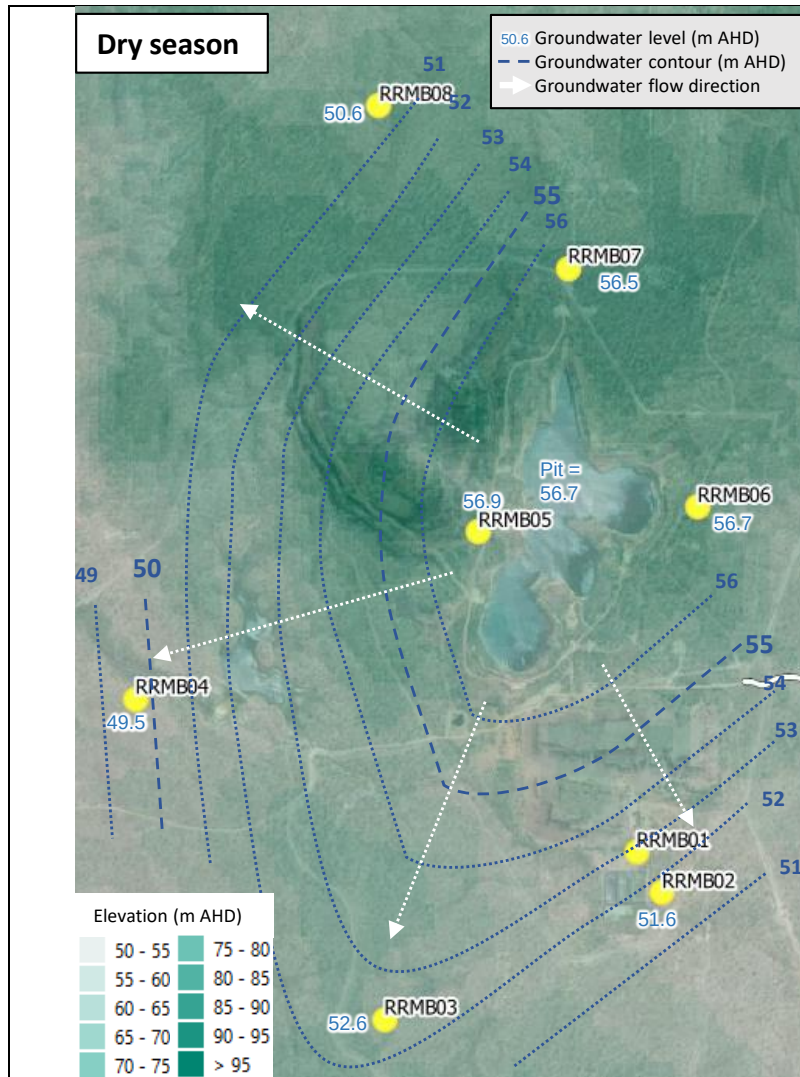


Figure 4-10 Rustlers Roost Groundwater Levels, estimated groundwater contours and indicative flow direction (04/12/2020)

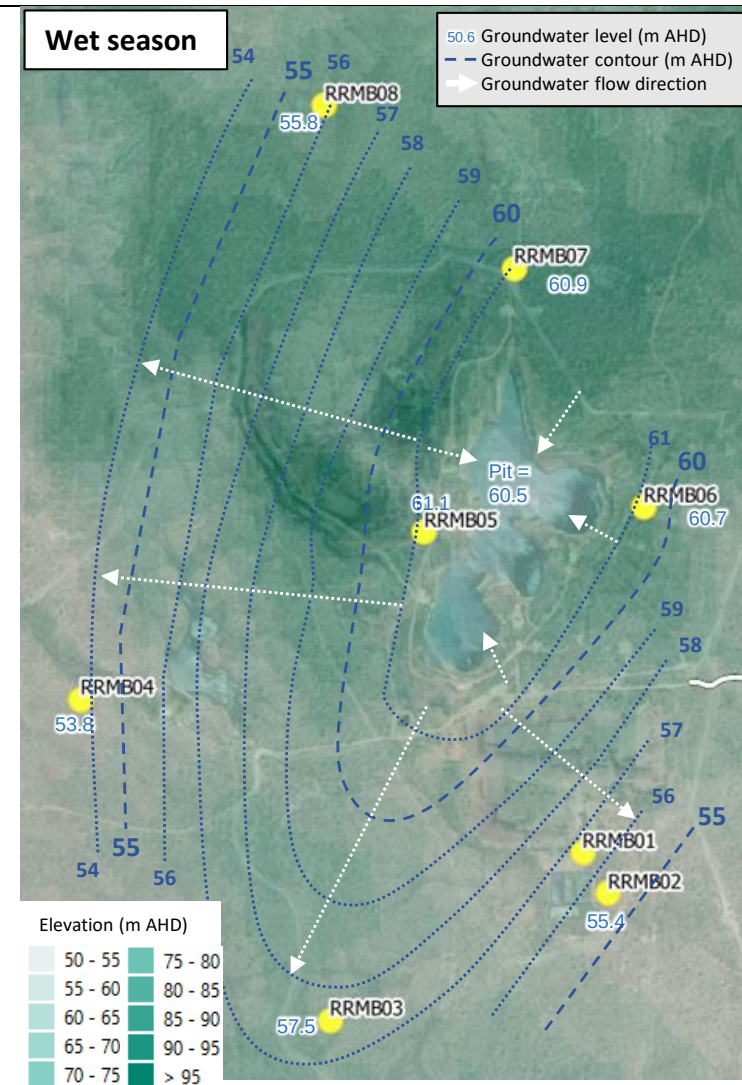


Figure 4-11 Rustlers Roost Groundwater Levels, estimated groundwater contours and indicative flow direction (16/04/2021)

4 Description of Environmental Values

4.4.4.3 Quest 29 2020-2021 Groundwater Levels

Depth to groundwater measured by EcOz during the 2020-2022 groundwater monitoring program are presented in Table 4-10, with corresponding reduced standing groundwater levels (relative to mAHD) presented in Table 4-11 and on Figure 4-9. An automatic level logger was installed in the Taipan and BHS pit lakes, and this data has been converted to elevation using survey levels provided by PGO. The pit lake elevation is shown in Figure 4-9.

Table 4-13 Quest 29 Depth to Groundwater (mbTOC) 2020-2021

EcOz Bore ID	PGO ID	2020				2021								2022	
		9	10	11	12	1	2	3	4	5	7	9	12	1	3
Q29MB01	No 1	4.91	5.24	5.42	5.31	3.1	2.4	0.42	0.66	-	2.72	3	4.75	1.97	-
Q29MB02	-	10.51	10.88	11.24	11.1	9.1	8.39	6.16	6.41	-	8.41	8.0	10.61	7.9	6.55
Q29MB03	QMB3	-	-	16.14	16.2	15.46	14.85	13.37	13.31	-	14.2	14.55	-	-	12.7
Q29MB04	QMB4	-	-	6.06	6.09	4.34	3.95	3.16	3.12	-	4.1	4.56	5.63	-	3.5
Q29MB05	QMB2	-	-	1.59	1.74	0.82	0.47	-	-	-	0.98	4.09	6.12	-	2.3
Q29MB06	QMB5/MB06	-	-	7.13	7.13	5.95	5.57	3.54	3.21	-	4.63	7.5	10.99	-	5.75
Q29MB07	QMB6	-	-	11.23	11.25	10.16	9.88	8.36	8.12	-	10.17	12.99	16.71	-	10.37
Q29MB08	QMB7	-	-	16.23	16.28	16.32	16.13	11.03	10	-	12.08	13.52	14.62	-	9.72
Q29MB09	QMB1	-	-	3.08	3	1.62	0.94	-	-	0.46	1.309	1.5	3.0	-	0

mbTOC: metres below top of casing

Table 4-14 Quest 29 Reduced Standing Groundwater Level (mAHD) 2020-2021

EcOz Bore ID	PGO ID	2020				2021								2022	
		9	10	11	12	1	2	3	4	5	7	9	12	1	3
Q29MB03	QMB3	-	-	34.221	34.161	34.901	35.511	36.991	37.051	-	36.161	35.81	-	-	37.66
Q29MB04	QMB4	-	-	36.796	36.766	38.516	38.906	39.696	39.736	-	38.756	38.3	37.23	-	39.36
Q29MB05	QMB2	-	-	45.092	44.942	45.862	46.212	-	-	-	45.702	42.59	40.56	-	44.38
Q29MB06	QMB5/MB06	-	-	46.014	46.014	47.194	47.574	49.604	49.934	-	514	45.64	42.15	-	47.39
Q29MB07	QMB6	-	-	46.045	46.025	47.115	47.395	48.915	49.155	-	47.105	44.29	40.57	-	46.91
Q29MB08	QMB7	-	-	78.629	78.579	78.539	78.729	83.829	84.859	-	82.779	81.34	80.24	-	85.14
Q29MB09	QMB1	-	-	64.962	65.042	66.422	67.102	-	-	67.582	66.733	66.54	65.04	-	68.04

mAHD: metres Australian Height Datum

Note: Reduced standing groundwater levels relative to mAHD could not be calculated for bores Q29MB01 and Q29MB02, as no survey data is available for the bores. Lidar elevation has been used to show the bore hydrographs.

4 Description of Environmental Values

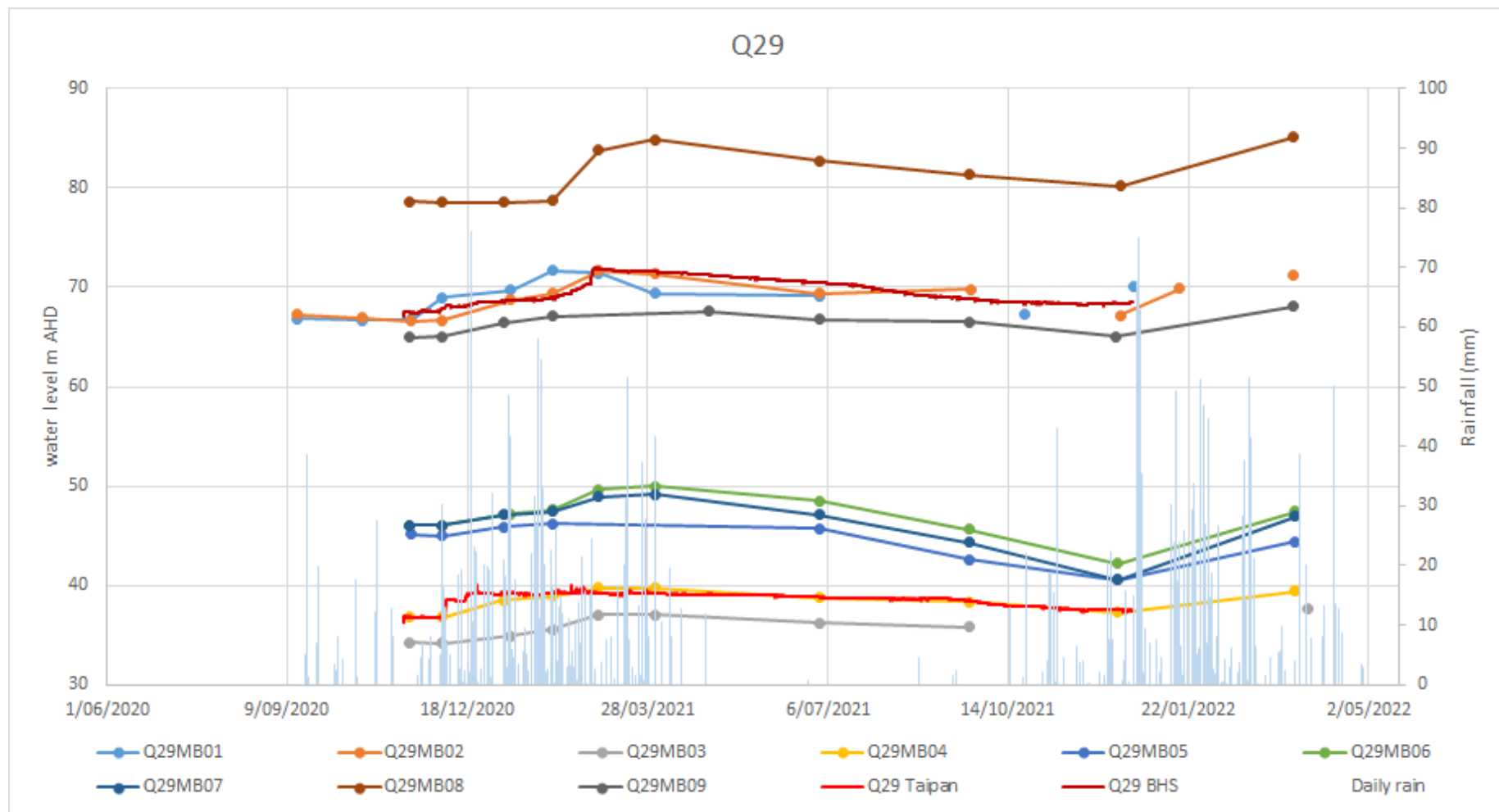


Figure 4-12 Quest 29 Reduced Standing Groundwater Levels (m AHD)

4 Description of Environmental Values

Table 4-15 Quest 29 Average Seasonal and Lowest and Highest Groundwater Levels (mAHD)

Bore ID	Winter, dry season	Hot, dry-wet transition	Summer, wet season	Hot, wet-dry transition	2020-2021	Lowest (04/12/2020)	Highest (16/04/2021)
Q29MB03	36.16	34.22	35.39	36.93	35.72	34.16	37.05
Q29MB04	38.76	36.80	38.47	39.59	38.58	36.77	39.74
Q29MB05	45.70	45.09	45.67	-	45.56	44.94	-
Q29MB06	48.51	46.01	47.60	47.89	47.59	46.01	49.84
Q29MB07	47.11	46.05	47.36	48.97	47.57	46.03	49.16
Q29MB08	82.78	78.63	79.92	84.64	81.30	78.58	84.86
Q29MB09	67.16	64.96	66.19	36.93	66.31	65.04	67.5

The regional groundwater flow and direction would be to the east/southeast of Quest 29, towards the McKinley River. However, the groundwater flow and direction are modified on a local scale by the local topography and by the existing open pits. Groundwater level contour maps representing dry and wet season water level conditions are presented in Figure 4-13 and Figure 4-14. It should be noted there is limited spatial extent of monitoring points and therefore the contours are controlled by the topography. There is some flow to the southeast for most of the site, however in the north of the site there is flow to the west and northwest, based on the topography and groundwater levels.

At Quest 29, the groundwater level around the various pits suggests that:

- The Zamu pit lake may act as a through flow lake, receiving groundwater from the northern side and losing to groundwater on the southern side (no pit lake level data available). The pit is not bunded, and its catchment is not limited to the pit, suggesting a larger runoff contribution than if the pit were bounded and pit catchment limited to the strict pit area;
- The Taipan pit lake is likely leaking to the groundwater aquifer at least on the south-east side of the pit. The pit lake may possibly be acting also as a through flow lake based on its position in the catchment;;
- The South Koolpin pit lake is likely acting a throughflow for groundwater, with seepage into the pit from the north and recharge to groundwater along the southern edge of the pit;
- The North Koolpin pit is recharging the groundwater. However, the location of the pit along a ridge may indicate that groundwater along the ridge may be flowing toward the pit (small amount of throughflow); and
- The BHS pit is recharging the aquifer. The standing water level in the BHS pit may result from rainfall runoff across a catchment that is not limited to the strict pit as the historical pit is not bunded.

4 Description of Environmental Values

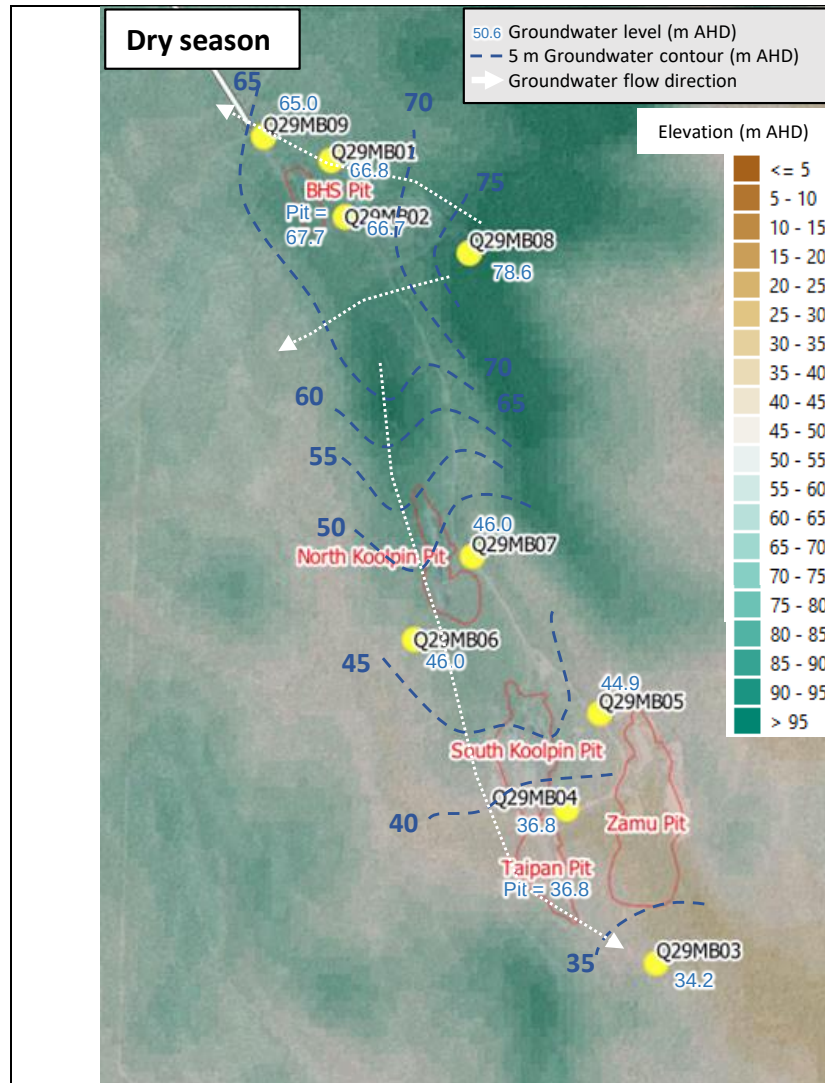


Figure 4-13 Quest 29 Groundwater Levels, estimated groundwater contours and indicative flow direction (04/12/2020)

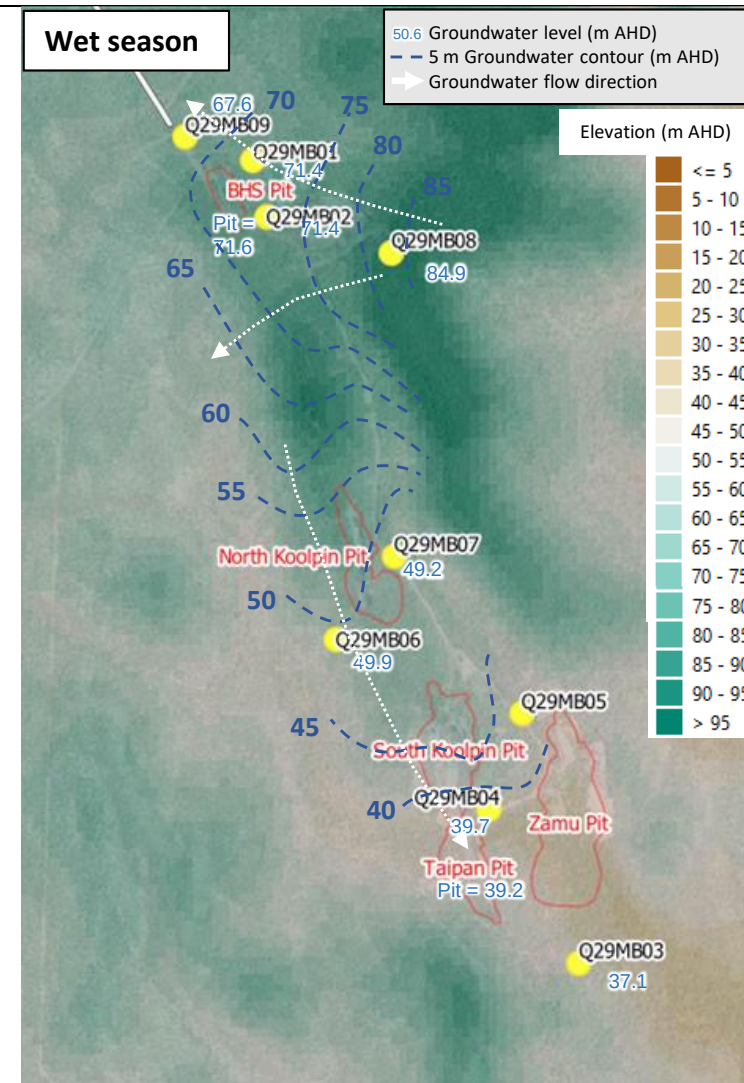


Figure 4-14 Quest 29 Groundwater Levels, estimated groundwater contours and indicative flow direction (16/04/2021)

4.4.5 Groundwater Quality

4.4.5.1 Rustlers Roost Historical investigations

An assessment of the groundwater quality at and near Rustlers Roost was undertaken as part of the EES 1993 hydrogeological study (Environmental and Earth Sciences Pty Ltd, January 1993). EES concluded that the groundwater showed minimal dissolution of major ions from the bedrock and no detectable copper, lead, zinc, cadmium, chromium, arsenic or mercury in the groundwater. Water quality throughout the lease was good with total dissolved solids (TDS) ranging from 10 to 50 mg/L. All parameters were within the ANZECC agricultural water quality guidelines.

The water is dominated by bicarbonate with chloride, potassium, sodium and magnesium subdominant. The bicarbonate levels most likely represent atmospheric carbon dioxide together with carbonate minerals dissolving in the groundwater whilst the other elements such as sodium, calcium, potassium and magnesium would be sourced from the fractured bedrock.

The low dissolved element levels indicate that there is minimal elemental dissolution from the rock and that a high level of meteoric rainfall infiltration into the folded and fractured turbidite sediments is occurring.

The bicarbonate to chloride ratios indicate that the water is relatively young with a low buffering capacity and pH values ranging from 4.9 to 5.5. The low to non-existent sulphate levels suggest that pyrite or other sulphides are absent or in minimal quantities in the oxidised and transitional weathering zones. The acidity is likely to be due to dissolved CO₂, particularly as bicarbonate is the dominant anion. Due to the presence of dissolved CO₂, the water is likely to be corrosive.

4.4.5.2 Rustlers Roost 2020-2021 Water Quality

Field water quality parameters measured during the 2020-2021 monitoring program and analysis results of groundwater and open pit sample are presented in Appendix A-1. A statistical summary of the groundwater analysis results is presented in Table 4-16.

4 Description of Environmental Values

Table 4-16 Rustlers Roost Statistical Summary of Groundwater Analysis Results

Analyte				Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Alkalinity													
Bicarbonate Alkalinity	mg/L	40	1	39	2	68.0769	195	48.7228	-	-	-	-	-
Carbonate Alkalinity	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Hydroxide Alkalinity	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Total Alkalinity	mg/L	40	1	39	2	68.0769	195	48.7228	-	-	-	-	-
Field Measurements													
Dissolved Oxygen (%sat) (field)	%	40	-	40	1	13.2335	39.9	12.0022	-	-	-	-	-
Electrical Conductivity (field)	µS/cm	40	-	40	36.1	155.3000	305.4	89.1028	Yes	-	-	-	-
ORP (field)	mV	40	-	40	-118	84.7425	271	86.0935	-	-	-	-	-
pH (field)	-	40	-	40	3.77	5.6970	6.78	0.7671	Yes	Yes	-	-	-
Salinity (field)	ppt	38	-	38	0.02	1.8726	44.2	8.0644	-	-	-	-	-
Temperature (field)	°C	40	-	40	30.8	32.5125	34.8	0.9079	-	-	-	-	-
Total Dissolved Solids (field)	mg/L	39	-	39	23.4	105.3269	196.4	56.6634	-	-	-	-	-
Turbidity (field)	NTU	40	-	40	0.42	27.2033	576	100.1201	Yes	-	-	-	-
Major Ions													
Calcium	mg/L	40	8	32	1	11.8438	50	12.6417	-	-	-	-	-
Chloride	mg/L	40	-	40	2	3.3000	6	0.9392	-	-	-	-	-
Magnesium	mg/L	40	5	35	1	5.9143	15	4.5463	-	-	-	-	-
Sodium	mg/L	40	-	40	1	7.2750	28	6.9393	-	-	-	-	-
Sulphate	mg/L	40	14	26	1	8.5385	31	8.6775	-	-	-	-	-
Metals (dissolved)													
Aluminium (dissolved)	mg/L	40	25	15	0.01	0.0747	0.19	0.0437	-	-	-	-	-
Arsenic (dissolved)	mg/L	40	11	29	0.001	0.0099	0.07	0.0169	Yes	-	Yes	-	-
Cadmium (dissolved)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Chromium (dissolved)	mg/L	40	38	2	0.001	0.0015	0.002	0.0007	-	-	Yes	-	-

4 Description of Environmental Values

Analyte	Units	No. Results	No. Results <LOR	Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Cobalt (dissolved)	mg/L	40	27	13	0.001	0.0055	0.015	0.0039	-	-	-	-	-
Copper (dissolved)	mg/L	40	19	21	0.001	0.0096	0.033	0.0103	Yes	-	Yes	-	-
Iron (dissolved)	mg/L	40	24	16	0.05	0.8831	2.47	0.8770	-	-	-	-	Yes
Lead (dissolved)	mg/L	40	37	3	0.003	0.0047	0.006	0.0015	1	-	2	-	-
Manganese (dissolved)	mg/L	40	2	38	0.001	0.1531	0.627	0.1821	-	-	-	-	Yes
Nickel (dissolved)	mg/L	40	18	22	0.001	0.0024	0.006	0.0015	-	-	-	-	-
Selenium (dissolved)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Tin (dissolved)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Uranium (dissolved)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Zinc (dissolved)	mg/L	40	7	33	0.005	0.0222	0.078	0.0200	Yes	-	Yes	-	-
Metals (total)													
Aluminium (total)	mg/L	40	14	26	0.01	0.2031	1.29	0.2852	-	-	-	-	-
Arsenic (total)	mg/L	40	10	30	0.001	0.0106	0.083	0.0185	-	-	Yes	-	-
Cadmium (total)	mg/L	40	39	1	0.0002	0.0002	0.0002	#DIV/0!	-	-	-	-	-
Chromium (total)	mg/L	40	37	3	0.001	0.0017	0.002	0.0006	-	-	Yes	-	-
Cobalt (total)	mg/L	40	27	13	0.001	0.0069	0.018	0.0046	-	-	-	-	-
Copper (total)	mg/L	40	17	23	0.001	0.0114	0.041	0.0122	-	-	Yes	-	-
Ferrous Iron	mg/L	40	25	15	0.1	0.8853	2.89	0.9061	-	-	-	-	-
Iron (total)	mg/L	40	18	22	0.05	0.9682	2.59	0.8238	-	-	-	-	-
Lead (total)	mg/L	40	36	4	0.001	0.0023	0.003	0.0010	-	-	-	-	-
Manganese (total)	mg/L	40	4	36	0.001	0.1745	0.608	0.1877	-	-	-	-	Yes
Nickel (total)	mg/L	40	15	25	0.001	0.0027	0.008	0.0018	-	-	-	-	-
Selenium (total)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Tin (total)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Uranium (total)	mg/L	40	40	-	-	-	-	-	-	-	-	-	-
Zinc (total)	mg/L	40	6	34	0.007	0.0237	0.07	0.0188	-	-	Yes	-	-

4 Description of Environmental Values

Analyte				Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Nutrients													
Ammonia	mg/L	40	27	13	0.01	0.2585	1.29	0.3873	-	Yes	1	-	-
Nitrate + Nitrite	mg/L	40	12	28	0.01	0.1371	1.6	0.2920	-	-	-	-	-
Total Kjeldahl Nitrogen as N	mg/L	40	35	5	0.3	0.8400	2.1	0.7301	-	-	-	-	-
Total Nitrogen as N	mg/L	40	28	12	0.1	0.6000	3.7	1.0000	-	-	-	-	-
Total Phosphorus	mg/L	40	6	34	0.01	0.1674	0.8	0.2317	-	Yes	-	-	Yes
Physico-chemical													
Total Hardness	mg/L	40	5	35	4	51.4000	187	45.3004	-	-	-	-	-
Total Suspended Solids	mg/L	40	27	13	5	30.0769	182	49.3684	Yes	-	-	-	-
Turbidity (lab)	NTU	40	13	27	0.1	20.3556	348	67.0665	Yes	-	-	-	-

Hydrogeochemistry

Based on the field water quality parameters, it can be concluded that the groundwater at Rustlers Roost:

- Is acidic to slightly acidic, with pH levels varying from 3.77 to 6.78, with an average of 5.7. Time series of field pH versus rainfall are presented in Figure 4-15. To a minor degree, pH levels vary with rainfall. pH levels in monitoring well RRMB07 are more acidic (i.e. between 3.8 and 4.4) than in the other monitoring wells (i.e. between 5.1 and 6.8). RRMB07 is located north of the open pit;
- Is fresh, with electrical conductivity (EC) varying from 36 $\mu\text{S}/\text{cm}$ to 305 $\mu\text{S}/\text{cm}$, with an average of 155 $\mu\text{S}/\text{cm}$, and total dissolved solids (TDS) varying from 23 mg/L to 196 mg/L, with an average of 105 mg/L. Time series of field EC versus rainfall are presented in Figure 4-16;
- Has low dissolved oxygen levels, ranging from 1% to 40% saturation, with an average of 13%; and
- Has bicarbonate alkalinity (as CaCO_3) ranging from 2 mg/L to 195 mg/L, with an average of 68 mg/L.

Piper diagrams of groundwater (historical and current data) and open pit water are presented on Figure 4-17. Based on the ionic composition:

- The groundwater at wells RRMB02, RRMB03, RRMB04, RRMB05, RRMB06, RRMB07 and RRMB08 can be classified as a “calcium-magnesium-bicarbonate” water type;
- The groundwater at well RRMB01 can be classified as a “mixed sodium-bicarbonate-chloride” water type. Monitoring well RRMB01 is located adjacent to the former heap leach pad. Groundwater quality in well RRMB01 shows evidence of influence from potential waste rock leachate; and
- The water in the open pit can be classified as a “calcium-magnesium-bicarbonate” water type.

4 Description of Environmental Values

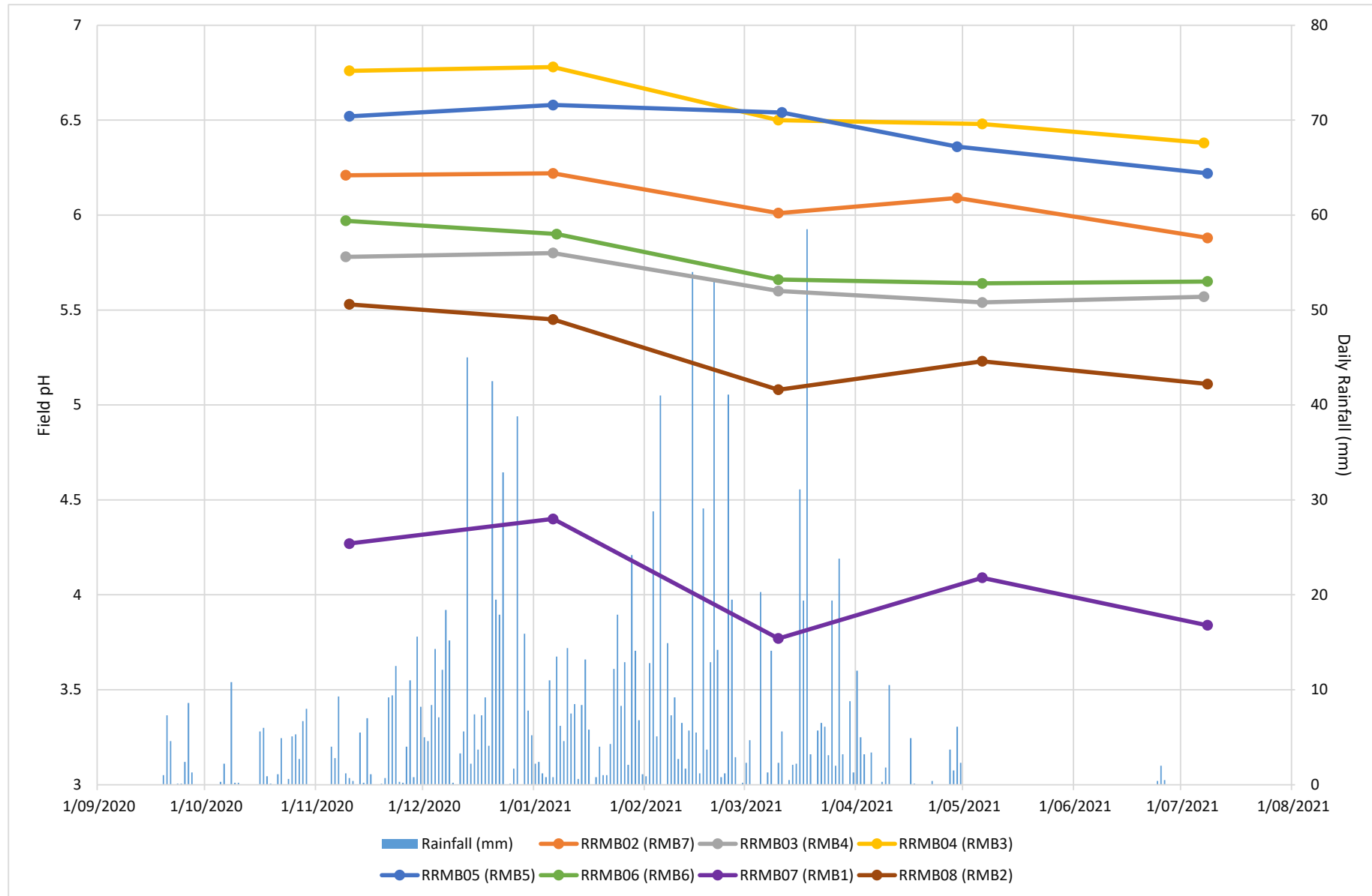


Figure 4-15 Field pH versus Rainfall in Monitoring Wells at Rustlers Roost

4 Description of Environmental Values

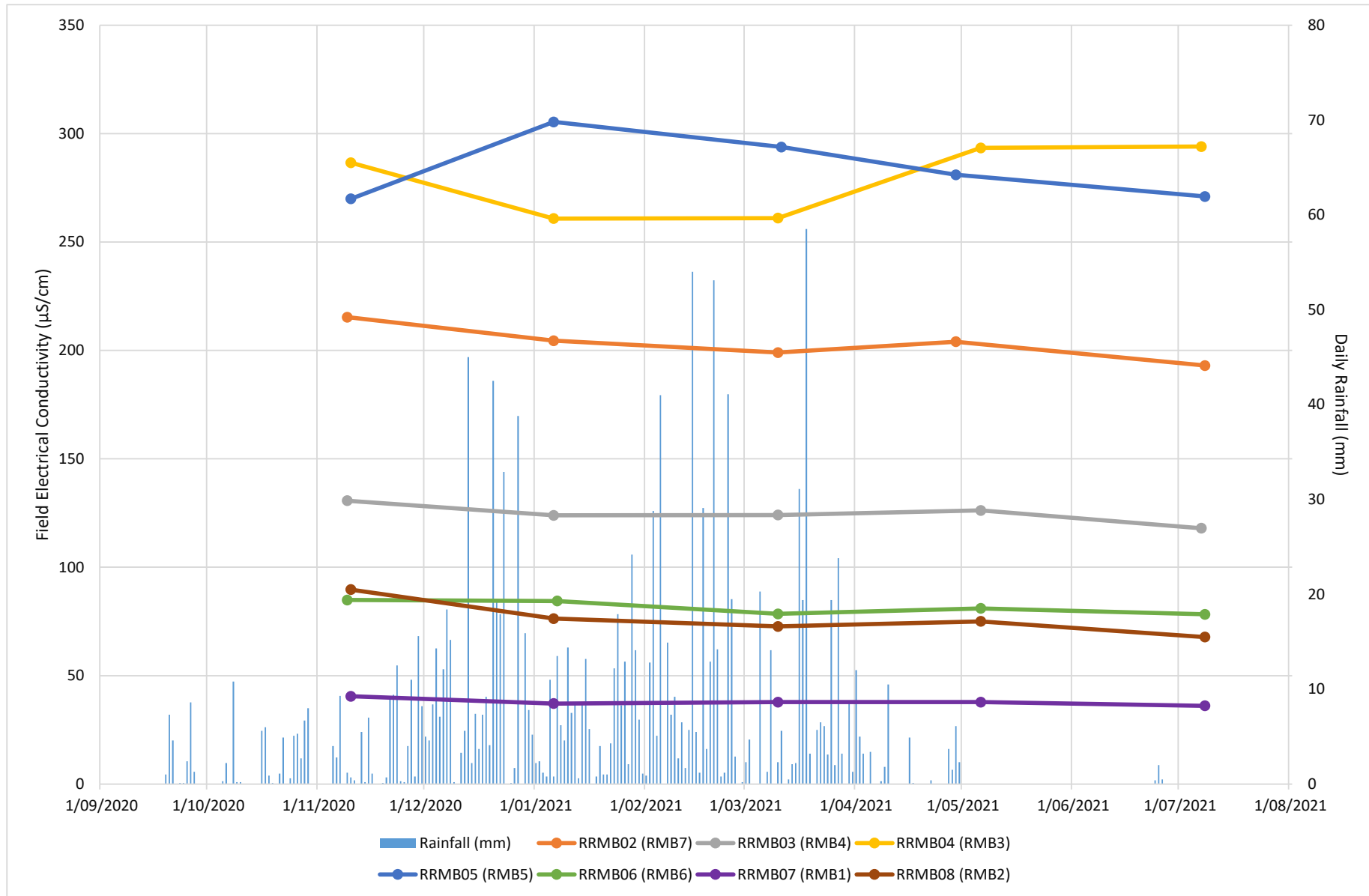


Figure 4-16 Field Electrical Conductivity versus Rainfall in Monitoring Wells at Rustlers Roost

4 Description of Environmental Values

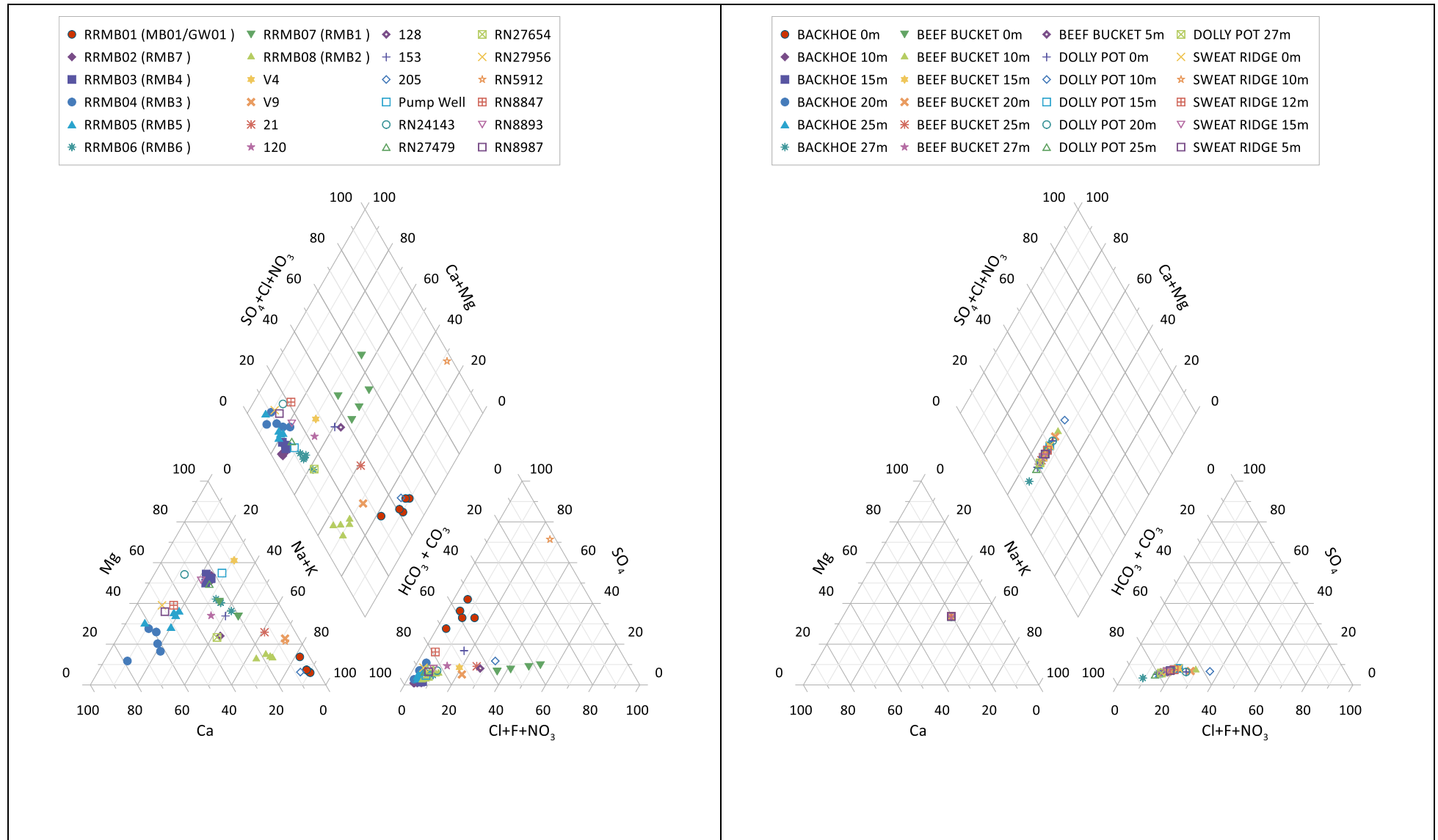


Figure 4-17 Piper Diagram – Groundwater and Open Pit Water at Rustlers Roost

4 Description of Environmental Values

Baseline Water Quality

Detailed groundwater, open pit and surface water analysis results, with comparison against the adopted water quality guidelines/trigger values are presented in Appendix A.

With respect to the groundwater exceedances of the adopted water quality guidelines/trigger values:

- Exceedances of the adopted trigger values for aquatic ecosystems are summarised in Table 4-17. It must be noted that, given the absence of GDEs in the Project area and the absence of groundwater discharge into local creeks and drainages, these trigger values are only relevant in case of abstraction of groundwater and discharge to surface water (e.g. for pit dewatering);
- There were no exceedances of the water quality guidelines for livestock watering; and
- Exceedances of the long-term irrigation guideline values were observed for iron, manganese and total phosphorus in some of the wells.

Table 4-17 Rustlers Roost Summary of Groundwater Exceedances of Aquatic Ecosystem Trigger Values

Analyte	RRMB01	RRMB02	RRMB03	RRMB04	RRMB05	RRMB06	RRMB07	RRMB08
Field Readings								
Electrical Conductivity	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes
pH	Yes	-	Yes	-	-	Yes	Yes	Yes
Turbidity	-	-	-	-	-	-	-	-
Metals (dissolved)								
Arsenic	-	-	-	-	Yes	Yes	-	-
Chromium	-	-	-	Yes	-	-	-	-
Copper	Yes	Yes	Yes	-	-	Yes	Yes	Yes
Lead	-	-	Yes	-	-	-	Yes	-
Zinc	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes
Nutrients								
Ammonia	Yes	-	-	-	-	-	-	-
Physico-chemical								
pH (lab)	Yes	-	-	-	-	-	-	-
Total Suspended Solids	Yes	-	-	-	-	-	-	-
Turbidity	Yes	-	-	-	-	-	-	-

Notes:

Light green highlight: only exceeds the Toms Gully SSTV

Light blue highlight: only exceeds the ANZG 2018 trigger value

Box and Whisker plots for selected analytes are presented in Appendix A. A summary description of selected water quality parameters for groundwater monitoring and analysis results obtained during the 2020-2021 monitoring program is presented in Table 4-18.

4 Description of Environmental Values

Table 4-18 Baseline Groundwater Quality at Rustlers Roost

Parameter	Water quality summary
Field Measurements	
Dissolved Oxygen (%sat) (field)	Based on 40 readings, values ranged from 1 % (at RRGB05) to 39.9 % (at RRGB07), with an average of 13.2 %. The DO values were outside the Tropical Australia Lowland Rivers guideline range of 85% to 120%.
Electrical Conductivity (field)	Based on 40 readings, values ranged from 36.1 $\mu\text{S}/\text{cm}$ (at RRGB07) to 305.4 $\mu\text{S}/\text{cm}$ (at RRGB05), with an average of 155.3 $\mu\text{S}/\text{cm}$. Exceedances of the Tropical Australia Lowland Rivers guideline range (20 – 250 $\mu\text{S}/\text{cm}$) were observed at wells RRGB04 and RRGB05.
pH	Based on 40 readings, values ranged from 3.77 (at RRGB07) to 6.78 (at RRGB04), with an average of 5.697, indicating that the groundwater was acidic to near neutral. Lowest, most acidic pH levels were observed at RRGB07. Values outside the adopted trigger value range were observed at wells RRGB01, RRGB03, RRGB06, RRGB07 and RRGB08.
Turbidity (field)	Based on 40 readings, values ranged from 0.42 NTU (at RRGB03) to 57.6 NTU (at RRGB01), with an average of 7.8 NTU.
Alkalinity	
Bicarbonate Alkalinity as CaCO_3	Based on 39 readings, values ranged from 2 mg/L (at RRGB07) to 195 mg/L (at RRGB05), with an average of 68.1 mg/L. The low levels are reflected by the measured pH <7 and indicate the reduced buffer capability, hence reduced acid neutralising ability of the groundwater.
Physico-Chemical	
Total Hardness	Based on 35 readings, values ranged from 4 mg/L (at RRGB01) to 187 mg/L (at RRGB05), with an average of 51.4 mg/L, indicating that the groundwater hardness varies from soft to moderately hard.
Major Ions	
Calcium	Based on 32 readings, values ranged from 1 mg/L (at RRGB01) to 50 mg/L (at RRGB05), with an average of 11.8 mg/L.
Chloride	Based on 40 readings, values ranged from 2 mg/L (at RRGB01) to 6 mg/L (at RRGB01), with an average of 3.3 mg/L.
Magnesium	Based on 35 readings, values ranged from 1 mg/L (at RRGB01) to 15 mg/L (at RRGB05), with an average of 5.9 mg/L.
Sodium	Based on 40 readings, values ranged from 1 mg/L (at RRGB04) to 28 mg/L (at RRGB01), with an average of 7.3 mg/L.
Sulphate	Based on 26 readings, values ranged from 1 mg/L (at RRGB07) to 31 mg/L (at RRGB01), with an average of 8.5 mg/L.
Metals	
Aluminium	Based on 15 readings, values ranged from 0.01 mg/L (at RRGB05) to 0.19 mg/L (at RRGB01), with an average of 0.075 mg/L. There are no trigger values for dissolved aluminium when pH is less than 6.5.
Arsenic	Based on 29 readings, values ranged from 0.001 mg/L (at RRGB01) to 0.07 mg/L (at RRGB05), with an average of 0.0099 mg/L. Exceedances of the adopted trigger values were observed only in wells RRGB05 and RRGB06.
Chromium	Based on 2 readings, values ranged from 0.001 mg/L (at RRGB04) to 0.002 mg/L (at RRGB04), with an average of 0.0015 mg/L. Exceedances of the adopted trigger values were observed only in well RRGB02.
Copper	Based on 21 readings, values ranged from 0.001 mg/L (at RRGB01) to 0.033 mg/L (at RRGB07), with an average of 0.0096 mg/L. Exceedances of the adopted trigger values were observed in most wells.
Manganese	Based on 38 readings, values ranged from 0.001 mg/L (at RRGB02) to 0.627 mg/L (at RRGB04), with an average of 0.153 mg/L.

4 Description of Environmental Values

Parameter	Water quality summary
Zinc	Based on 33 readings, values ranged from 0.005 mg/L (at RRGB02) to 0.078 mg/L (at RRGB03), with an average of 0.022 mg/L. Exceedances of the adopted trigger values were observed in all wells, except in RRGB05
Nutrients	
Ammonia	Based on 13 readings, values ranged from 0.01 mg/L (at RRGB03) to 1.29 mg/L (at RRGB01), with an average of 0.26 mg/L. Exceedances of the adopted trigger values were observed only in well RRGB01.
Total Nitrogen as N	Based on 12 readings, values ranged from 0.1 mg/L (at RRGB04) to 3.7 mg/L (at RRGB01), with an average of 0.6 mg/L.
Total Phosphorus	Based on 34 readings, values ranged from 0.01 mg/L (at RRGB07) to 0.8 mg/L (at RRGB06), with an average of 0.16 mg/L.

Summary

Overall, the groundwater quality monitoring has shown groundwater is typically fresh, acidic to near neutral and has exceedances of aquatic ecosystems guideline values (GVs) for some metals and nutrients at some sampling occasions and locations. The elevated phosphorus and metal concentrations may be associated with underlying mineralogical deposits entailing weathered zones.

The groundwater monitoring bores show limited impacts from previous mining activities. Only RRGB01, which is located next to the heap leach pad, shows signals of influence from potential waste rock leachate.

4.4.5.3 Quest 29 2020-2021 Water Quality

Field water quality parameters measured during the 2020-2021 monitoring program and analysis results of groundwater and open pit sample are presented in Appendix B. A statistical summary of the groundwater analysis results is presented in Table 4-19.

4 Description of Environmental Values

Table 4-19 Quest 29 Statistical Summary of Groundwater Analysis Results

Analyte	Units	No. Results	No. Results <LOR	Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Alkalinity													
Bicarbonate Alkalinity	mg/L	66	2	64	12	136.0313	255	53.6127	-	-	-	-	-
Carbonate Alkalinity	mg/L	69	63	6	5	41.6667	133	57.9333	-	-	-	-	-
Hydroxide Alkalinity	mg/L	48	48	-	-	-	-	-	-	-	-	-	-
Total Alkalinity	mg/L	48	-	48	12	129.6042	255	58.9792	-	-	-	-	-
Field Measurements													
Dissolved Oxygen (%sat) (field)	%	45	-	45	1	8.6022	59.9	13.5569	-	-	-	-	-
Electrical Conductivity (field)	µS/cm	64	-	64	4.29	473.6889	1213	337.6680	Yes	-	-	-	-
ORP (field)	mV	45	-	45	-237	-22.1800	192	88.6116	-	-	-	-	-
pH (field)	-	68	-	68	4.47	6.3775	7.6	0.6408	Yes	Yes	-	-	-
Salinity (field)	ppt	44	-	44	0.02	0.1880	0.51	0.1229	-	-	-	-	-
Temperature (field)	°C	45	-	45	30.7	32.0911	33.7	0.7147	-	-	-	-	-
Total Dissolved Solids (field)	mg/L	45	-	45	25.1	247.2600	676	168.0982	-	-	-	-	-
Turbidity (field)	NTU	58	-	58	0.32	34.8486	400	93.3683	Yes	-	-	-	-
Major Ions													
Calcium	mg/L	69	-	69	3	54.0043	140	43.6974	-	-	-	-	-
Chloride	mg/L	68	-	68	2	6.2588	16	3.0799	-	-	-	-	-
Magnesium	mg/L	26	-	26	8	13.0000	19	3.9192	-	-	-	-	-
Sodium	mg/L	68	-	68	2	12.6426	44	9.2435	-	-	-	-	-
Sulphate	mg/L	67	-	67	1	105.3448	445	159.1398	Yes	-	-	-	-
Metals (dissolved)													
Aluminium (dissolved)	mg/L	67	52	15	0.01	0.0327	0.31	0.0768	Yes	-	-	-	-
Arsenic (dissolved)	mg/L	67	5	62	0.00185	0.0406	0.2	0.0471	Yes	-	Yes	-	Yes
Cadmium (dissolved)	mg/L	67	52	15	0.0001	0.0002	0.00113	0.0003	Yes	-	Yes	-	-

4 Description of Environmental Values

Analyte	Units	No. Results	No. Results <LOR	Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Chromium (dissolved)	mg/L	67	51	16	0.001	0.0041	0.011	0.0029	Yes	-	Yes	-	-
Cobalt (dissolved)	mg/L	67	36	31	0.001	0.0016	0.005	0.0010	-	-	-	-	-
Copper (dissolved)	mg/L	67	49	18	0.001	0.0029	0.009	0.0026	Yes	-	Yes	-	-
Iron (dissolved)	mg/L	67	5	62	0.01	3.1869	19	5.1002	Yes	-	-	-	Yes
Lead (dissolved)	mg/L	67	56	11	0.001	0.0014	0.005	0.0012	-	-	Yes	-	-
Manganese (dissolved)	mg/L	67	-	67	0.013	0.4864	1.5	0.3831	-	-	-	-	Yes
Nickel (dissolved)	mg/L	67	34	33	0.001	0.0046	0.02	0.0048	Yes	-	4	-	-
Selenium (dissolved)	mg/L	45	45	-	-	-	-	-	-	-	-	-	-
Tin (dissolved)	mg/L	45	45	-	-	-	-	-	-	-	-	-	-
Uranium (dissolved)	mg/L	57	57	-	-	-	-	-	-	-	-	-	-
Zinc (dissolved)	mg/L	67	14	53	0.001	0.0208	0.0846	0.0208	Yes	-	Yes	-	-
Metals (total)													
Aluminium (total)	mg/L	45	28	17	0.01	0.0518	0.29	0.0889	-	-	-	-	-
Arsenic (total)	mg/L	45	5	40	0.004	0.0568	0.209	0.0577	-	-	Yes	-	Yes
Cadmium (total)	mg/L	66	61	5	0.0001	0.0007	0.0028	0.0012	-	-	Yes	-	-
Chromium (total)	mg/L	66	66	-	-	-	-	-	-	-	-	-	-
Cobalt (total)	mg/L	59	41	18	0.001	0.0022	0.004	0.0010	-	-	-	-	-
Copper (total)	mg/L	66	50	16	0.002	0.0057	0.013	0.0036	-	-	Yes	-	-
Ferrous Iron	mg/L	45	7	38	0.1	1.6971	5.38	1.4392	-	-	-	-	-
Iron (total)	mg/L	45	4	41	0.13	1.7354	4.56	1.2349	-	-	-	-	-
Lead (total)	mg/L	66	62	4	0.001	0.0123	0.044	0.0212	-	-	Yes	-	-
Manganese (total)	mg/L	66	19	47	0.0005	0.3599	1.08	0.2724	-	-	-	-	Yes
Nickel (total)	mg/L	45	22	23	0.001	0.0063	0.025	0.0058	-	-	Yes	-	-
Selenium (total)	mg/L	45	45	-	-	-	-	-	-	-	-	-	-
Tin (total)	mg/L	45	44	1	0.001	0.0010	0.001	-	-	-	-	-	-
Uranium (total)	mg/L	45	45	-	-	-	-	-	-	-	-	-	-

4 Description of Environmental Values

Analyte	Units	No. Results	No. Results <LOR	Results > LOR					Exceedances				
				No. Results	Minimum	Average	Maximum	StDev	Toms Gully SSTV (8th percentile)	Tropical Australia Lowland Rivers	ANZG 218 freshwater - 95% species protection	ANZECC 2 Livestock Watering (beef cattle)	ANZECC 2 long term irrigation
Zinc (total)	mg/L	66	19	47	0.0012	0.0323	0.472	0.0688	-	-	Yes	-	-
Nutrients													
Ammonia	mg/L	45	21	24	0.01	0.0571	0.23	0.0666	-	Yes	-	-	-
Nitrate + Nitrite	mg/L	45	28	17	0.02	0.0506	0.15	0.0378	-	-	-	-	-
Total Kjeldahl Nitrogen as N	mg/L	45	36	9	0.1	0.1889	0.3	0.0601	-	-	-	-	-
Total Nitrogen as N	mg/L	45	35	10	0.1	0.2100	0.3	0.0568	-	-	-	-	-
Total Phosphorus	mg/L	45	7	38	0.01	0.0658	0.14	0.0380	-	Yes	-	-	Yes
Physico-chemical													
Total Hardness	mg/L	48	-	48	7	165.6667	455	118.9485	-	-	-	-	-
Total Suspended Solids	mg/L	68	24	44	5	35.2273	470	71.8949	Yes	-	-	-	-
Turbidity (lab)	NTU	45	2	43	0.2	8.5093	29.9	8.2711	-	-	-	-	-

Hydrogeochemistry

Based on the field water quality parameters, it can be concluded that the groundwater at Quest 29:

- Is acidic to neutral, with pH levels varying from 4.47 to 7.6, with an average of 6.38. Time series of field pH versus rainfall are presented in Figure 4-18. To a minor degree, pH levels vary with rainfall. pH levels in monitoring well Q29MB03 are more acidic (i.e. between 4.47 and 5.86) than in the other monitoring wells (i.e. between 4.73 and 7.33);
- Is fresh, with electrical conductivity (EC) varying from 4.3 $\mu\text{S}/\text{cm}$ to 1,213 $\mu\text{S}/\text{cm}$, with an average of 473 $\mu\text{S}/\text{cm}$, and total dissolved solids (TDS) varying from 25 mg/L to 676 mg/L, with an average of 247 mg/L. Time series of field EC versus rainfall are presented in Figure 4-19;
- Has low dissolved oxygen levels, ranging from 1% to 60% saturation, with an average of 9%; and
- Has bicarbonate alkalinity (as CaCO_3) ranging from 12 mg/L to 255 mg/L, with an average of 136 mg/L.

Piper diagrams of groundwater and open pit water are presented on Figure 4-20. Based on the ionic composition:

- The groundwater at wells Q29MB03, Q29MB04, Q29MB05, Q29MB06, Q29MB07, Q29MB08 and Q29MB09 can be classified as a “calcium-magnesium-bicarbonate” water type;
- The groundwater at wells Q29MB01 and Q29MB02 can be classified as a “calcium-magnesium-sulphate” water type. These wells are located near the BHS heap leach pad and groundwater may have been impacted by leachate from the heap leach pad; and
- The water in the open pit can be classified as a “sodium-chloride” water type.

4 Description of Environmental Values

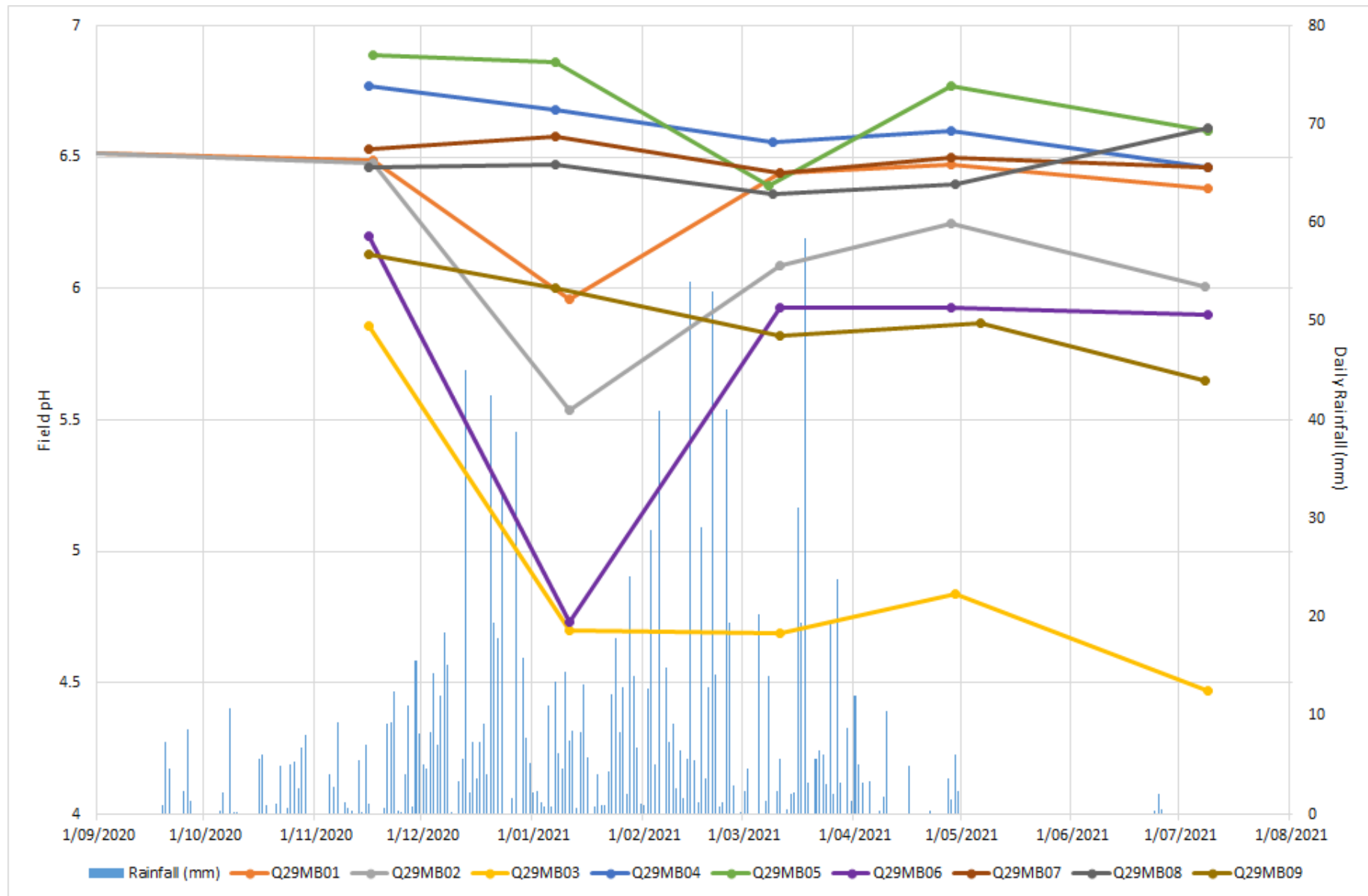


Figure 4-18 Field pH versus Rainfall in Monitoring Wells at Quest 29

4 Description of Environmental Values

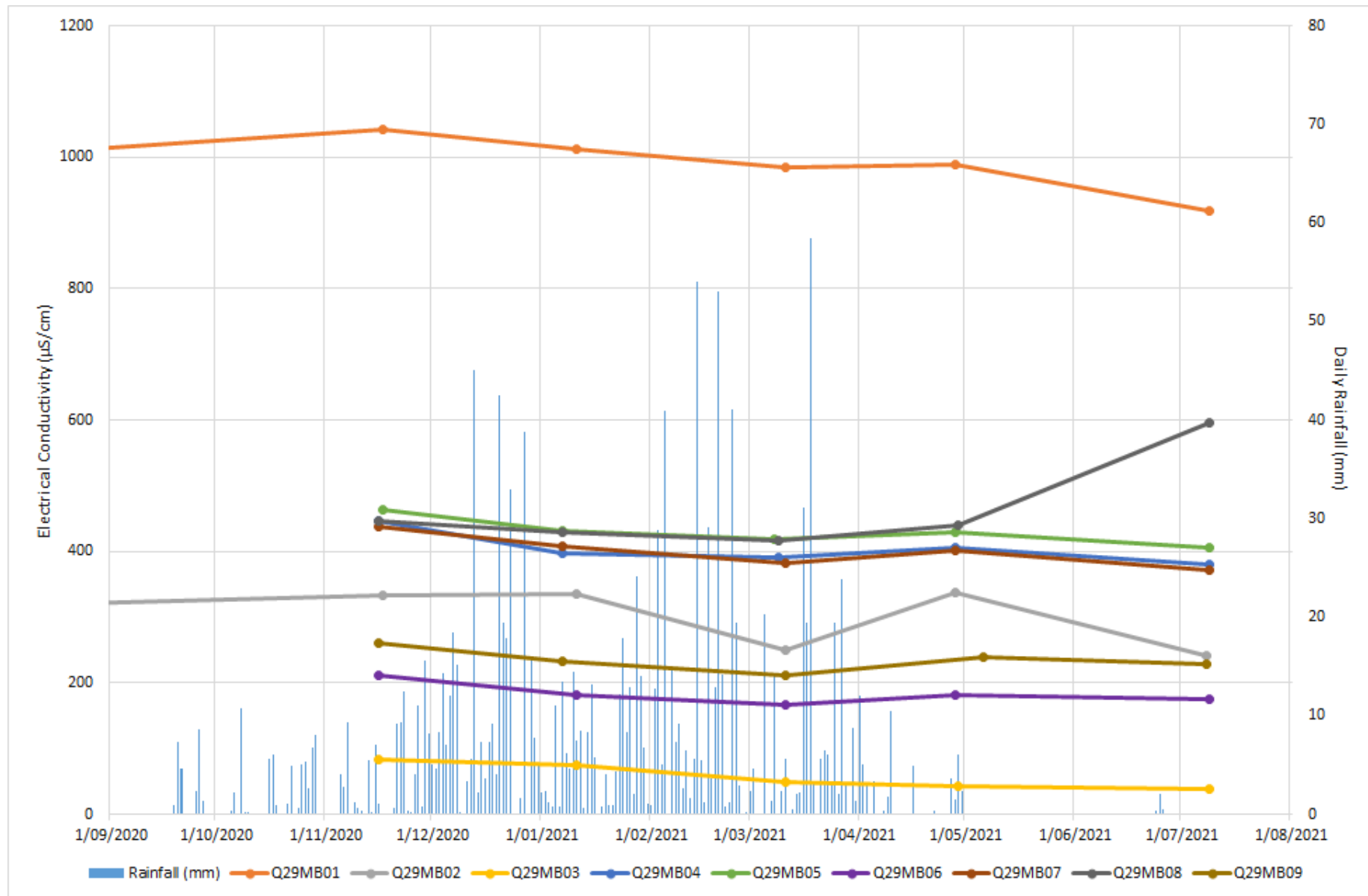


Figure 4-19 Field Electrical Conductivity versus Rainfall in Monitoring Wells at Quest 29

4 Description of Environmental Values

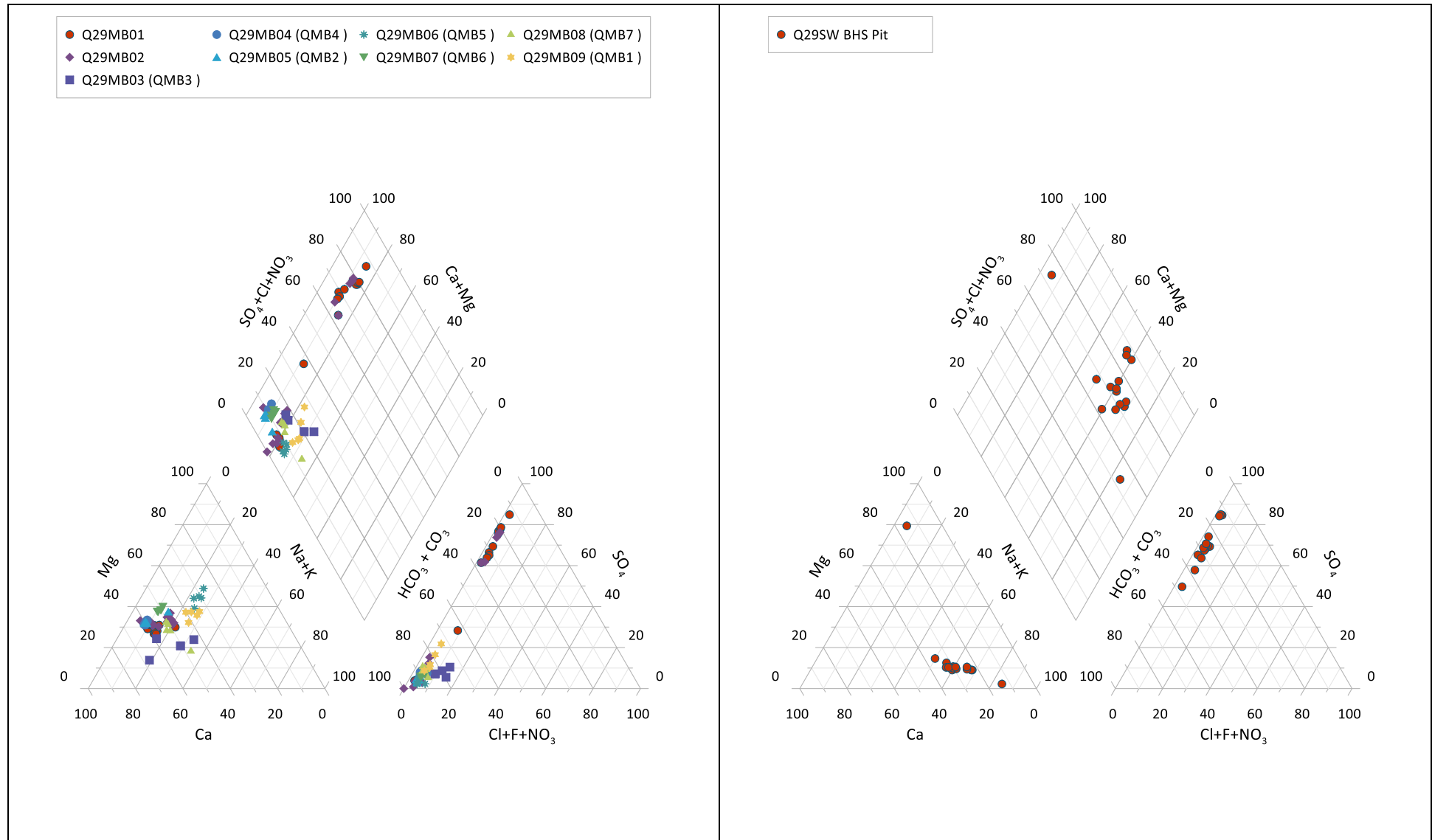


Figure 4-20 Piper Diagram – Groundwater and Open Pit Water at Quest 29

4 Description of Environmental Values

Baseline Water Quality

Detailed groundwater, open pit and surface water analysis results, with comparison against the adopted water quality guidelines/trigger values are presented in Appendix B.

With respect to the groundwater exceedances of the adopted water quality guidelines/trigger values:

- Exceedances of the adopted trigger values for aquatic ecosystems are summarised in Table 4-20. It must be noted that, given the absence of GDEs in the Project area and the absence of groundwater discharge into local creeks and drainages, these trigger values are only relevant in case of abstraction of groundwater and discharge to surface water (e.g. for pit dewatering);
- There were no exceedances of the water quality guidelines for livestock watering; and
- Exceedances of the long-term irrigation guideline values were observed for arsenic, iron, manganese and total phosphorus in most wells.

Table 4-20 Quest 29 Summary of Groundwater Exceedances of Aquatic Ecosystem Trigger Values

Analyte	Q29 MB01	Q29 MB02	Q29 MB03	Q29 MB04	Q29 MB05	Q29 MB06	Q29 MB07	Q29 MB08	Q29 MB09
Field Readings									
Electrical Conductivity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
pH	-	Yes	Yes	-	-	Yes	-	-	Yes
Turbidity	Yes	Yes	-	-	-	-	-	-	-
Major Ions									
Sulphate	Yes	Yes	-	-	-	-	-	-	-
Metals (dissolved)									
Aluminium	Yes	-	-	-	-	-	-	-	-
Arsenic	Yes	Yes	-	Yes	Yes	-	Yes	-	-
Cadmium	Yes	-	-	-	-	-	-	-	-
Chromium	Yes	Yes	-	-	-	-	-	-	-
Copper	Yes	-	Yes	-	-	-	-	-	Yes
Iron	Yes	Yes	-	-	-	-	Yes	-	-
Lead	-	Yes	-	-	-	-	-	-	-
Nickel	-	-	Yes	Yes	-	-	-	-	-
Zinc	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Physico-chemical									
Total Suspended Solids	Yes	Yes	-	-	-	-	-	-	-

Notes:

Light green highlight: only exceeds the Toms Gully SSTV

Light blue highlight: only exceeds the ANZG 2018 trigger value

Box and Whisker plots for selected analytes are presented in Appendix B. A summary description of selected water quality parameters for groundwater monitoring and analysis results obtained during the 2020-2021 monitoring program is presented in Table 4-21.

4 Description of Environmental Values

Table 4-21 Baseline Groundwater Quality at Quest 29

Parameter	Water quality summary
Field Measurements	
Dissolved Oxygen (%sat) (field)	Based on 45 readings, values ranged from 1 % (at Q29MB07) to 59.9 % (at Q29MB03), with an average of 8.6%. The DO values were outside the Tropical Australia Lowland Rivers guideline range of 85% to 120%.
Electrical Conductivity (field)	Based on 64 readings, values ranged from 4.29 $\mu\text{S}/\text{cm}$ (at Q29MB05) to 1213 $\mu\text{S}/\text{cm}$ (at Q29MB01), with an average of 473 $\mu\text{S}/\text{cm}$. Exceedances of the Tropical Australia Lowland Rivers guideline range (20 – 250 $\mu\text{S}/\text{cm}$) were observed at in all monitoring wells. However, the groundwater is still classified as “fresh”.
pH	Based on 68 readings, values ranged from 4.47 (at Q29MB03) to 7.6 (at Q29MB02), with an average of 6.3, indicating that the groundwater was acidic to near neutral. Lowest, most acidic pH levels were observed at Q29MB03. Values outside the adopted trigger value range were observed at wells Q29MB01, Q29MB02, Q29MB03, Q29MB06 and Q29MB09.
Turbidity (field)	Based on 58 readings, values ranged from 0.32 NTU (at Q29MB02) to 400 NTU (at Q29MB02), with an average of 34.8 NTU. Exceedances of the adopted trigger value were observed at wells Q29MB01 and Q29MB02.
Alkalinity	
Bicarbonate Alkalinity as CaCO_3	Based on 64 readings, values ranged from 12 mg/L (at Q29MB03) to 255 mg/L (at Q29MB08), with an average of 136.0 mg/L. The low levels are reflected by the measured pH <7 and indicate the reduced buffer capability, hence reduced acid neutralising ability of the groundwater.
Physico-Chemical	
Total Hardness	Based on 48 readings, values ranged from 7 mg/L (at Q29MB03) to 455 mg/L (at Q29MB02), with an average of 165.7 mg/L, indicating that the groundwater hardness varies from soft to hard.
Major Ions	
Calcium	Based on 69 readings, values ranged from 3 mg/L (at Q29MB03) to 140 mg/L (at Q29MB01), with an average of 54.0 mg/L.
Chloride	Based on 68 readings, values ranged from 2 mg/L (at Q29MB03) to 16 mg/L (at Q29MB08), with an average of 6.3 mg/L.
Magnesium	Based on 26 readings, values ranged from 8 mg/L (at Q29MB06) to 19 mg/L (at Q29MB07), with an average of 13 mg/L.
Sodium	Based on 68 readings, values ranged from 2 mg/L (at Q29MB03) to 44 mg/L (at Q29MB08), with an average of 12.6 mg/L.
Sulphate	Based on 67 readings, values ranged from 1 mg/L (at Q29MB03) to 445 mg/L (at Q29MB01), with an average of 105.3 mg/L.
Metals	
Aluminium	Based on 15 readings, values ranged from 0.01 mg/L (at Q29MB01) to 0.31 mg/L (at Q29MB01), with an average of 0.033 mg/L. Exceedances of the adopted trigger values were observed only in well Q29MB01.
Arsenic	Based on 62 readings, values ranged from 0.00185 mg/L (at Q29MB01) to 0.2 mg/L (at Q29MB04), with an average of 0.041 mg/L. Exceedances of the adopted trigger values were observed in all wells, except Q29MB03, Q29MB06, Q29MB08 and Q29MB09.
Cadmium	Based on 15 readings, values ranged from 0.0001 mg/L (at Q29MB01) to 0.00113 mg/L (at Q29MB01), with an average of 0.00024 mg/L. Exceedances of the adopted trigger values were observed only in well Q29MB01.
Chromium	Based on 16 readings, values ranged from 0.001 mg/L (at Q29MB01) to 0.011 mg/L (at Q29MB01), with an average of 0.004 mg/L. Exceedances of the adopted trigger values were observed only in wells Q29MB01 and Q29MB02.
Copper	Based on 18 readings, values ranged from 0.001 mg/L (at Q29MB01) to 0.009 mg/L (at Q29MB03), with an average of 0.0029 mg/L. Exceedances of the adopted trigger values were observed only in wells Q29MB01, Q29MB03 and Q29MB09.

4 Description of Environmental Values

Parameter	Water quality summary
Lead	Based on 11 readings, values ranged from 0.001 mg/L (at Q29MB01) to 0.005 mg/L (at Q29MB02), with an average of 0.00136 mg/L. Exceedances of the adopted trigger values were observed only in well Q29MB02.
Zinc	Based on 53 readings, values ranged from 0.001 mg/L (at Q29MB01) to 0.0846 mg/L (at Q29MB01), with an average of 0.0208 mg/L. Exceedances of the adopted trigger values were observed in all wells.
Nutrients	
Ammonia	Based on 24 readings, values ranged from 0.01 mg/L (at Q29MB01) to 0.23 mg/L (at Q29MB02), with an average of 0.0571 mg/L. There were no exceedances of the adopted trigger values.
Total Nitrogen as N	Based on 10 readings, values ranged from 0.1 mg/L (at Q29MB02) to 0.3 mg/L (at Q29MB02), with an average of 0.21 mg/L.
Total Phosphorus	Based on 38 readings, values ranged from 0.01 mg/L (at Q29MB03) to 0.14 mg/L (at Q29MB02), with an average of 0.066 mg/L.

Summary

Overall, the groundwater at Quest 29 is acidic to neutral and fresh. Exceedances of the adopted aquatic freshwater trigger values were observed for several analytes in all monitoring wells. All monitoring bores, except for Q29MB01 and Q29MB02, showed similar water chemistry with small variations indicating limited impacts from previous mining activities.

Existing water quality results indicate that groundwater may have been locally impacted by historical mining activities (i.e. at Q29MB01 and Q29MB02), as evidenced by the elevated sulphate levels observed in these bores. Bores Q29MB01 and Q29MB02 are located in proximity to the BHS leach pad and appear to be impacted by rock solutes with elevated sulphate levels.

Recent monitoring of Q29MB01 shows elevated EC and dissolved metals in comparison to other sites. pH values range between 6.09 to 7.33, and elevated EC, well above the aquatic ecosystem protection GV of 250 $\mu\text{S}/\text{cm}$ (ranging from 210 to 1,213 $\mu\text{S}/\text{cm}$) and exceedance of the ecosystem protection GV of Al, As, Cd, Cr, Cu and Zn.

Q29MB02 located west of the heap leach ponds and pad has had elevated EC and occasional exceedances of the aquatic ecosystem protection GV of As, Cd, Cr, Cu, Pb and Zn. pH values range from slightly acidic (6.49) to slightly alkaline (7.6), and elevated EC, above the aquatic ecosystem protection GV of 250 $\mu\text{S}/\text{cm}$ (ranging from 210 to 336 $\mu\text{S}/\text{cm}$).

4.4.6 Groundwater Recharge and Discharge

Groundwater recharge within the mining lease is considered to result from direct rainfall infiltration during runoff and, to a much lesser extent, from small dams located within the lease area. These dams would give localised groundwater “highs” which are superimposed on the regional flow pattern (Environmental and Earth Sciences Pty Ltd, January 1993).

Groundwater discharge would be mainly through limited seepage within the existing open pits or regionally through discharge into creeks and surface water drainages/bodies.

5. Groundwater Modelling

5.1 Overview

A numerical groundwater model, referred to as the Project groundwater model, was developed as part of this study. The objectives of the model were to estimate the potential drawdown extents induced by the proposed mining pits at the Rustlers Roost and Quest 29 portions of the Project area for the following time periods:

- At the end of mining, which is also when the spatial extent of drawdown is the largest; and
- 10, 20, 30 and 40 years post mining.

Given limited data availability, the model was developed in a conservative manner to ensure the predicted drawdowns were not underestimated. As additional data become available further model refinements would act to further improve model accuracy and reduce uncertainty.

The groundwater model incorporated the following assumptions/simplifications:

- The fault zones were not included in the model;
- A detailed geological model was not available at the time of reporting;
- The hydro-stratigraphic units (HSUs) in the modelled area were simplified to be two units with the upper unit inferred to conduct the majority of regional flow based on literature of the surrounding area;
- The interaction between surface water bodies and groundwater was not yet defined/quantified;
- Only major watercourses were considered in this study;
- Infiltration process related to the proposed WRD were not simulated;
- The TSF was represented as a recharge source (based on leakage through a HDPE liner) for the entirety of the model duration and progressive construction was not considered (the entire TSF basin is proposed to be covered by composite liner of HDPE and CSL – refer to Appendix G of this SEIS for further details); and
- Dewatering and progressive mining periods were ignored with final pit extents and dewatering conditions assumed at the commencement of the dewatering process as a conservative measure.

5.2 Model Confidence Level Classification

The degree of confidence with which a model's predictions can be used is a critical consideration for any groundwater modelling exercise. Several factors are typically considered to determine model confidence level classification, and the Australian Groundwater Modelling Guidelines (Barnett *et al.*, 2012) define a system to classify the confidence level of groundwater models based on the following factors:

- Available data;
- Calibration procedures;
- Calibration and prediction consistency; and

- Level of stress (i.e. hydraulic stress in the model).

Models are classified as Class 1, 2 or 3 in order of increasing confidence (and complexity). In general, a model will not fit entirely into one class of confidence level because determining the most appropriate class depends upon multiple factors. The current developed groundwater model is generally consistent with a level 2 confidence level classification.

The Class 2 groundwater model developed for the Project is considered capable of adequately predicting the impacts on groundwater levels due to the dewatering of the pits during mining. As it is considered that the assumptions and simplifications inherent to the model have resulted in an overestimation of the predicted impacts, the model is considered fit-for-purpose to assess the potential impacts of the Project on existing and future groundwater levels. As the Project develops, monitoring of groundwater system response would allow for further model refinement and subsequent increase in model Class.

5.3 Numerical Model

5.3.1 Numerical Code

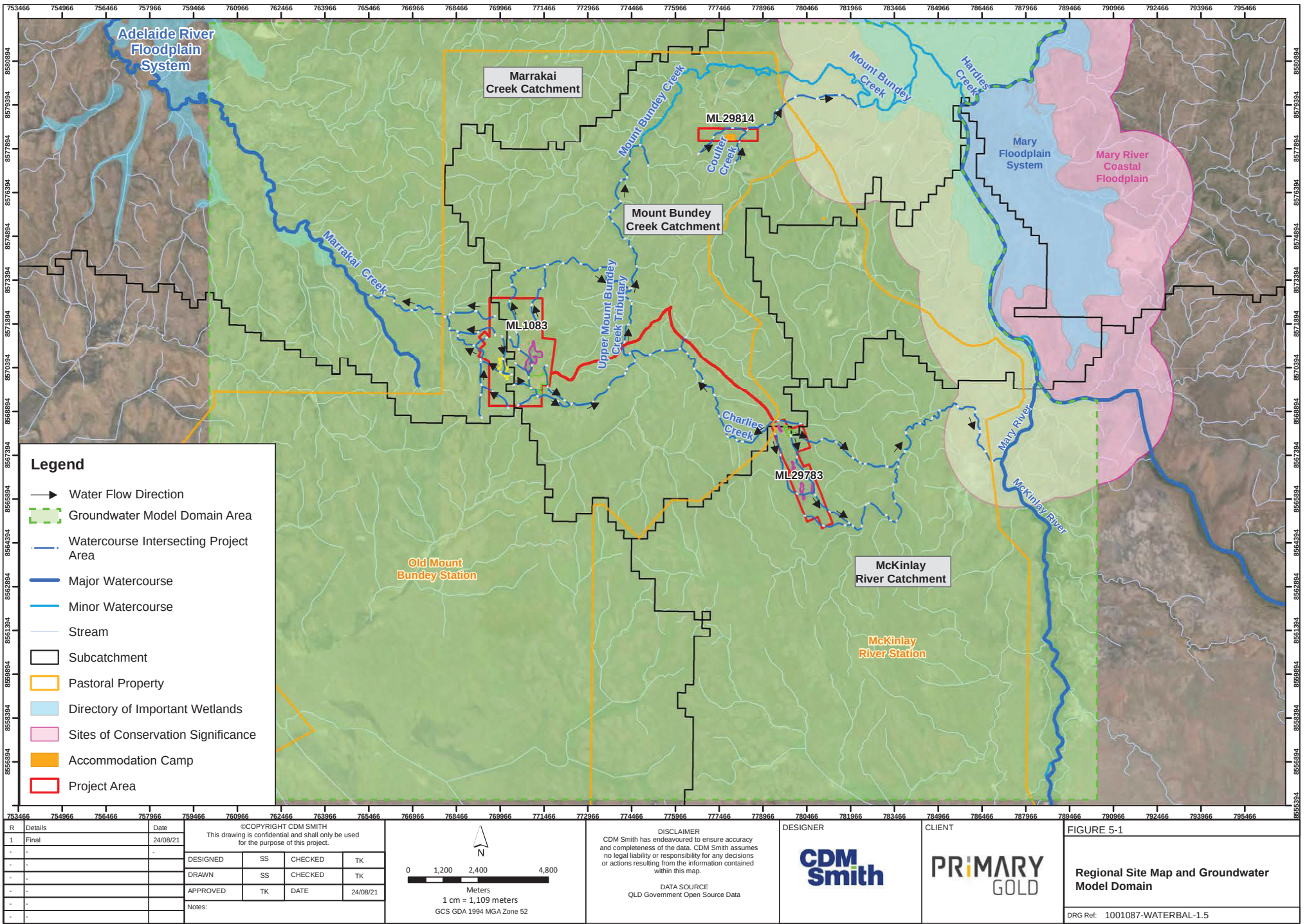
The Project model was developed using MODFLOW-USG (Panday *et al.*, 2013), which is part of the industry standard MODFLOW suite. MODFLOW-USG was selected due to its support for flexible grid structure, enabling features such as the proposed mining pits to be represented more accurately compared to traditional MODFLOW. MODFLOW-USG also allows cell refinement within areas of interest without extending the refinement to the model edges like traditional MODFLOW does. It is therefore possible to set up extremely fine cells within areas of interest (as was done in this study) whilst keeping the model run time reasonable for the Project timeframe.

Groundwater Vistas version 8 (ESI, 2020) and FloPy (Bakker *et al.*, 2016) were used as the pre- and post-processor for the Project model.

5.3.2 Spatial Discretisation

The Project model domain (Figure 5-1 with detailed site maps shown in Figure 1-2 and for Rustlers Roost and Figure 1-3 for Quest 29) was designed such that the boundary conditions at the model edges are sufficiently distant from the proposed mining pits to avoid the boundary conditions from constraining the pit simulations (also known as the boundary effect).

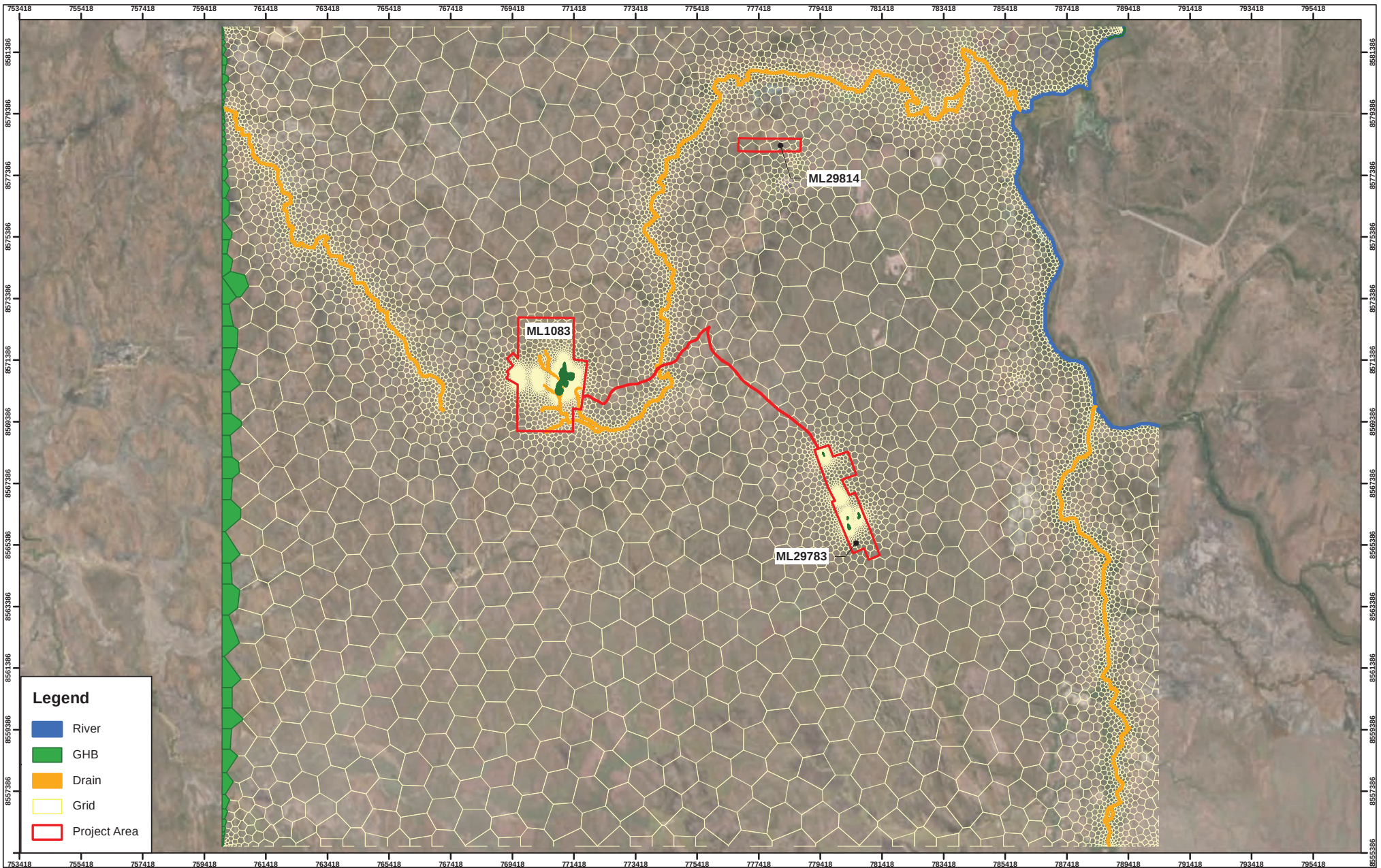
The southern and western model edges were approximately 10 km from the proposed pits, while the northern and eastern model edges were extended further than 10 km from the proposed pits to capture the Mount Bunday Creek and part of the Mary River. This resulted in a model domain that extended 30.4 km in the east-west direction and 26.6 km in the north-south direction, with the origin positioned at Easting-760000 and Northing-8555600 (GDA 94 MGA Zone 52). The Mary River was considered as a major model boundary condition and hence the portion of the model domain to the east of Mary River was set to be inactive.



A Voronoi grid, generated by Algomesh version 2 (HydroAlgorithmics, 2020), was used for the Project model (Figure 5-2). The use of a Voronoi grid improves the model accuracy and convergence as it ensures the lines connecting the cell nodes are perpendicular to the cell interfaces. The maximum edge length (distance between cell nodes) was capped at:

- 15 m within the proposed maximum pit extents (equivalent to a square cell size of 10 m x 10 m);
- 150 m at the groundwater observation wells and key registered bores (equivalent to a square cell size of 100 m x 100 m); the key registered bores include RN036401, RN032317, RN005912 and RN027956, as suggested by previous investigations (CDM Smith, 2019; Groundwater Enterprises, 2020);
- 150 m for the pit lakes (pre-proposed mining) and along the Mary River, McKinlay River, Mount Bunday Creek and Marrakai Creek (equivalent to a square cell size of 100 m x 100 m); and
- 1,500 m for the remaining part of the model domain (equivalent to a square cell size of 1 km x 1 km).

The cell size specifications above resulted in 61,125 cells per model layer. With three model layers (see Section 5.3.3), the Project model had a total of 183,375 cells.



R Details		Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.				 		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. DATA SOURCE QLD Government Open Source Data		DESIGNER 		CLIENT 		FIGURE 5-2	
Voronoi Grid and Model Boundary Conditions for Predictive Modelling																
1 First Draft	24/08/21	DESIGNED	SS	CHECKED	TK	DRG Ref: 1001087-WATERBAL-1.7										
2 Second Draft	08/07/22	DRAWN	SS	CHECKED	TK											
-	-	APPROVED	TK	DATE	08/07/22											
-	-	Notes:														
-	-															
-	-															
-	-															

5.3.3 Model Layers and Surfaces

The HSUs within the model domain were simulated collectively as two fractured rock aquifers, the upper fractured rock aquifer was adopted from literature of the surrounding region (Section 4.4.3). This upper unit was interpreted as consisting of fractured rock which had undergone weathering and hence was hydrogeologically separate from the lower unweathered portions of the system (Section 4.4.3). The unweathered fractured rock aquifer was discretised into two model layers to enhance the vertical resolution of the model, this resulted in three model layers in total.

The top model layer surface was based on the Digital Elevation Model (DEM) from LiDAR (2 m resolution) where available, and 1-second Shuttle Radar Topography Mission (SRTM) (30 m resolution) elsewhere (Figure 5-3). Given the proposed maximum pit depth of approximately -125 m AHD in Rustlers Roost (Groundwater Enterprises, 2020), a constant thickness of 80 m was assigned to each model layer.

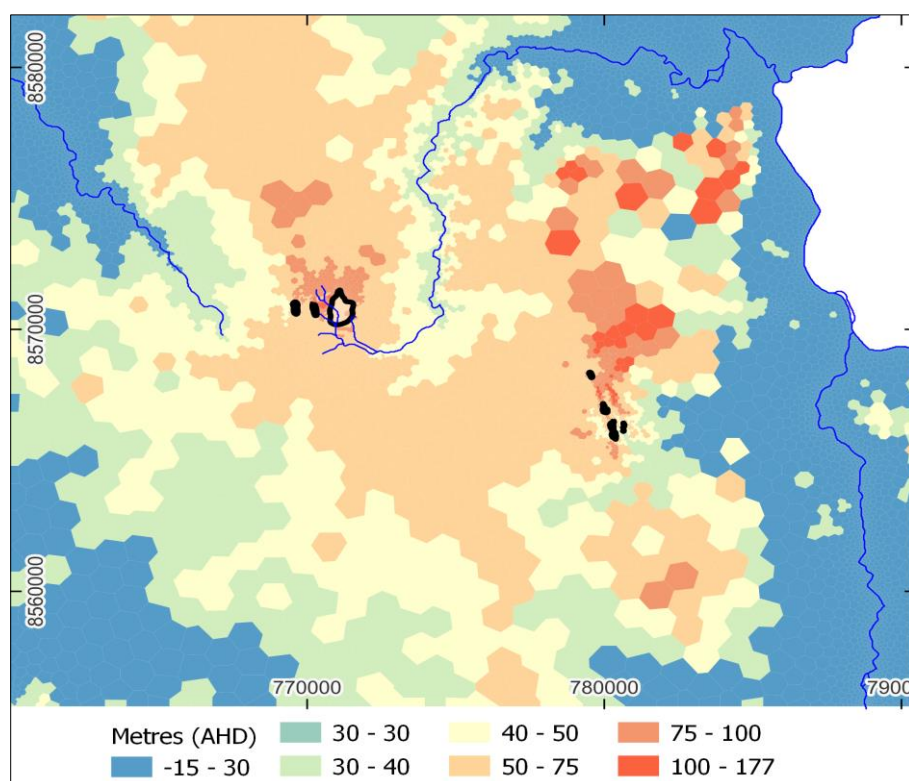


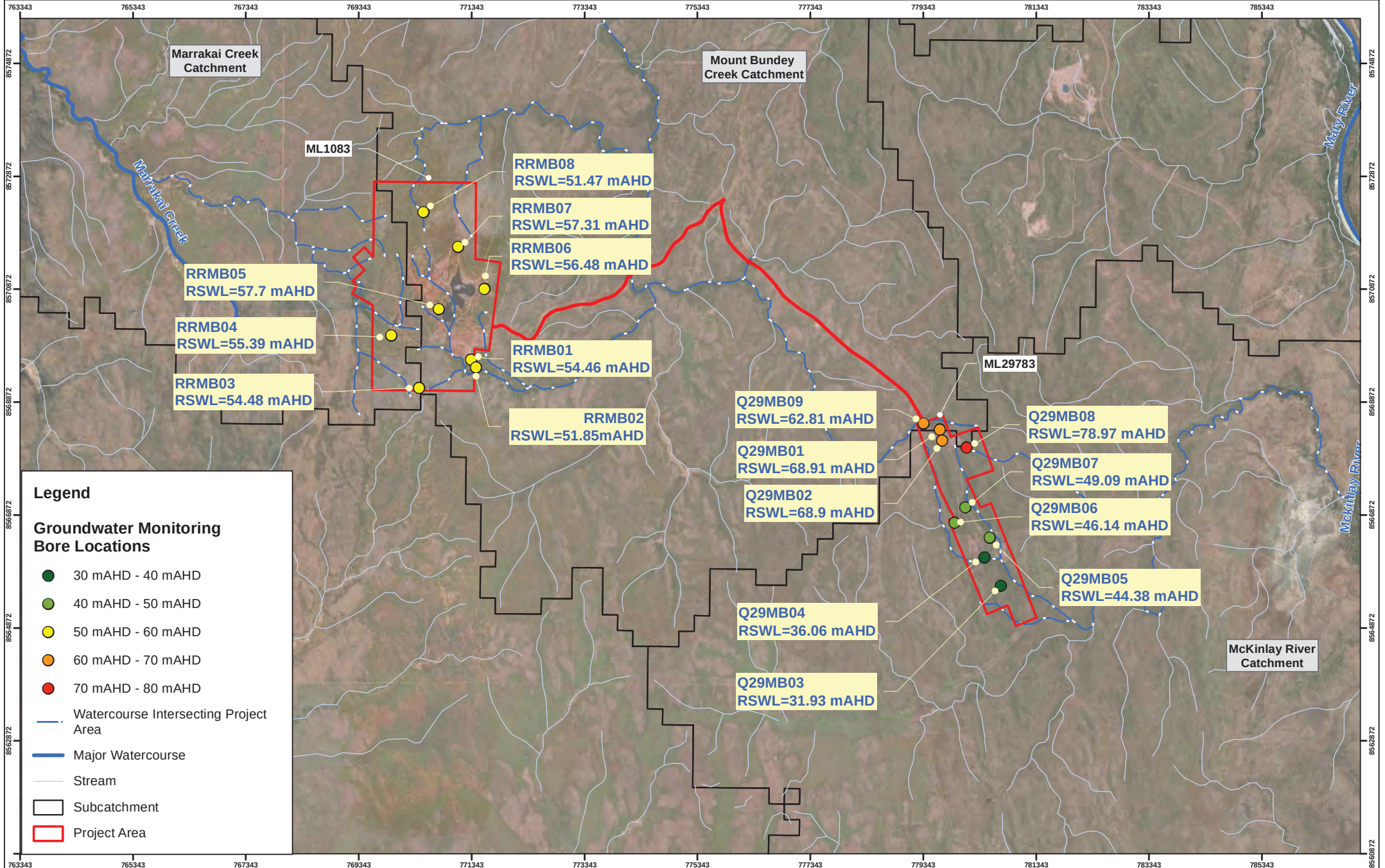
Figure 5-3 Top Model Layer Elevation Surface (m AHD)

5.3.4 Boundary Conditions

The Project model comprised a range of boundary conditions (Figure 5-2), including regional groundwater inflows and outflows, surface water features, proposed mining pits, rainfall recharge and evapotranspiration (ET). Each of these boundary conditions is discussed in detail in the following sections.

5.3.5 Regional Groundwater Inflows and Outflows

In the model domain, regional groundwater generally flowed to the east/north-east towards the Mary River (CDM Smith, 2019; Groundwater Enterprises, 2020). A General Head Boundary (GHB) was set along the western model edge to provide regional groundwater inflow and outflow depending on the local hydraulic conditions. The GHB head was set to 3 m below the land surface based on the surrounding groundwater level observations. The GHB conductance was derived from model calibration (see Section 5.3.12). A hydrostatic equilibrium was assumed by applying the same GHB to all model layers. Model testing indicated that the absence of a GHB along the top and bottom boundaries has negligible effect on the simulated groundwater levels. The average groundwater level recorded on site are illustrated in Figure 5-4.



R Details		Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.				065013002600 Meters 1 cm = 608 meters GCS GDA 1994 MGA Zone 52	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	CLIENT	FIGURE 5-4 Average Recorded Groundwater Levels DRG Ref: 1001087-WATERBAL-1.9
1 Final		13/09/21	DESIGNED	SS	CHECKED	TK		CDM Smith	PRIMARY GOLD			
			DRAWN	SS	CHECKED	TK						
			APPROVED	TK	DATE	13/09/21						
			Notes:									

5.3.6 Surface Water Features

There are four significant rivers and creeks in the model domain, including the Mary River, McKinlay River, Mount Bunday Creek and Marrakai Creek. The spatial locations of these water features are based on the Hydrological Geofabric (Bureau of Meteorology, 2021).

The Mary River is conceptualised to be flowing for the majority of time (Primary Gold, 2021) and simulated using the MODFLOW River package. The riverbed elevation was sourced from the DEM (see Section 5.3.3). The river stage was assumed to be 2.5 m above the riverbed based on gauging station G8180084 and G8180085 (Department of Environment, Parks and Water Security, 2021). The riverbed conductance was derived from model calibration (see Section 5.3.12).

The McKinlay River, Mount Bunday Creek and Marrakai Creek are ephemeral in nature (Primary Gold, 2021) and were simulated using the MODFLOW Drain package. The drain stage was sourced from the DEM (see Section 5.3.3) and the drain conductance was derived from model calibration (see Section 5.3.12).

The pit lakes formed from legacy mining were simulated using the MODFLOW General Head Boundary (GHB) package. The surface areas of these pit lakes were digitised from satellite imagery. As the North Koolpin pit lake was barely visible on satellite imagery and is relatively insignificant in volume, this pit lake was not included in the model for calibration purposes. The pit water levels prior to available observation data are presented in Table 5-1. Pit water levels were adopted where possible using the mean recorded water level for the respective time period. The GHB conductance was derived from model calibration.

In the mining pits where backfilling operations are not planned (all pits excluding Annie Oakley, Annie Dam and Zamu), post proposed mining pit water levels were adopted from the recoveries predicted through GoldSim modelling Section 6.3.5.6. Post mining water levels were simulated using general head boundary conditions to allow for a varying water level based on the Goldsim predictions (Section 6.3.5.6). In Annie Oakley, Annie Dam and Zamu (backfilled pits) the drain cells were deactivated at the end of mining with cell water levels left to recover with no external inputs.

The above discussed surface water features were assigned to the top model layer. The part of Mount Bunday Creek that overlaps with the proposed mining pits were excluded from the predictive modelling.

Table 5-1 Assumed Pit Standing Water Levels for the Pre-Mining Phase

Pit lake	Standing Water Level Pre-Mining Phase (m AHD)
Rustlers Roost	56.9
Zamu pit	37.5
Taipan pit	39
South Koolpin pit	40
North Koolpin pit	52.5
BHS pit	70.5

5.3.7 Mining Pits

The proposed mining pits and dewatering processes were represented using the MODFLOW Drain package in the predictive modelling. As a conservative approach, the maximum pit extents were used to set up the drain cells. Also, the minimum pit base elevation was applied uniformly as the drain stage for each pit (Table 5-2). The initial drain conductance was derived from model calibration. The drain cells were assigned to the top model layer, as well as the second model layer in areas where the drain stage is below the bottom elevation of layer 1.

Table 5-2 Minimum Base Elevation for the Proposed Pits

Location	Proposed Mining Pit	Minimum Pit Base Elevation (m AHD)
Rustlers Roost	Rustlers Roost Main Pit	-125
Rustlers Roost	Annie Okaley Pit	5
Rustlers Roost	Annie's Dam Pit	35
Quest 29	BHS Pit	48
Quest 29	North Koolpin Pit	22
Quest 29	South Koolpin Pit	-3.5
Quest 29	Taipan Pit	-11
Quest 29	Zamu Pit	-36

5.3.8 Rainfall Recharge

Rainfall groundwater recharge was estimated using the chloride mass balance technique (Leaney *et al.*, 2011) as follows.

$$R = \frac{D}{C} \times 100$$

where:

- R is rainfall groundwater recharge (mm/y);
- D is chloride deposition rate from rainfall ($\text{kg ha}^{-1} \text{y}^{-1}$);
- C is chloride concentration of groundwater (mg/L); and
- The value of 100 is a unit conversion factor.

The chloride deposition rate from rainfall is assumed to be $5 \text{ kg ha}^{-1} \text{y}^{-1}$ for the modelled area (Davies and Crosbie, 2018). Site monitoring data indicate a mean groundwater chloride concentration of 3.8 mg/L (Q: average Cl at Rustlers Roost is 3.3 mg/L and at Quest 29 is 6.3 mg/L based on EcOz monitoring results. Average across both areas is 5.2 mg/L) (see Section 4.4.5). Using the average chloride concentration from Rustlers Roost, the calculated rainfall groundwater recharge rate is 151 mm/y, which is comparable to the deep drainage estimate of approximately 150 mm/y from the Bureau of Meteorology (BoM) that was used in the Toms Gully groundwater model (GHD, 2018). Given the mean annual rainfall of 1420 mm/y recorded at the Middle Point Rangers station (Station 14090; located approximately 40 km south-west of the modelled area), the chloride mass balance analysis suggests 10.6% of rainfall becomes recharge.

There are some degrees of uncertainty in the adopted chloride deposition rate from rainfall as it is based on a national mapping study (Davies and Crosbie, 2018). Therefore, the recharge multiplier (percentage of precipitation that becomes recharge) was initially set at 10% and refined through model calibration (see Section 5.3.12).

Model precipitation was obtained from recorded daily recharge estimates between 2000 and June 2022 from SILO, with forward estimates of daily recharge obtained from Surface Water and Erosion Solutions. It was noted that a two-month lag was present between peak rainfalls in January and peak standing water levels in March as shown in Figure 5-5. Both the Rainfall recharge data and the stress period phases were offset by two months from the precipitation wet/dry cycles, based on observed trends in the groundwater monitoring data. The average recharge over each stress period was applied to respective stress periods.

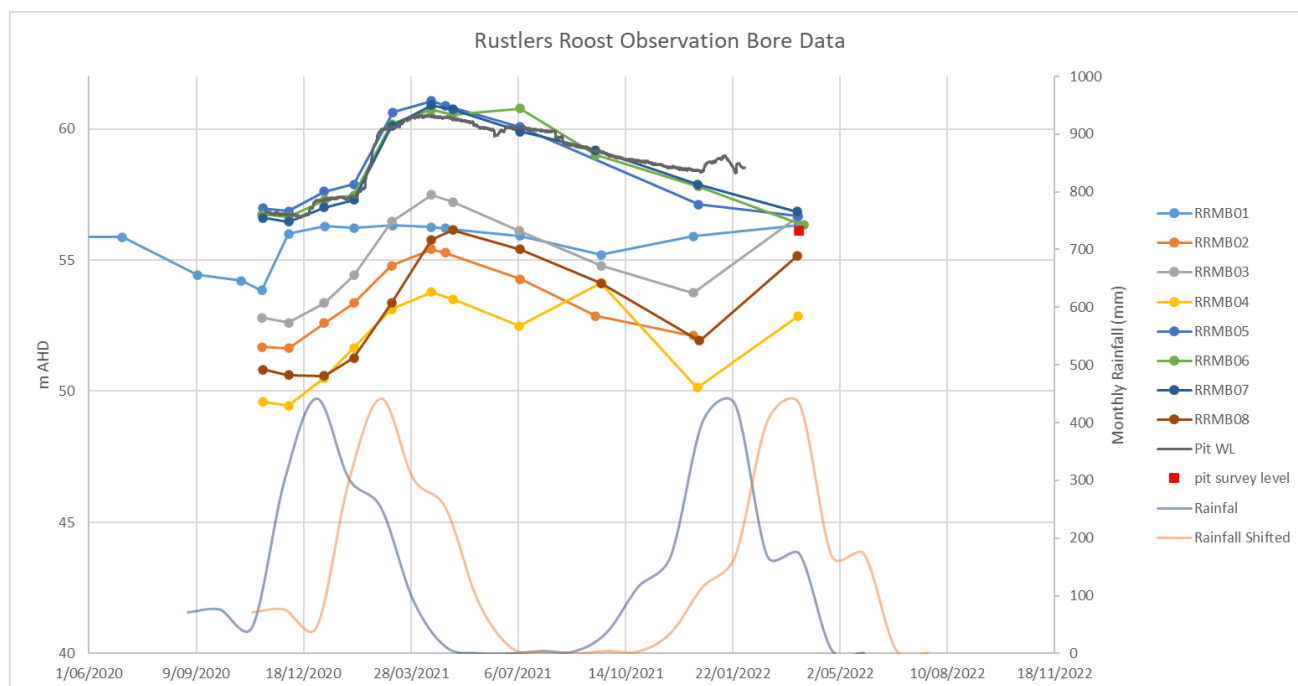


Figure 5-5 Groundwater Observation data and Monthly rainfall data over the period of observations. The Rainfall shifted line refers to a 2 month delay in rainfall data.

5.3.9 Evapotranspiration

Evapotranspiration (ET) from shallow groundwater was adopted from the FAO56 values recorded at the Middle Point Rangers weather station (Station 014090). FAO56 is the approved U.N. World Meteorological Organization standard for evapotranspiration calculations. An evapotranspiration depth of 2 m below ground level (bgl) was applied.

5.3.10 Hydraulic Parameters

The hydrostratigraphic units within the model domain were simulated as two fractured rock aquifer units based on the conceptualisation that hydraulic conductivity decreases with depth in fractured rock aquifers (Section 4.4.3). As discussed above, the shallow portion of the region was conceptualised to represent weathered fractured rock units. Weathering of this upper unit is assumed to be the driver for a resulting elevated hydraulic conductivity and storage parameters in the upper (~80 m) portion of the fractured rock aquifer. Section 4.4.3 summarises the hydraulic conductivity estimates from previous investigations, including studies related to the Toms Gully Mine. As discussed in Section 4.4.3, the slug test estimates are relatively high, which may be influenced by the gravel pack surrounding the tested bores, isolated conductive fractures close to the well or preferential screening of bores in zones of maximum yield (e.g., fault zones) and not representative of regional conditions.

Table 5-3 Hydraulic Conductivity Estimates (m/d) from Previous Investigations

Location	Method	Geometric mean	Min	Max	Source
Rustlers Roost	Pump test	1.2	0.8	1.8	Valdora (1994)
Rustlers Roost	Slug test	4.1	0.8	12.5	Groundwater Enterprises (2021)
Quest 29	Slug test	5.2	0.3	38.8	Groundwater Enterprises (2021)
Toms Gully	Pump test	0.5	0.1	1.0	AGE (2019)
Toms Gully	Model calibration	0.001	0.001	0.001	AGE (2019)
Toms Gully	Model calibration	0.2	0.01	1.0	GHD (2018)

Table 5-4 Storage Parameter estimates (v/v) from Previous Investigations

Parameter	Method	Value	Source
Specific Storage	Pump test	1e-5 to 2.5e-5	Rustlers Roost RN24143 26 hour pumping test
	Model calibration	1e-5	Union Reef mine (GHD, 2019)
	Model calibration	1e-6	Toms Gully calibrated model AGE, 2019
Specific Yield	Model calibration	0.01 (shallow (<40m)) 0.005 (deep >40m)	Union Reef mine calibrated model (GHD, 2019)
	Model calibration	0.0083	Fountain Head calibrated model (CDM Smith, 2021)
	Model calibration	0.0005	Toms Gully calibrated model (AGE, 2019)

5.3.11 Temporal Discretisation

The Project model comprised 99 stress periods. Stress period length during the pre-mining, calibration, mining and immediate post mining (10 years) phases was selected to be 6 months to reflect the wet/dry climate at the Site. The stress period length was progressively increased after 10 years post proposed mining. A summary of the temporal discretisation is presented in Table 5-5 below.

Table 5-5 Temporal Discretisation Summary

Time period	Stress period	Phase	Stress period length	Comment	Type
Pre 2010	1	Initial condition	NA	Pre-proposed mining conditions but post legacy mining conditions – assumed system has reached post legacy mining equilibrium	Steady State
2010 - 2020	2-22	Model warm up	6 months	Model run under transient conditions for stability prior to calibration phase	Transient
2021-2022	22-26	Calibration	6 months	Stress periods cover available mine pit and observation bore data	
2022-2023	27-28	Pre-mining	6 months	Delay to move mining schedule to future time period	
2023-2033	29-48	Mining	6 months	Mining pits turned on and off according to proposed mining schedule	
2033-2043	49-68	Post mining	6 months	Stress period length increases with time after mining	
2043-2056	69-81		1 year		
2056-2072	82-89		2 years		
2072-2096	90-95		4 years		
2096-2122	96-99		8 years		

5.3.12 Model Calibration and Sensitivity Analysis

5.3.12.1 Calibration Approach

Model calibration, also known as model inversion, is a process of estimating the model inputs that can produce outputs that match the field observations. Due to the limited period for which groundwater data was available (two dry and one wet season), average groundwater levels for the respective stress periods were calculated using levels for 8 wells in the Rustlers Roost portion of the Project area and 9 wells in the Quest 29 portion (Figure 5-4).

The GoldSim modelling (described in more detail in Section 6) was used to obtain predicted groundwater inflow rates to the pits during and post mining (Section 6.3.5.2), in addition to modelling post mining pit water levels (Section 6.3.5.6). While the Goldsim post mining water levels were represented in the model generation using the GHB package, the GoldSim predicted fluxes were set as a soft target for the calibration process. The groundwater flux targets were assigned a calibration weighting of 0.1 in recognition of the uncertainty attached to them.

The groundwater levels were calibrated against hydraulic conductivity, rainfall recharge multiplier, specific yield, specific storage and boundary conductance. Groundwater model calibration is non-unique in that there are numerous combinations of parameters that can achieve a similar fit to the field observations. To address this issue, this study used a stochastic modelling approach through PESTPP-IES (White, 2018) to develop 105 different parameter combinations (also known as realisations) that were calibrated to the groundwater level observations and the GoldSim estimates of groundwater flux to the pits. This model ensemble contains 5 spare realisations to account for potential failures, and the best performing (i.e. smallest misfit) 100 realisations were selected for prediction. This stochastic approach is superior to the traditional deterministic modelling approach where only a single model is used for predictions.

The stochastic approach used in this study also enabled probabilistic predictions and a more robust uncertainty analysis (see Section 5.3.13).

Hydraulic conductivity, specific yield (S_y), specific storage (S_s) and the rainfall recharge multiplier were calibrated using pilot points (Doherty *et al.*, 2010), a technique where parameters are estimated at the pilot point locations and then interpolated onto the whole model domain. As the run time of PESTPP-IES is not dependent on the number of calibration parameters, this study used a highly parameterised modelling approach (i.e. an exceptionally high number of calibration parameters) with 885 pilot points for K_h , K_v , S_y , and S_s in both the upper and lower units (i.e., 1770 total pilot points for each parameter). As recharge was only applied to the upper unit, the recharge multiplier parameter had 885 pilot points. In addition, the conductance values of surface water features, mining pits and GHB were included in the calibration.

In addition to matching the calibration targets, the calibration parameters also needed to be constrained within a range that applies to the hydrogeological understanding of the site. The upper and lower bounds for each calibration parameter are provided in Table 5-6.

Table 5-6 Parameter Upper and Lower Bounds for Model Calibration

Parameter	Initial Value	Lower Bound	Upper Bound
Hydraulic conductivity Layer 1 (m/d)	0.1	0.001	1
Hydraulic conductivity Layer 2 (m/d)	0.01	1E-4	0.1
S_s Layer 1 (m^{-1})	1E-6	1E-7	1E-5
S_s Layer 2 (m^{-1})	1E-6	1E-7	1E-5
S_y Layer 1 (-)	0.01	0.05	0.001
S_y Layer 2 (-)	0.001	1E-4	0.01
Recharge Multiplier	0.108	0.001	0.20
Surface water feature conductance (m^2/d)	10	0.001	50
GHB conductance (regional) (m^2/d)	10	0.001	50
GHB conductance (pit lakes) (m^2/d)	100	0.1	500

5.3.12.2 Calibration Performance

The locations of the monitoring bores at Rustlers roost and Quest 29 are shown on Figure 4-7 and Figure 4-8, respectively.

The observed and simulated groundwater levels are compared in Figure 5-6. The dots and error bars in the figure represent the mean and the range of the 100 calibrated model realisations respectively.

Figure 5-6 shows that all data points and error bars are close to the 1:1 reference line (i.e. the observed and simulated values are very similar), indicating a satisfactory calibration. The model ensemble has a mean Root Mean Squared Error (RMSE) of 2.1 m (ranging between 1.9 and 2.3 m) and a Scaled RMSE (SRMSE) of 4.2% (ranging between 3.8% and 4.6%). The low RMSE and SRMSE suggest that each of the 100 model realisations matched the field observations satisfactorily.

While the model has a good fit to the data in general, the modelled water level at select bores (Q29MB05, Q29MB06, Q29MB07) remains static when compared to the observed data. The dynamic water levels observed in the monitoring data are interpreted to be due to local preferential recharge features that have not been captured in the model, (e.g. potential surface flow into the North and South Koolpin Pits resulting in a multiplied recharge in the area). The deviations between modelled and observed heads in these bores are not inferred to result in notable impact to the model given the satisfactory overall fit of the modelled data to the observed data.

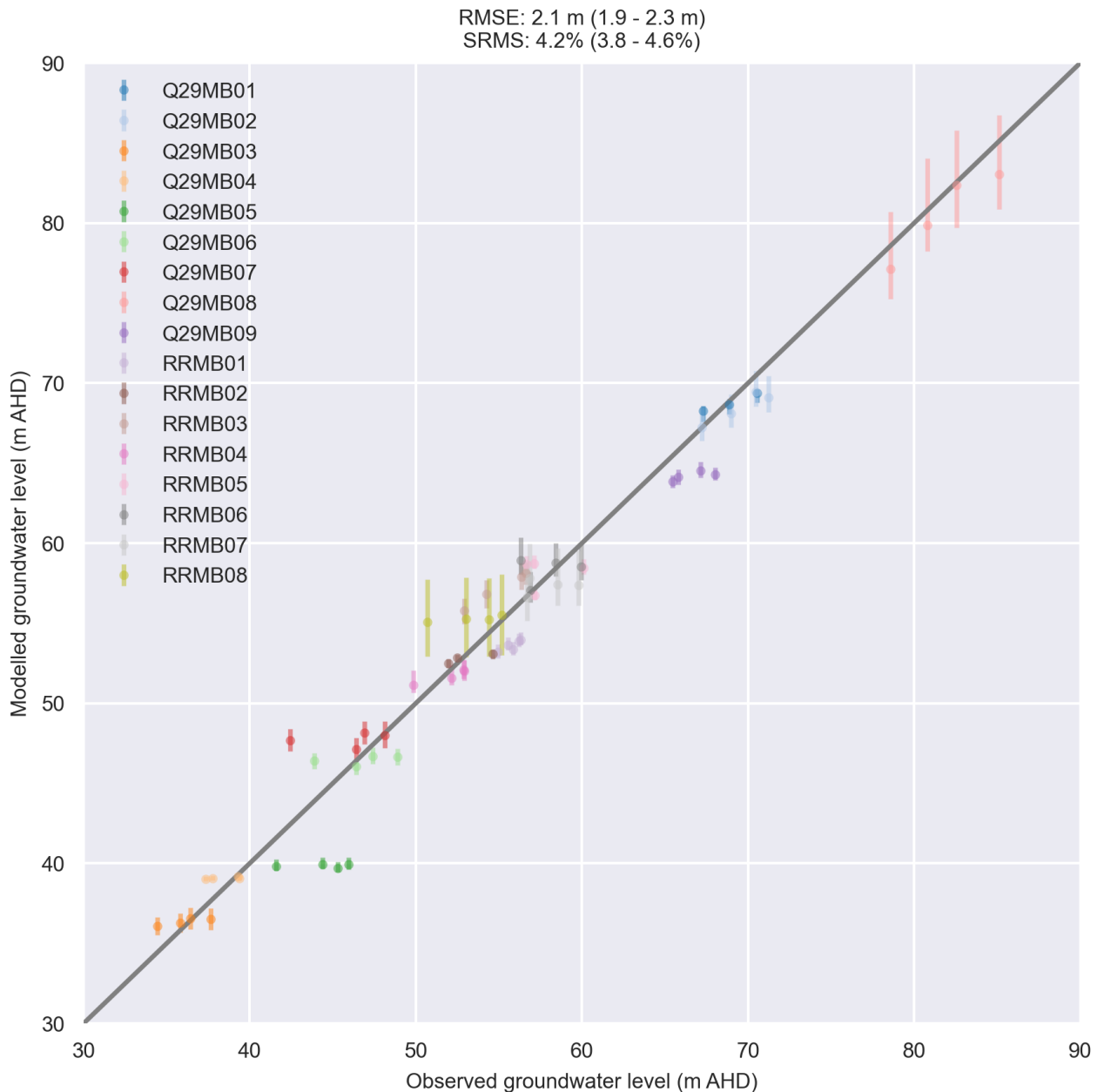


Figure 5-6 Comparison of Observed and Simulated Groundwater Levels

To maintain the readability of this report, hydrographs with observed and all Pits are shown in Appendix C, and select hydrographs are presented in Figure 5-7. In general, the hydrographs suggest a reasonable match between the observed and modelled water levels with observed wet and dry seasons water levels aligning with those predicted in the model. As discussed above Q29MB05 shows a discrepancy between the modelled and observed groundwater levels, with the model underpredicting the water level by 4-6 m and displaying reduced wet/dry season amplitude when compared to the observed data. As discussed above, this bore may be subject to localised preferential recharge which was not able to be captured in the regional scale model. When viewing the simulated hydrographs (Appendix C.1) for bores adjacent to the existing Rustlers Roost mine pit lake (RRMB05-RRMB07) there is a marked increase in the simulated water-level in 2021. An example of this increase is presented in Figure 5-7 for this increase in RRMB06. This increase is due to the set GHB water levels within the pit. The pre-2021 mine pit water levels were taken as the first observation available,

with transient data only available between 2021 and 2022, as this transient data captures wet and dry season cycles the corresponding regional water levels observed in the monitoring bore locations correspondingly rise.

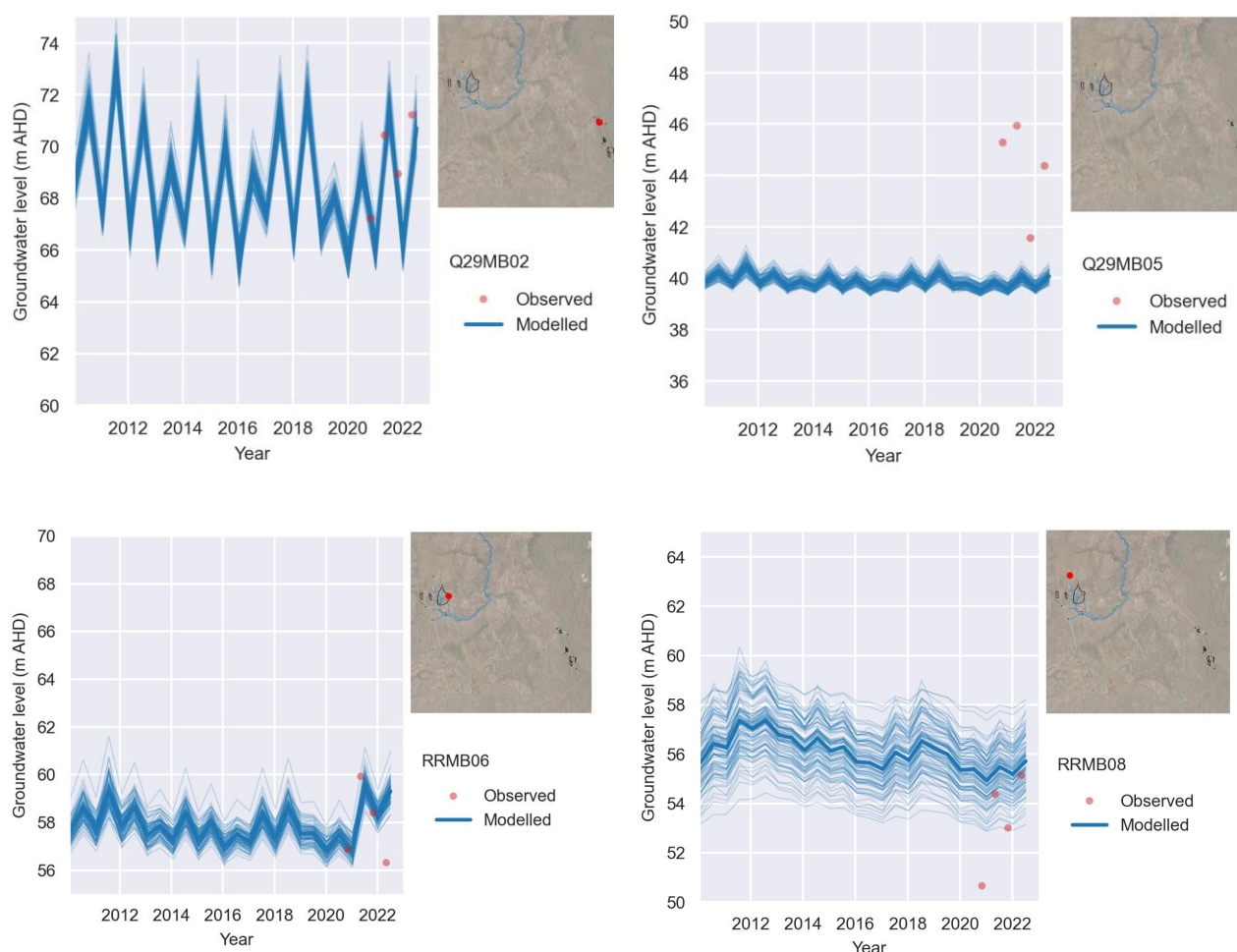


Figure 5-7 Comparison of Observed and Simulated Groundwater Levels for Q29MB02, Q29MB05, RRM06 and RRM08

Figure 5-8 to Figure 5-15 compare the target and modelled groundwater flux for the mine pits. Given the uncertainty in the flux targets (i.e. a hard match is not intended), the comparison shows a satisfactory match. It is noted that in the post mining phase once recovery of the pit water levels have been achieved, that there is a negative flux of groundwater out of the mining pit lakes - this indicates that these features are acting as a groundwater source within the model domain. This aligns with measured groundwater observations which show groundwater bores adjacent to pit lakes at a consistently elevated water level compared to more distal bores. When viewing the predicted vs simulated groundwater flux plots for Taipan (Figure 5-15), the modelled flux shows a sharp outflow from the Pit lake in the stress periods preceding the mining operations. The pre-mining outflow and reduced inflow during the first half of the mining phase is due to the superposition of the drawdown cone from the mining of the adjacent Zamu pit which reduces the surrounding water levels and hence reduces the hydraulic gradient between the pit and the regional water table. This trend is also observed in the predicted versus simulated flux plots for the South Koolpin pits.

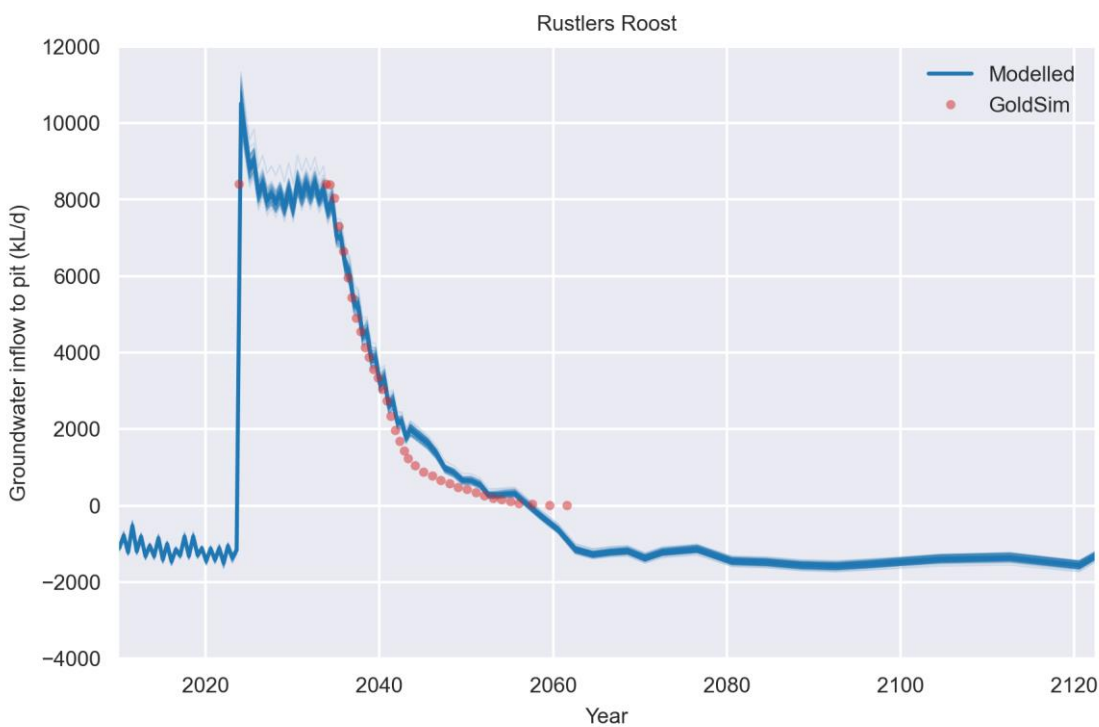


Figure 5-8 Comparison of groundwater flux to the Rustlers Roost pit - GoldSim (orange) and 2022 MODFLOW model (blue)

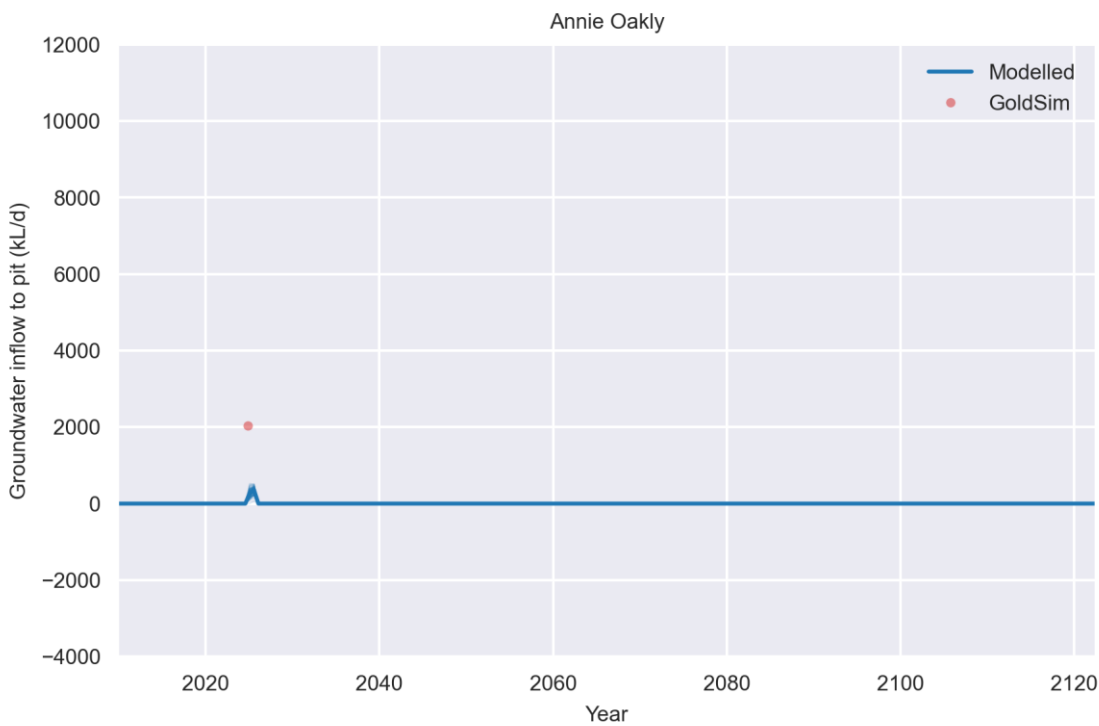


Figure 5-9 Comparison of groundwater flux to the Annie Oakly - GoldSim (orange) and 2022 MODFLOW model (blue)

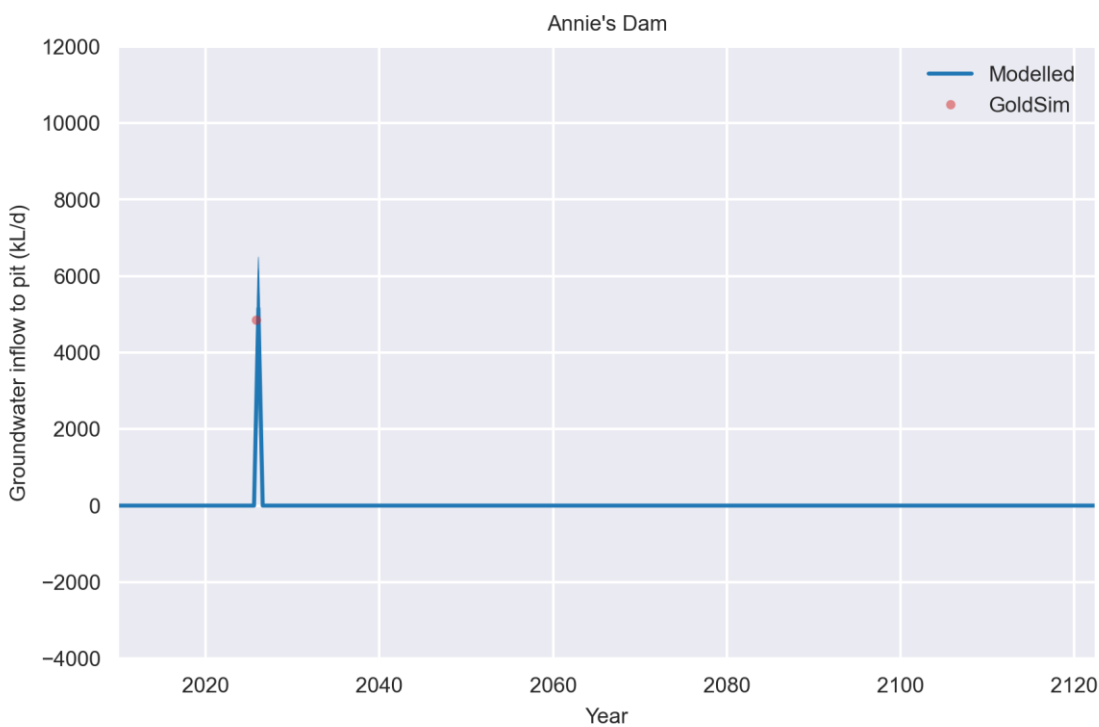


Figure 5-10 Comparison of groundwater flux to the Annie’s Dam pit - GoldSim (orange) and 2022 MODFLOW model (blue)

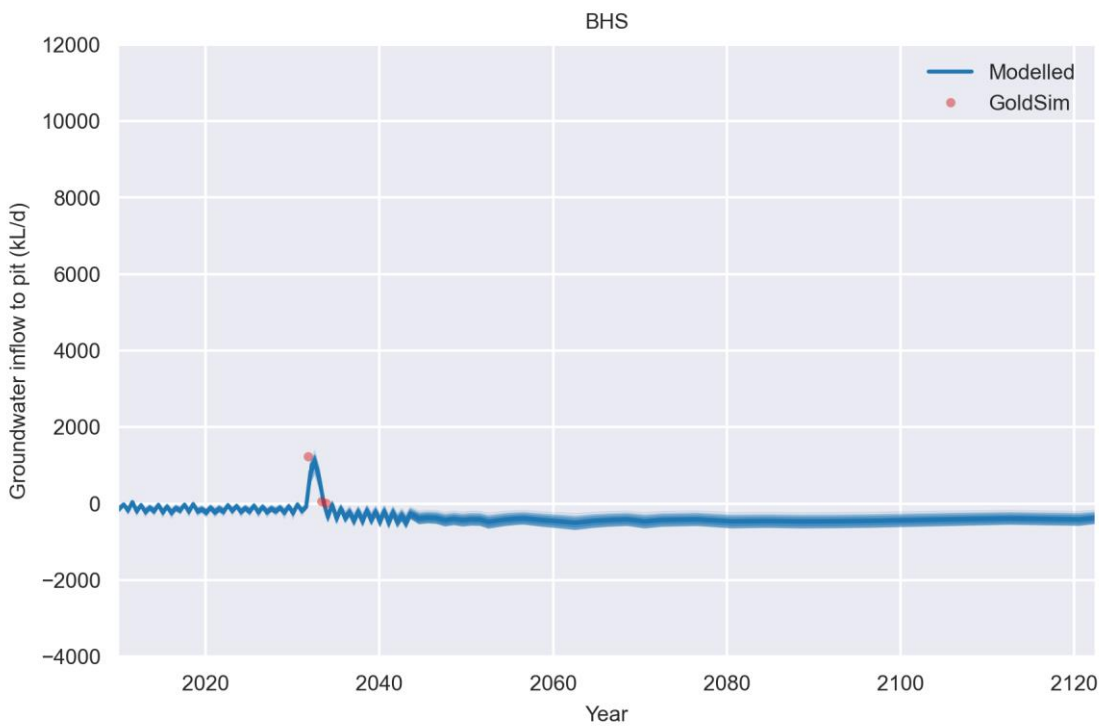


Figure 5-11 Comparison of groundwater flux to the BHS pit - GoldSim (orange) and 2022 MODFLOW model (blue)

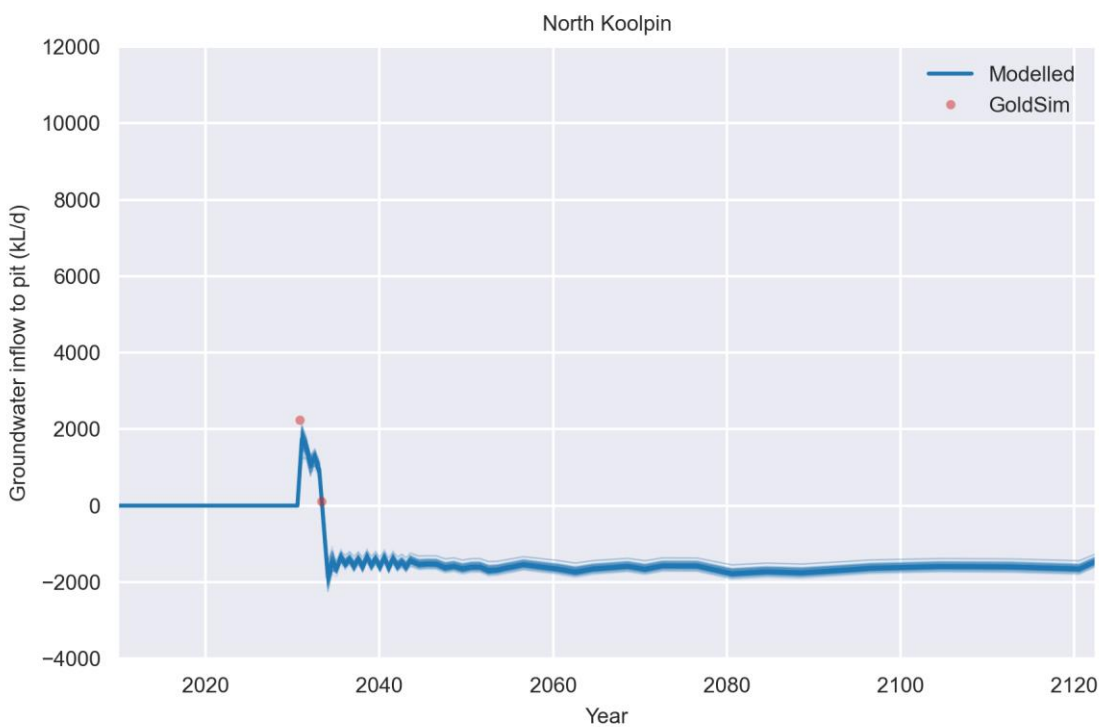


Figure 5-12 Comparison of groundwater flux to the North Koolpin pit - GoldSim (orange) and 2022 MODFLOW model (blue)

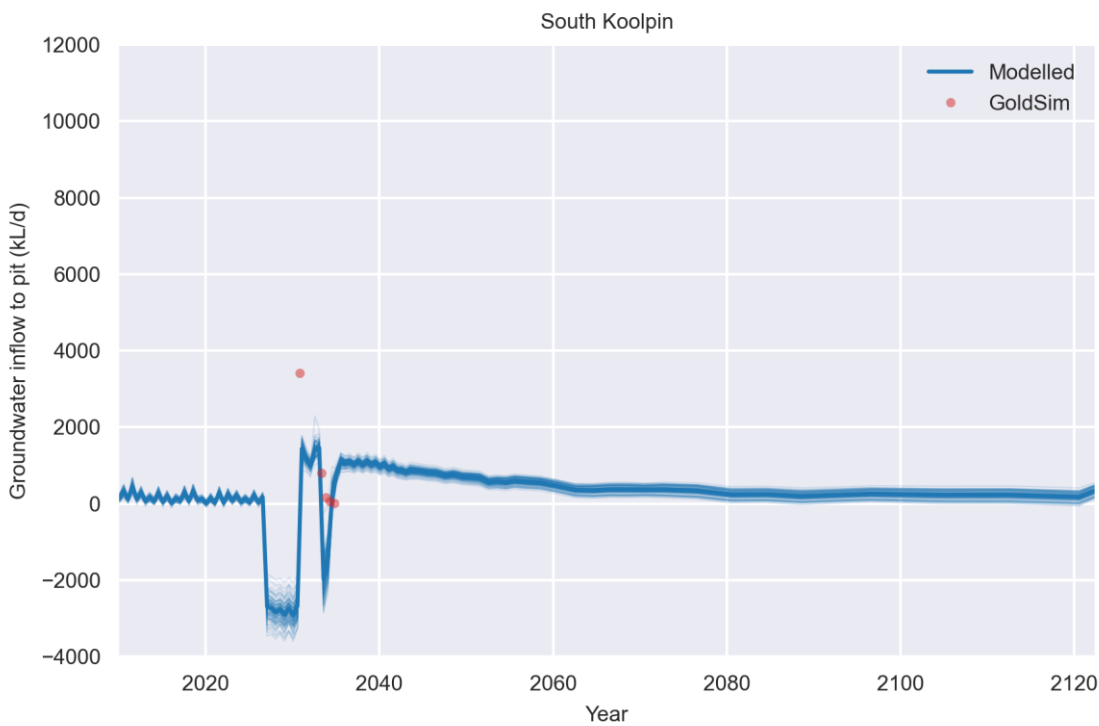


Figure 5-13 Comparison of groundwater flux to the South Koolpin pit - GoldSim (orange) and 2022 MODFLOW model (blue)

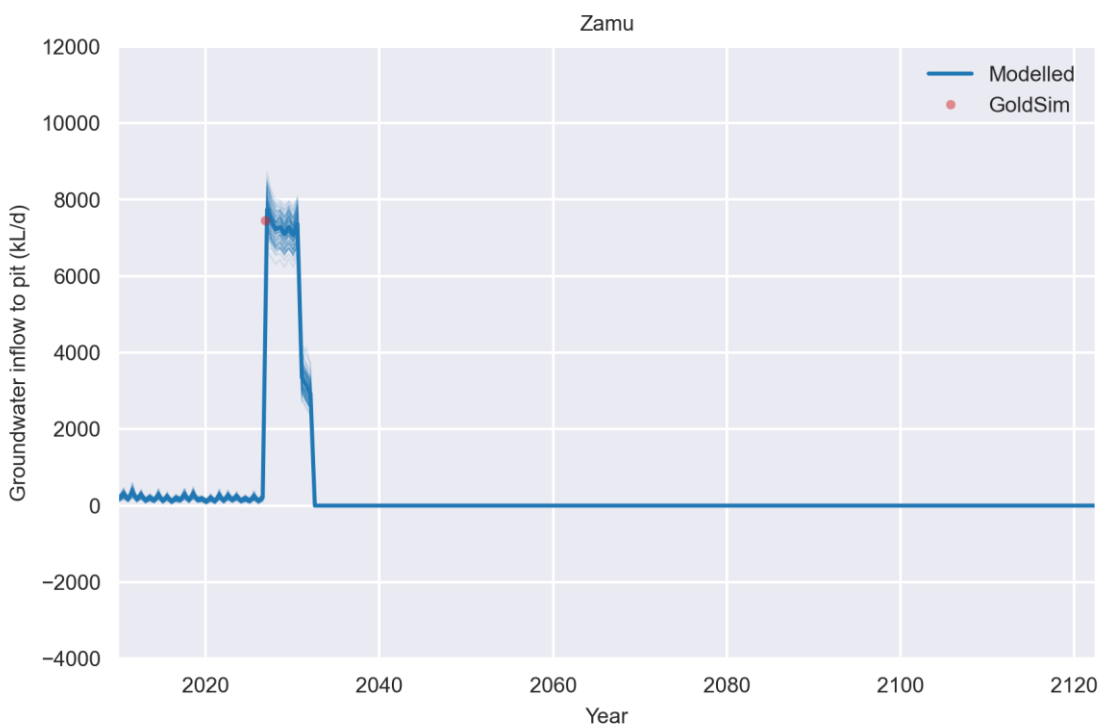


Figure 5-14 Comparison of groundwater flux to the Zamu pit - GoldSim (orange) and 2022 MODFLOW model (blue)

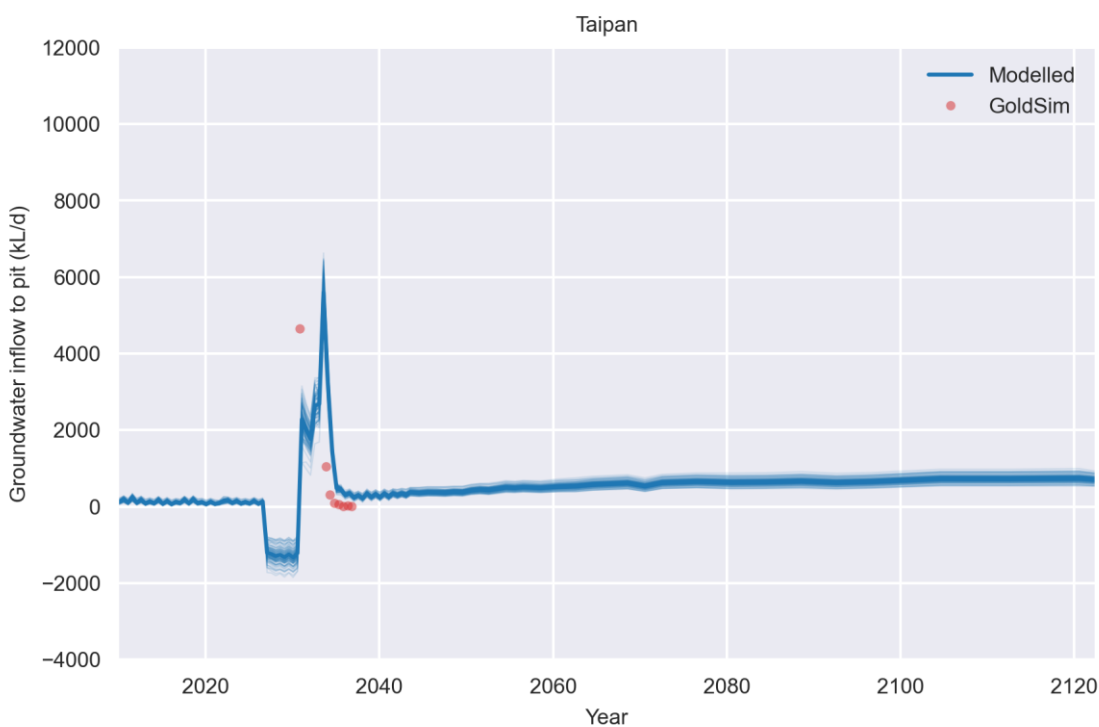


Figure 5-15 Comparison of groundwater flux to the Taipan pit - GoldSim (orange) and 2022 MODFLOW model (blue)

5.3.12.3 Calibrated Parameters

Although all the 100 model realisations fitted the field observations satisfactorily (see Section 5.3.12.2), calibrated parameters varied considerably across the realisations, demonstrating the impact of non-uniqueness. Assuming the parameters are log-normally distributed, the geometric mean represents the mostly likely value. As such, all the values shown in this section are the geometric mean across the 100 calibrated model realisations.

Figure 5-16 shows the Layer 1 K_h while Figure 5-17 show K_h for Layers 2 and 3. The figures indicate a region of elevated (0.8-1.1 m/d) K_h to the southwest of both the Rustlers Roost and Quest29 mining pits in layer 1, with generally lower (0.001 – 0.2 m/d) K_h to the north east of the mining pits. In layers 2 and 3 (Figure 5-17), K_h is an order of magnitude lower. A higher (0.08 – 0.1 m/d) K_h zone is present around the Rustlers Roost mining pit and to the northwest of the Quest 29 mining pits.

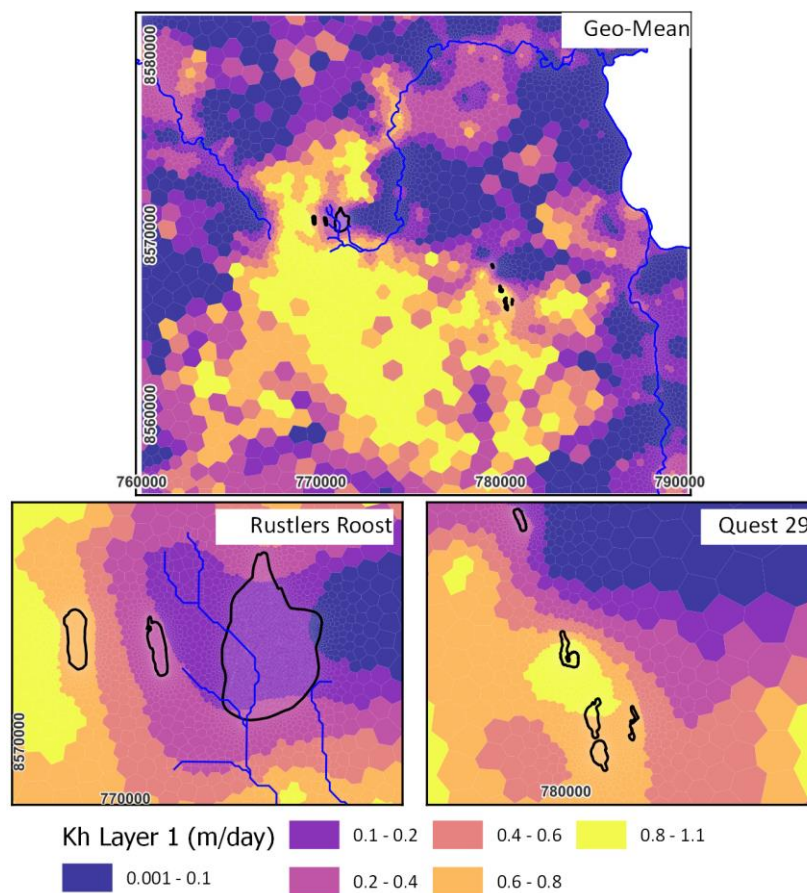


Figure 5-16 Calibrated Hydraulic Conductivity (K_h) (in m/d) of Layer 1 (geometric mean across the 100 model realisations)

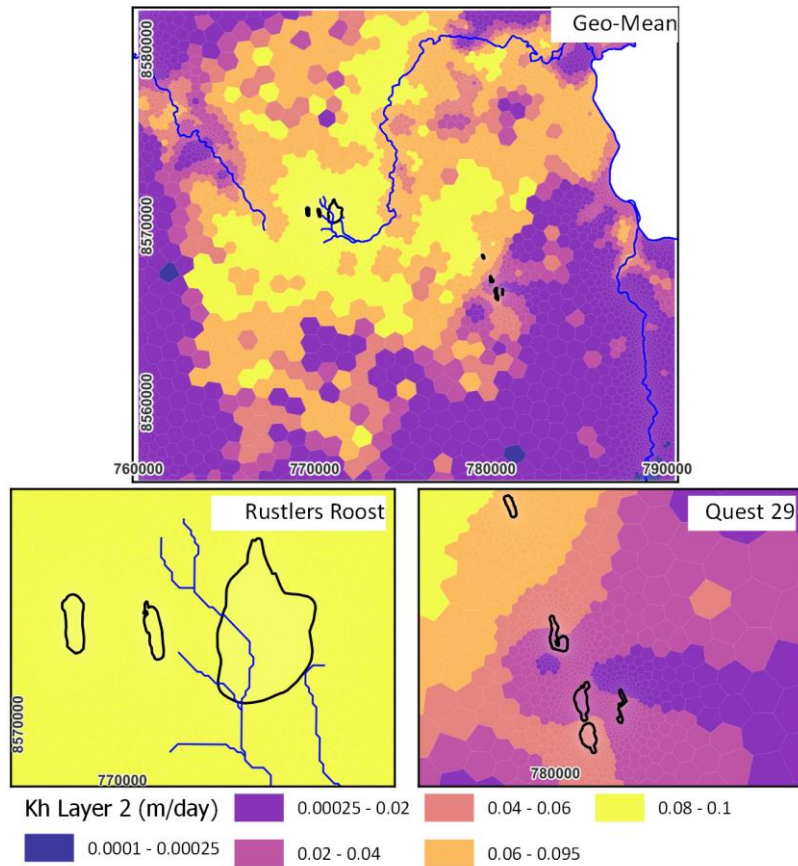


Figure 5-17 Calibrated mean Hydraulic Conductivity (K_h) (in m/d) of Layer 2 & 3 1 (geometric mean across the 100 model realisations)

The $K_h : K_v$ ratios for layer 1 and layers 2 and 3 are presented in Figure 5-18 and Figure 5-19, respectively. The mean calibrated model data indicates high $K_h : K_v$ ratio along a north-west to south-east band through the centre of Layer 1. While in layers 2 and 3 high $K_h : K_v$ ratios are dominant in the north-western quadrant of the model domain.

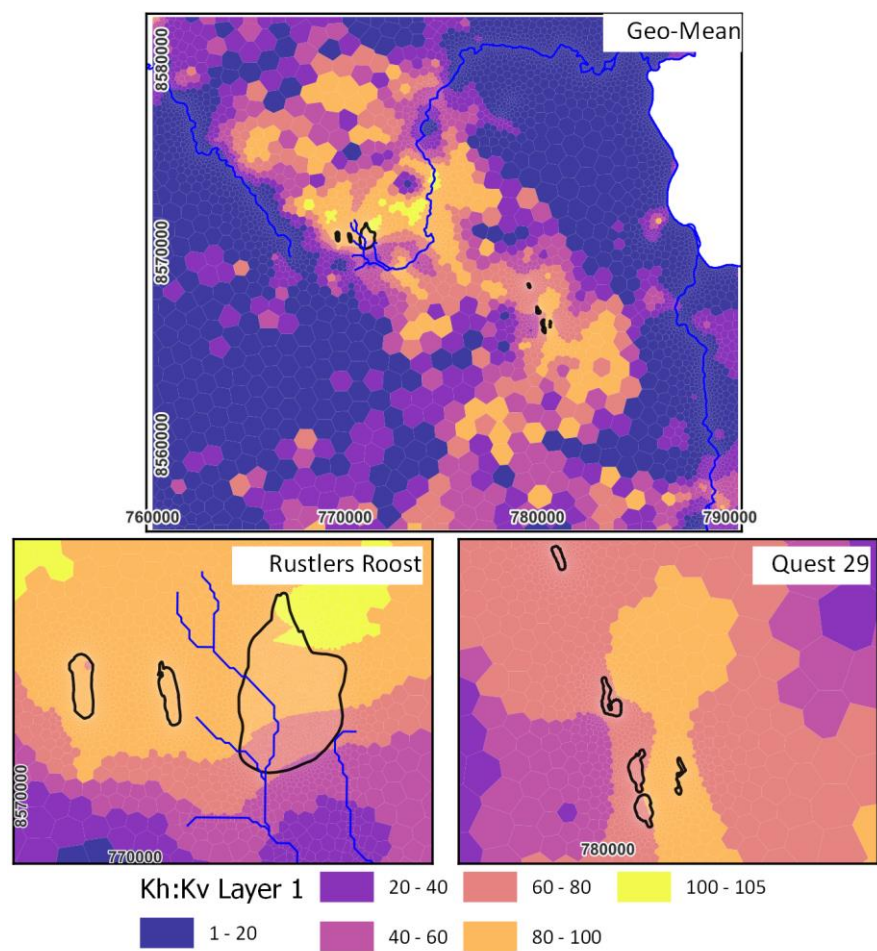


Figure 5-18 Calibrated mean $K_h : K_v$ ratio for Layer 1 (geometric mean across the 100 model realisations)

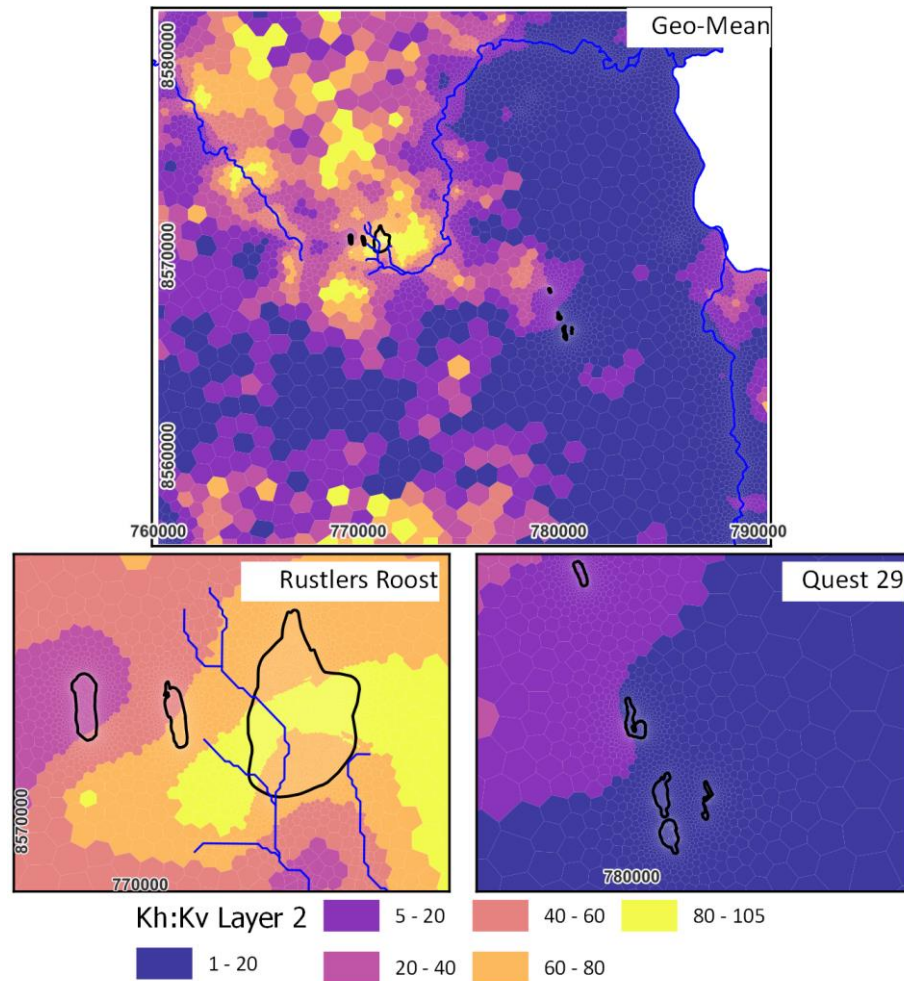


Figure 5-19 Calibrated mean Kh : Kv ratio for layers 2 and 3 (geometric mean across the 100 model realisations)

The mean S_s for Layer 1 and Layers 2 and 3 are shown in Figure 5-20 and Figure 5-21, respectively. In layer 1, mean S_s values dominantly fall between $1E-6$ and $5E-6$. In layers 2 and 3, the area surrounding Rustlers Roost and the region to both the north and south of the mining pit show elevated calibrated S_s values ($7.5E-7$ – $3E-6$) when compared to the region around the Quest 29 pits ($1E-9$ to $5E-7$). This finding is consistent with Rau et al. (2018), who suggested a physical upper limit of $1.3E-5 \text{ m}^{-1}$ for S_s .

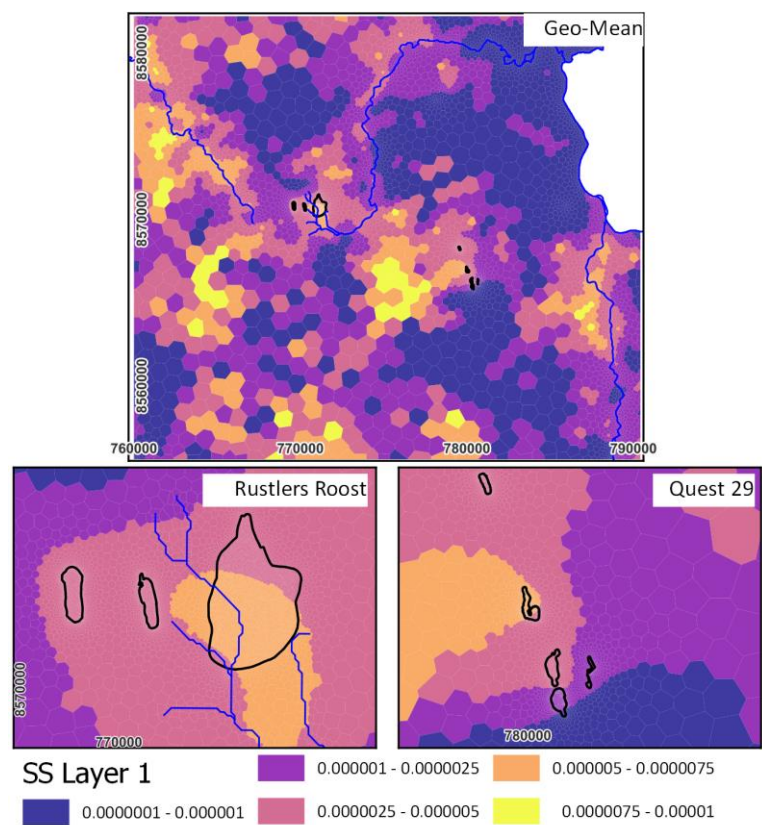


Figure 5-20 Calibrated mean Ss values for Layer 1 (geometric mean across the 100 model realisations)

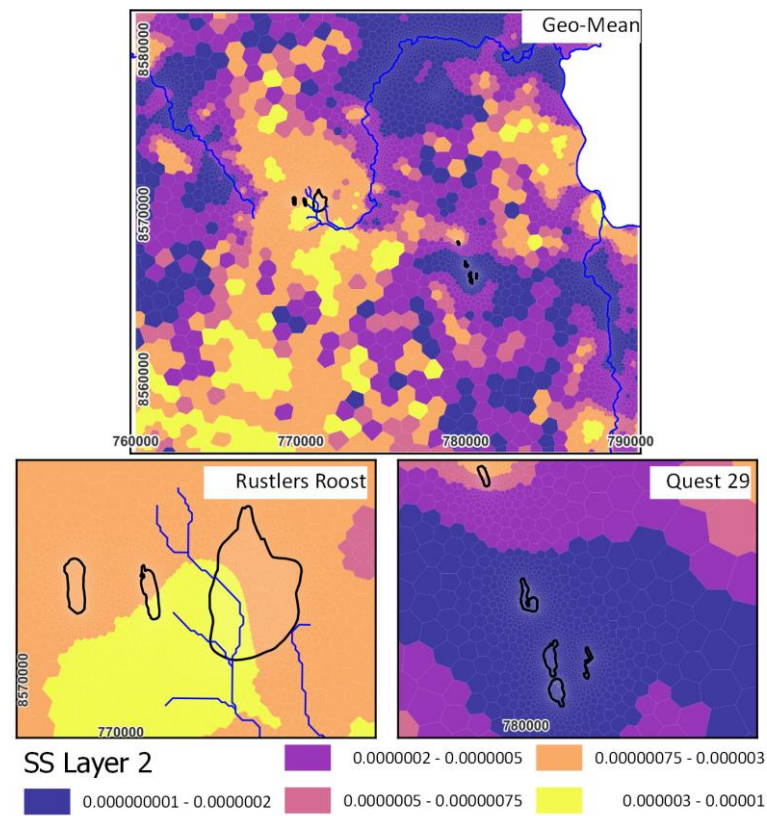


Figure 5-21 Calibrated mean Ss values for layers 2 and 3 (geometric mean across the 100 model realisations)

The mean calibrated specific yield values indicate a region of higher yield (3 % to 5.2%) to the north of Rustlers Roost and to the north-east of the Quest29 pits in Layer 1. In other areas of the model domain S_y ranged dominantly ranges between 0.1% and 2%. In layers 2 and 3 S_y was elevated in the north-eastern half of the model domain with values generally between 0.15% and 1%. In the south-western half of the model domain S_y in layers 2 and 3 generally ranged from 0.01% to 0.05%. Excluding the area adjacent to the Rustlers Roost mining pit, layers 2 and 3 are not likely to become unconfined and hence S_y values are largely not impactful to model predictions. Plots of S_y for Layer 1 are presented in Figure 5-22.

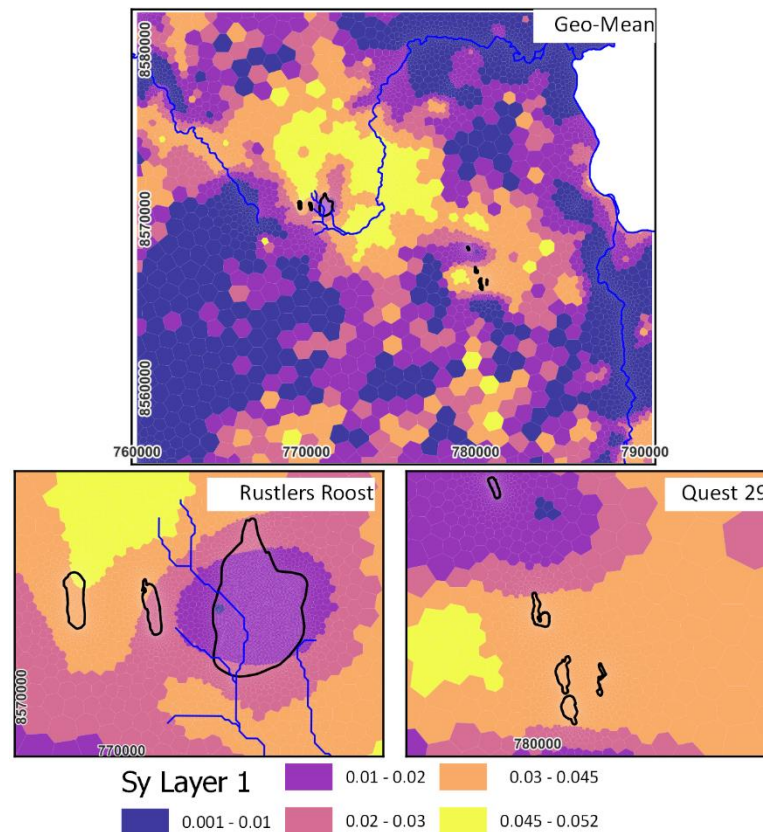


Figure 5-22 Calibrated mean S_y values for Layer 1 (geometric mean across the 100 model realisations)

Figure 5-23 shows the calibrated mean rainfall recharge multipliers (unitless) across the 100 model realisations. The recharge multiplier is the portion of rainfall that can become recharge. Recharge multipliers are high (0.15-0.21) to the south of Rustlers Roost, and to the north and east of the Quest29 mining pits. The elevated recharge multipliers generally align with surface elevations (Figure 5-23) with areas of higher topography generally having a higher recharge multiplier.

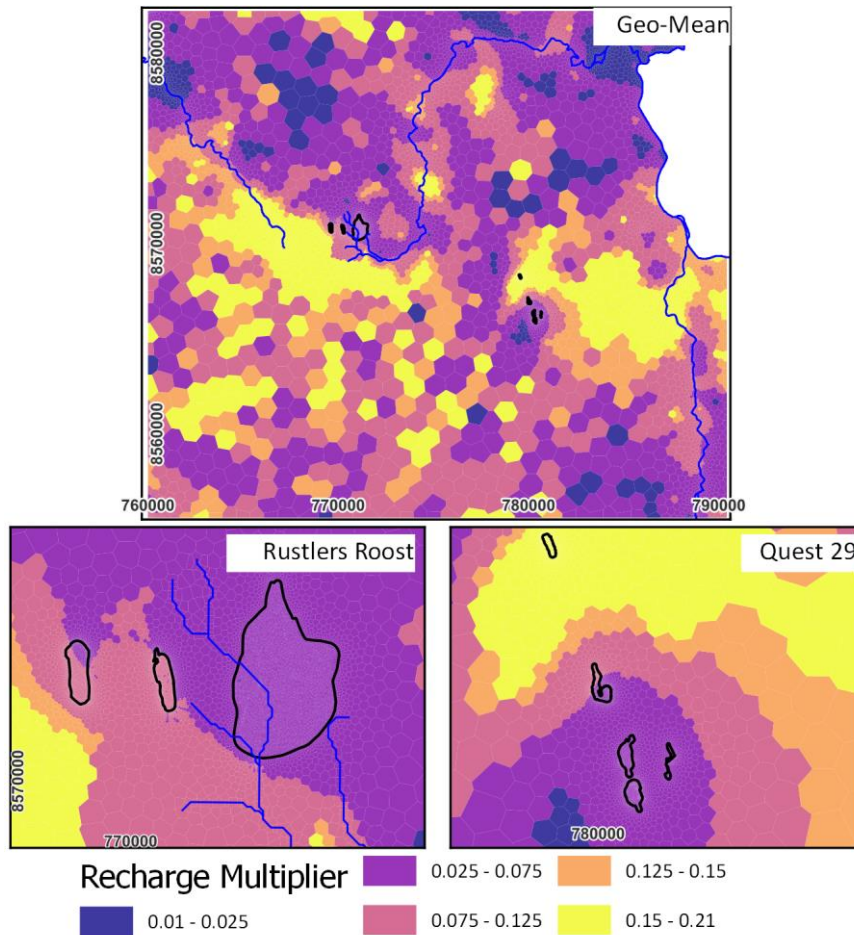


Figure 5-23 Calibrated mean Rainfall Recharge multipliers of the Base Model Realisation (geometric mean across the 100 model realisations)

Table 5-7 summarises the calibrated parameter statistics across the 100 model realisations, with the uncertainty presented as the 5th and 95th percentiles. For most model parameters, the range between the 5th and 95th percentiles were very wide though consistent with conceptual knowledge of the region (e.g., pump test data), suggesting a reasonable coverage of parameter space for predictive modelling (i.e. the parameter combinations used for predictive modelling are sufficiently different from each other).

Table 5-7 Calibrated Parameters for the Base Model Realisation and Statistics for the 100 Calibrated Model Realisations

Parameter	Layer	Description	100 Calibrated Model Realisations		
			Geometric	5 th percentile	95 th percentile
Hydraulic conductivity (m/d)	1	Geometric mean	0.33	0.16	0.53
	2/3		0.06	0.03	0.09
Kh :Kv (-)	1		60.62	28.58	89.62
	2/3		17.26	7.14	44.08
SS (m ⁻¹)	1		3.2E-06	6.5E-07	8.5E-06
	2/3		8.0E-07	2.3E-07	3.1E-06
Sy (-)	1		0.024	0.012	0.037
	2/3		0.0011	0.00023	0.0054
Recharge multipliers	1		0.07	0.04	0.1
GHB conductance (m ² /d)	N/A	Western boundary	31	7	50
		Rustlers Roost pit lake	79	12	401
		Annie Okaley Pit	41	5	289
		Annie's Dam Pit	18	3	117
		BHS pit lake	259	52	500
		South Koolpin pit lake	10	1	50
		North Koolpin pit lake	16	3	111
		Taipan pit lake	31	7	50
		Zamu pit lake	79	12	401
Drain conductance (m ² /d)	N/A	Mount Bunday Creek	14	2	50
		Marrakai Creek	13	2	50
		McKinlay River	19	4	49
		Rustlers Roost pit lake	77	12	426
		Annie Okaley Pit	35	5	135
		Annie's Dam Pit	36	4	189
		BHS pit lake	37	5	146
		South Koolpin pit lake	470	319	500
		North Koolpin pit lake	156	16	500
		Taipan pit lake	211	39	500
		Zamu pit lake	161	16	500
Riverbed conductance(m ² /d)		Mary River	20	3	50

Groundwater Levels

The simulated groundwater levels from the calibrated base model realisation are shown in Figure 5-24. In the Quest 29 area, groundwater generally flows to the east/south-east towards the McKinlay River, with a groundwater mound to the north-east of the site that coincides with the topographic high. The Rustlers Roost portion of the Project area is located on a groundwater divide, with some groundwater flowing to the east towards Mount Bunday Creek and some flowing to the west towards the Marrakai Creek.

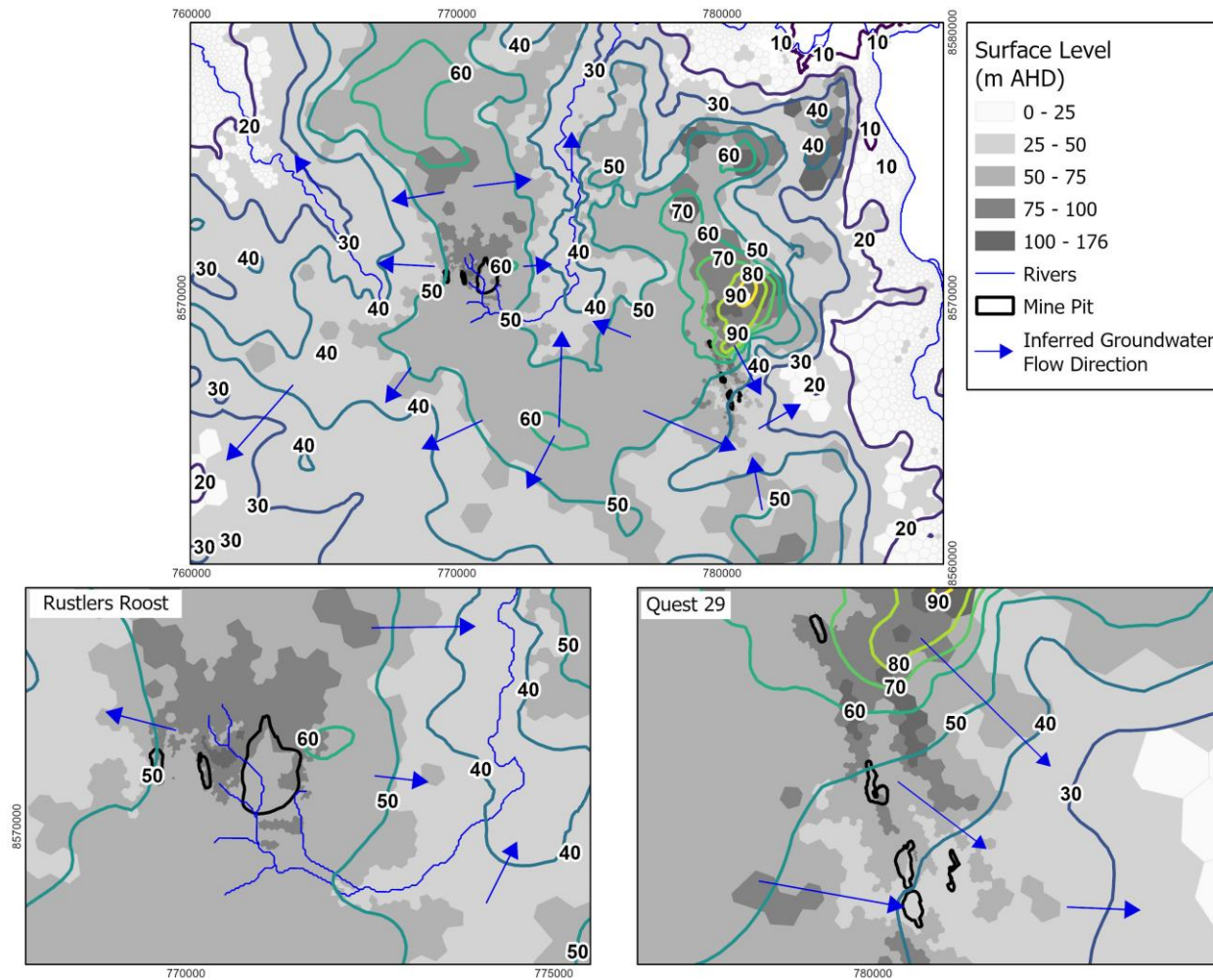


Figure 5-24 Modelled Groundwater Levels (m AHD) for the Pre-Proposed Mining Conditions (geometric mean across the 100 model realisations)

The modelled groundwater contours appear to have largely recovered by 20 years post mining. The predicted 20 year post mining groundwater contours and inferred flow directions are presented in Figure 5-25. These data indicate that Rustlers Roost remains on a groundwater divide with inferred groundwater flow moving to the east and west of the former mining pit. The Quest 29 mining pits are located on a regional groundwater flow path and hence have an increased potential for throughflow.

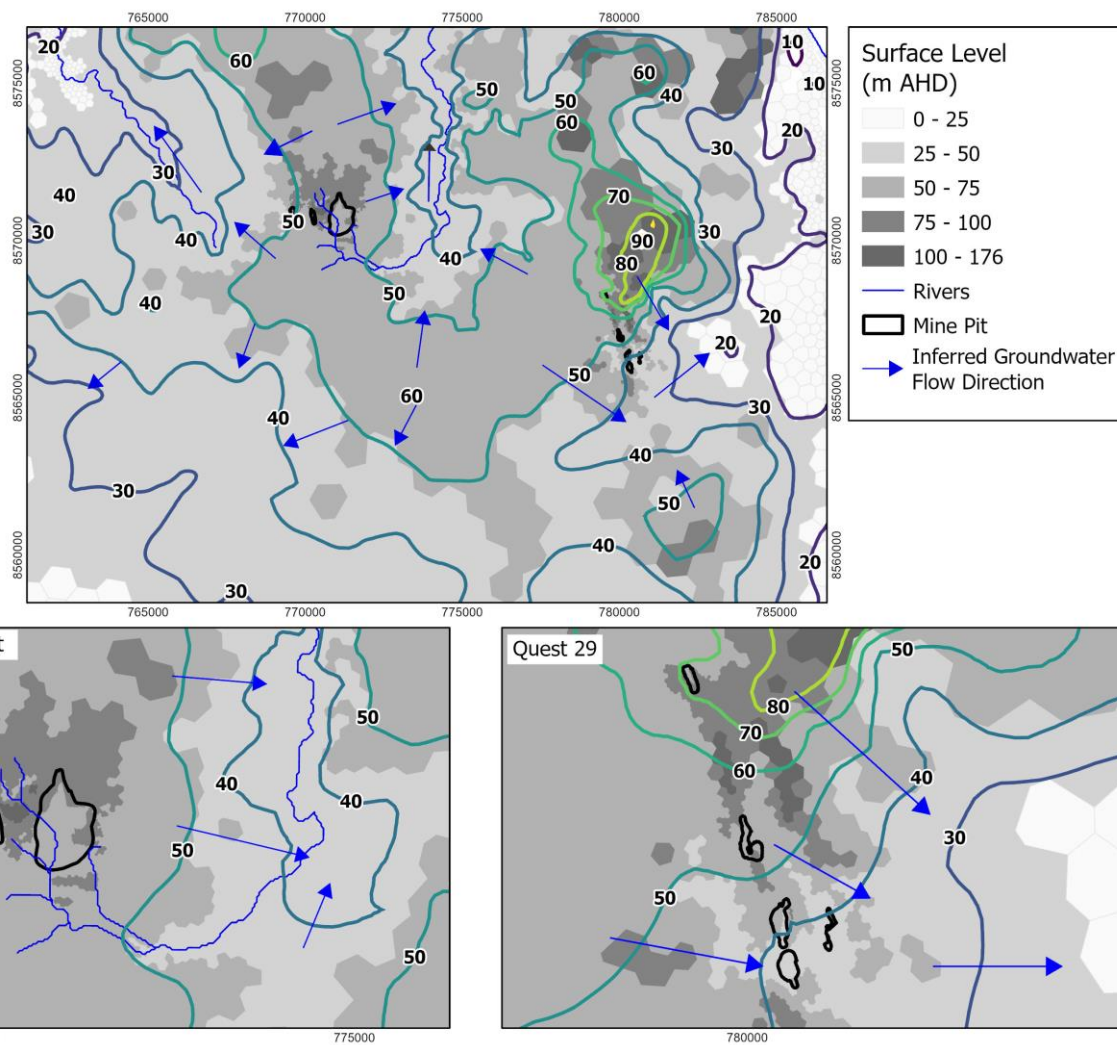


Figure 5-25 Modelled Groundwater Levels (m AHD) 20 years post mining (geometric mean across the 100 model realisations)

Mass Balance

Table 5-8 shows the mean mass balance across the 100 calibrated model realisations. The inflows and outflows of the groundwater system are dominated by rainfall recharge and ET respectively. All 100 model realisations show negligible mass balance discrepancies, indicating good convergence performance. This is consistent with the Australian Groundwater Modelling Guidelines (Barnett *et al.*, 2012) recommended mass balance discrepancy limit of <1%.

Table 5-8 Mass Balance (kL/d) (Mean of the 100 Calibrated Model Realisations)

Water Balance Component	Steady-state (Average between 1900 and 2010)	End of Calibration Period (Nov 2021 – Apr 2022)
Storage IN	0.0	39,797
GHB IN	1,940	2,509
Recharge IN	319,059	117,949
River	6,899	7,344
Total IN	327,899	167,601
Storage OUT	0	0
Drains OUT	320	103
GHB OUT	2498	1996
ET OUT	325,004	165,423
Total OUT	327,913	167,601
IN - OUT	-14	-0.7
Percent discrepancy	-0.004%	-0.0004%

Sensitivity Analysis

Due to the stochastic approach adopted in this study, the sensitivity analysis needs to be undertaken in a different manner using the concept of relative uncertainty reduction of parameters (Manewell and Doherty, 2021), which is defined as follows:

$$r_i = 1 - \frac{\sigma_i^{post}}{\sigma_i^{prior}}$$

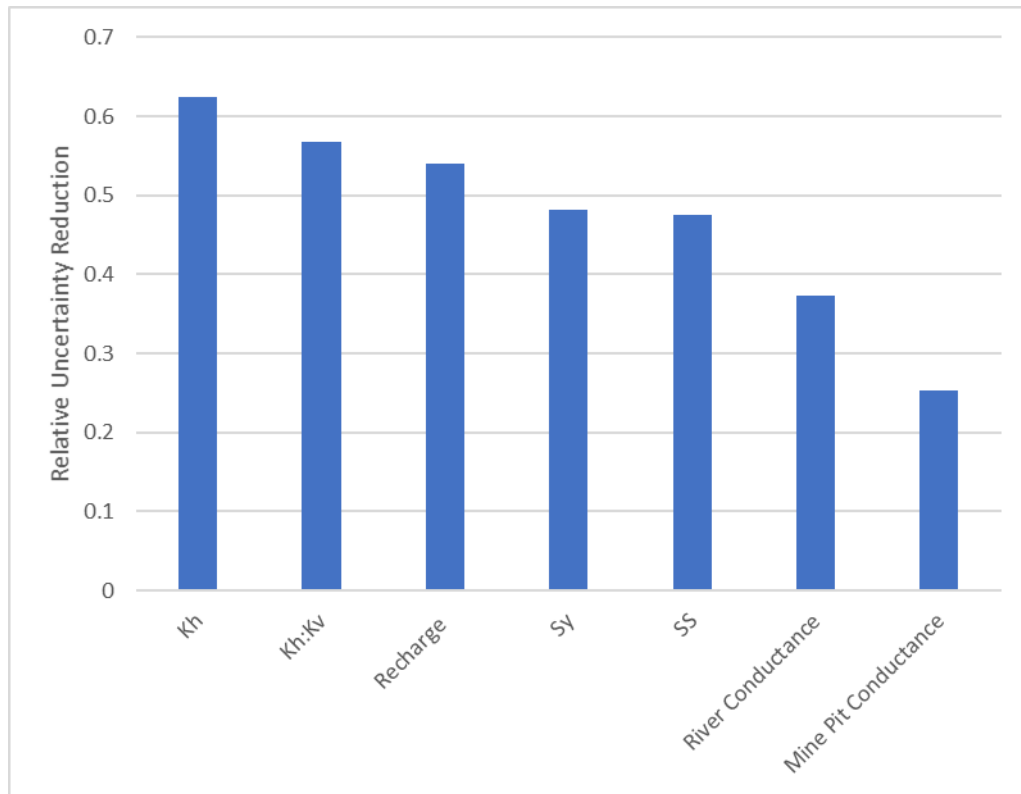
Where:

- r_i is the relative uncertainty reduction of parameter i .
- σ_i^{prior} is the prior uncertainty of parameter i (i.e. the standard deviation of parameter i across the 100 realisations before calibration).
- σ_i^{post} is the posterior uncertainty of parameter i (i.e. the standard deviation of parameter i across the 100 realisations after calibration).

This approach is based on the rationale that the uncertainty (i.e. the standard deviation across the 100 realisations) of a more sensitive parameter would be reduced more by the calibration, and vice versa.

Figure 5-26 presents the results of the parameter sensitivity analysis. The sensitivity results were aggregated for each main type of parameter for clarity purposes. The results show that horizontal hydraulic conductivity is the most sensitive parameter, followed by the horizontal to vertical hydraulic conductivity ratio and recharge. The model was more sensitive to changes in the aquifer properties and recharge parameters and less sensitive to the conductance values for

both the mining pits and river features. The lower model sensitivity to mine pit conductance values may be due to the lower weighting assigned to the GoldSim flux targets when compared to the head targets.



Kh = Horizontal hydraulic conductivity, Ss = specific storage, Sy = specific yield, Kh:Kv = Vertical anisotropy of hydraulic conductivity

Figure 5-26 Parameter sensitivity analysis

5.3.13 Probabilistic Predictive Modelling and Uncertainty Analysis

The developed transient groundwater model was used in predictive mode to simulate the impact of the proposed mining operations (in terms of dewatering of the mining pits) on groundwater levels and drawdown, using the stochastic approach adopted for the model calibration.

Model uncertainty was assessed using two main methods, firstly the 95th percentile of modelled drawdowns were investigated. These data were calculated on a cell by cell basis and represent that 95% of the model simulations had drawdowns less than or equal to those represented in the 95th percentile plots (Section 5.3.13.1). Uncertainty surrounding the GoldSim predicted post mining pit water levels was assessed by running the 5th percentile of the simulated recovery rates and as such represent a slower mine pit recovery than the geometric mean case. Both of these approaches allow for the model to simulate the plausible range of model conditions that may be expected.

5.3.13.1 Groundwater Drawdowns from Dewatering of Proposed Pits

The extents of predicted maximum drawdown (as represented by the 1 m drawdown level) resulting from the dewatering of the proposed pits are shown in Figure 5-27. Drawdown values were calculated by subtracting the simulated groundwater levels from baseline values established using an additional set of simulations where pre-mining boundary conditions were active for the entire model duration (i.e., further mining never occurs). Maximum drawdown extents were noted in the stress period immediately after the cessation of mining of the Rustlers Roost pit. The 1 metre drawdown has been selected as the indicator of the maximum extent as drawdowns of less than 1 m are considered beyond the model accuracy, due to limited data availability and associated model uncertainty. In the area surrounding

the Rustlers Roost, Annie Oakley, and Annie's Dam Pits, the drawdown cone is elongated to the north and south along a topographic high.

Mean drawdowns of up to 1 m are predicted up to 2.0 km to the east and west, 4.8 km to the north and 3.0 km to the south of the Rustlers Roost mining pit. The Annie Oakley and Annie's Dam Pits do not appear to have a notable impact on the predicted drawdowns.

With the Quest29 mining Pits drawdown is centralised around the Taipan and Zamu pits. The drawdown extent looks to be limited to the north by the sharp topographic high, though extends to the west along a more subdued topographic high. The predicted drawdown around the Quest29 pits appears to be much more radial in nature with drawdowns of up to 1 metre predicted up to 2 km from the Taipan pit to the north, south and east, and 3.5km to the west.

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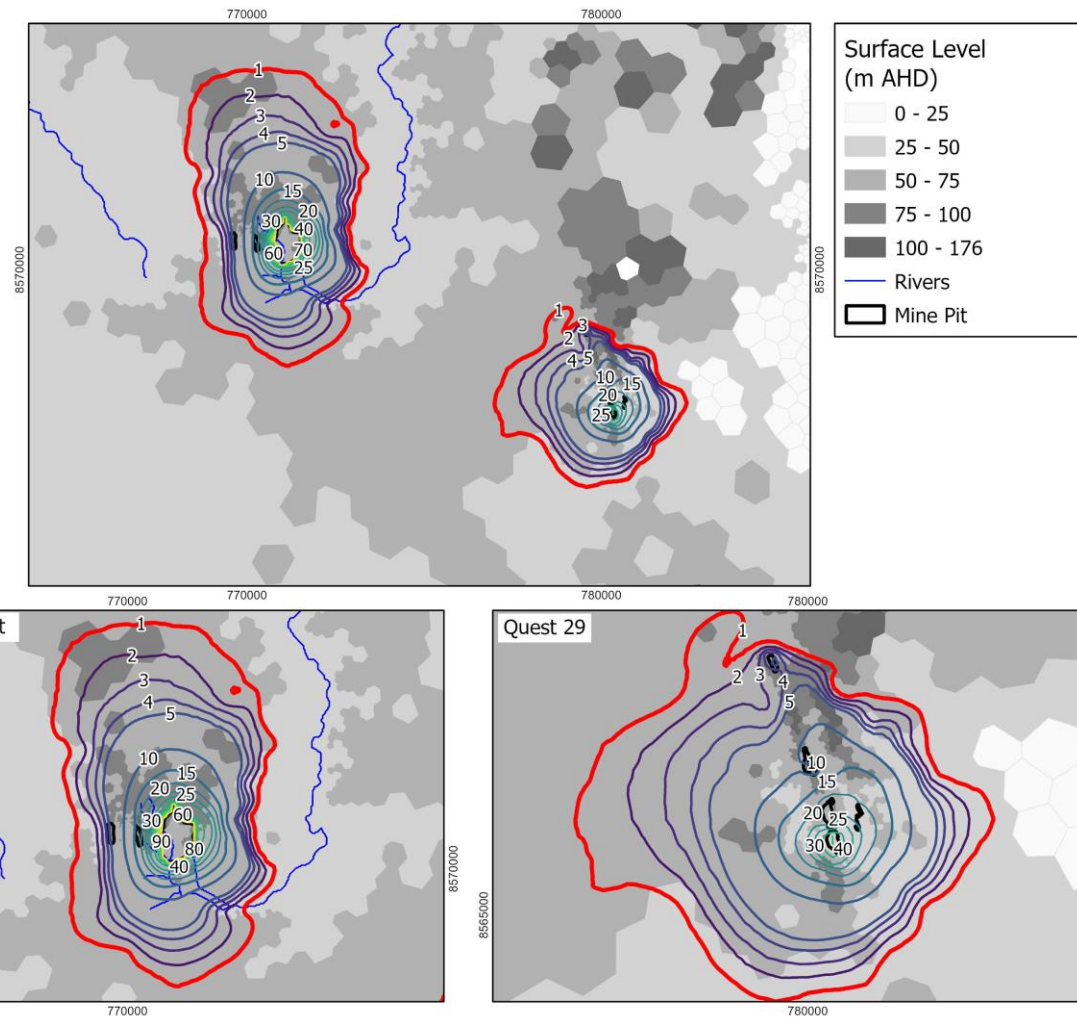


Figure 5-27 Modelled mean maximum Groundwater drawdowns (m) (geometric mean across the 100 model realisations). Grey shading shows topographic surface elevation

When viewing the predicted drawdowns calculated for the 95th percentile, there is only minor (dominantly 200-500 m) increases in the predicted 1 m drawdown extent. Figure 5-28 shows the 95th percentile predicted drawdowns with the mean 1 m drawdowns displayed as dashed lines for reference. With the exception of the north-western portion of the Rustlers Roost cone of depression where the 95th percentile 1 m drawdown is ~1 km greater than the mean predicted position, there is minimal variation between the 1 m draw down extents. This indicates that the mean simulation has a reduced uncertainty, as the simulated models show general agreeance with minimal variation in the predicted extent.

The predictive modelling suggests that the Mary River and McKinlay River are unlikely to be impacted by the proposed pits. The 95th percentile 1 m drawdown contours remain at least 11km and 4.6 km away from the Mary River and the McKinlay River, respectively).

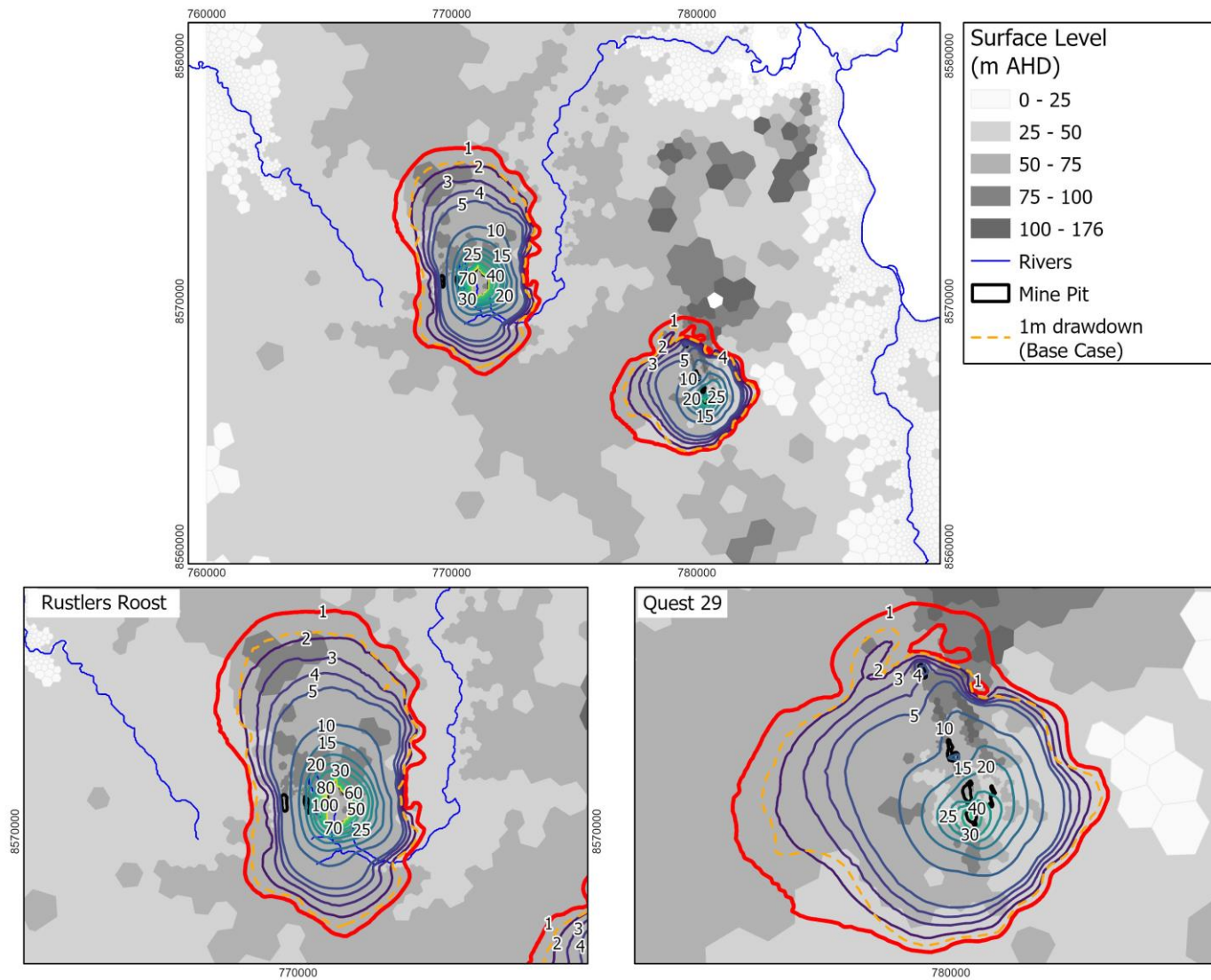


Figure 5-28 Modelled 95th percentile maximum Groundwater drawdowns (m). Grey shading shows topographic surface elevation

The model predictions indicate that the regional water table in the post mining period remains depressed for several years following the cessation of mining. Figure 5-29 and Figure 5-30 show the predicted regional drawdowns for 10, 20, 30 and 40 years post mining. The model predicts that groundwater levels to the north of the Rustlers Roost pit remain depressed (drawdown of up to 1 m) for at least 30 years post mining. Groundwater levels around Rustlers Roost are predicted to have generally recovered by 40 years post mining, with the region of predicted drawdown at this time localised around the Rustlers Roost pit boundary.

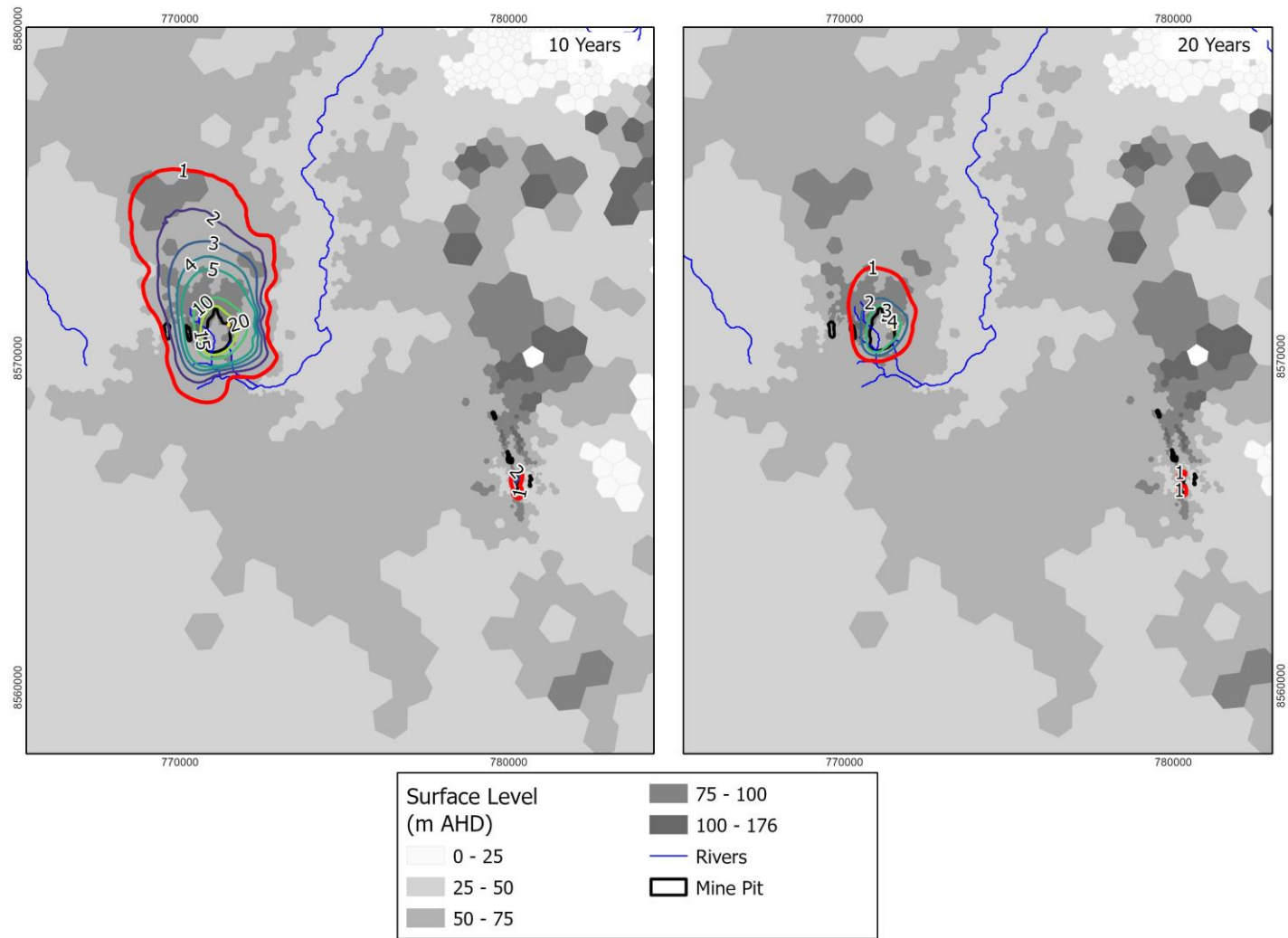


Figure 5-29 Modelled Groundwater drawdowns (m) (geometric mean across the 100 model realisations) for 10, 20 years post mining. Grey shading shows topographic surface elevation.

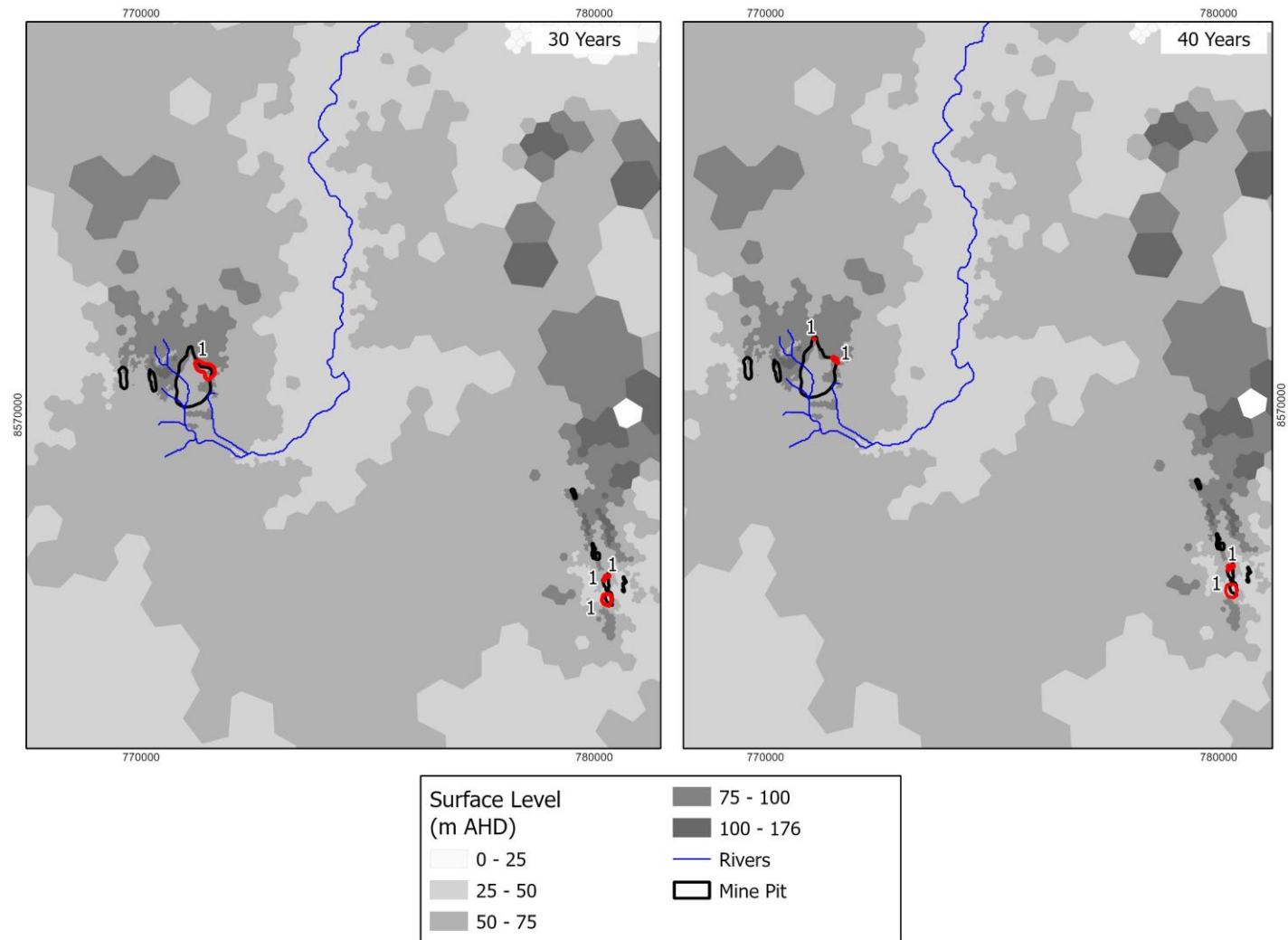


Figure 5-30 Modelled Groundwater drawdowns (m) (geometric mean across the 100 model realisations) for 30, 40 years post mining. Grey shading shows topographic surface elevation.

Groundwater drawdowns around the Quest29 pits have generally recovered by 10 years post mining, with only localised drawdown around the Taipan pit. The contrasting recovery times between the Rustlers Roost drawdown zone and the Quest29 drawdown zone is interpreted to be largely due to the position of each area in the hydrogeological landscape. Rustlers Roost is located on a groundwater divide and hence receives minimal lateral flow and is hence likely much more reliant on local recharge. In contrast, the Quest29 pits are in within a zone of regional groundwater flow (Figure 5-24), and hence are more likely to receive lateral flow from the west. As such, the recovery of the Quest29 drawdown zone is reliant on both localised recharge and inputs from the west.

Given the limited spatial extents of modelled drawdown, cumulative impact assessment in relation to the Toms Gully mine is not considered warranted.

5.3.13.2 Groundwater Throughflow Analysis for the Proposed Pit Lakes

The mean flux data for the proposed mining pits from 10 years post mining to the end of the simulation are presented in Table 5-9. These flux data indicate that the BHS and North Koolpin mining pits act as net groundwater sources with minimal outflows, while the Taipan pit lake act as a net groundwater sink within minimal inflow. Rustlers Roost and South Koolpin mining pits have both an inflow and a notable outflow component. As such these is potential that Rustlers Roost and South Koolpin may have a throughflow component.

Table 5-9 Predicted inflow and out flow fluxes from the general head boundary elements 10 years post mining to the end of the simulations.

Feature	Mean Flux 10 years post mining to End of Simulation			Comment
	Inflow (leakage to aquifer)	Outflow (discharge from aquifer)	Net	
Rustlers Roost pit	976	227	-749	Potential groundwater source
Annie Okaley Pit	Mine Pit Backfilled			
Annie's Dam Pit	Mine Pit Backfilled			
BHS pit lake	414	4	-410	Potential groundwater source
North Koolpin pit	1584	2	-1582	Potential groundwater source
South Koolpin pit	271	867	595	Potential groundwater sink
Taipan pit lake	28	510	482	Potential groundwater sink
Zamu pit lake	Mine Pit Backfilled			

Particle tracking was performed to gain a better understanding of the throughflow process. Particles were set up around each post-mining pit lakes. To be consistent with Table 5-9, the particles were released at 10 years post mining and tracked till the end of simulation at 2122. Porosity is assumed to be 1% uniformly.

The particle tracking results are shown in Figure 5-31. For clarity reasons, only the worst-case realisation with the longest path lines is presented. Consistent with Figure 4-11, most of the particles released near the Rustlers Roost pit lake are captured by the lake, but one particle that was released slightly more distant from the pit lake is not captured but travel approximately 700 m to the west by 2122, following the regional flow field.

The particle tracking results for the BHS pit lake is consistent with Table 5-9 in that the particles are not captured by the lake but travel to the west and south, with a maximum distance of 1.7 km to the southwest by 2122. Most of the particles around the North Koolpin pit are captured by the South Koolpin and Taipan pits to the south, but the particles to the east of North Koolpin pit are not captured but travel approximately 3.7 km to the east by 2122, following the regional flow field. Similarly, most of the particles around the South Koolpin and Taipan pit lakes are captured by these lakes, but the particles to the east of the pits are not captured but travel approximately 1.8 km to the southeast by 2122.

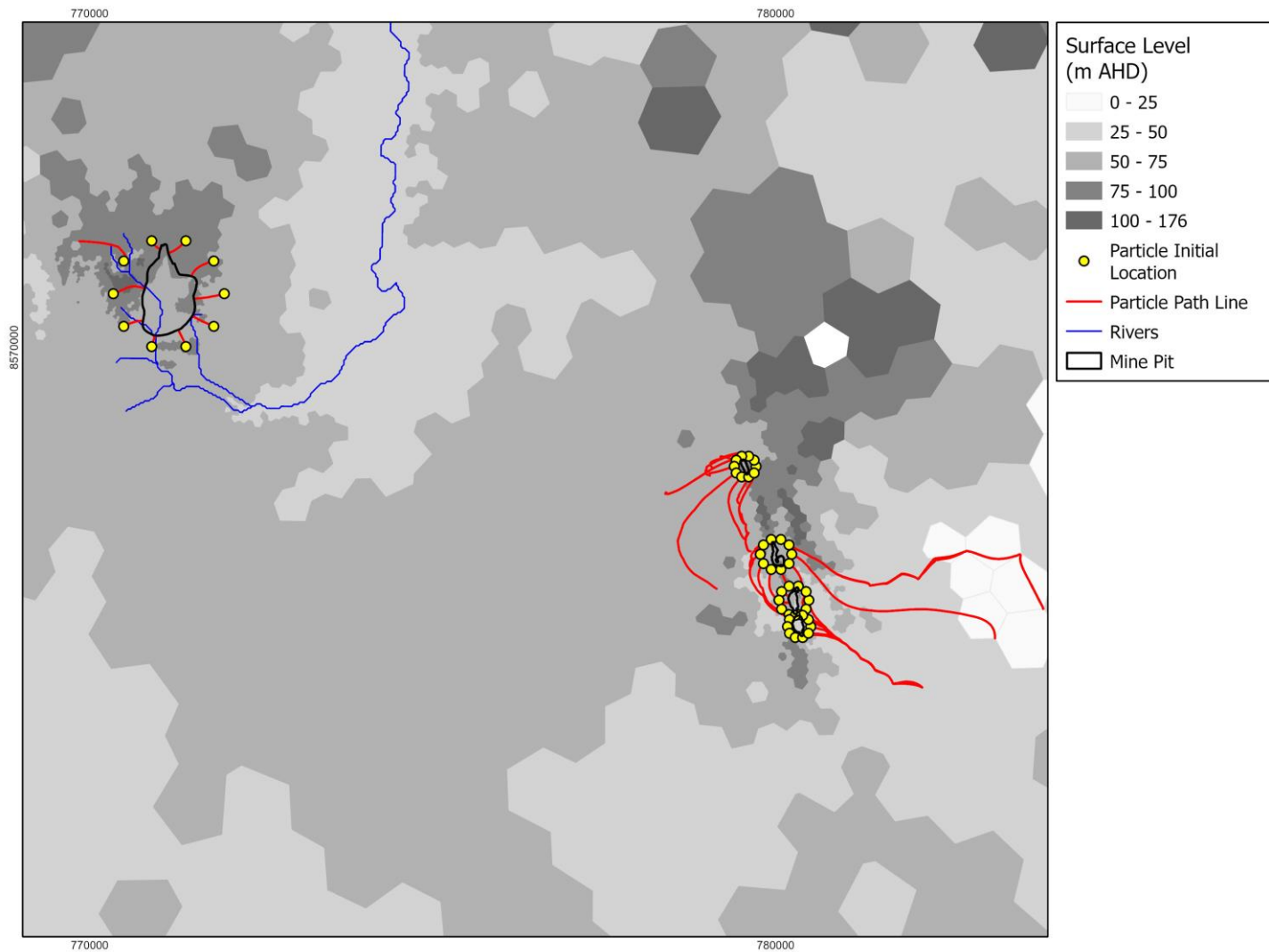


Figure 5-31 Particle tracking results, with particles released at 10 years post mining (worst case of the 100 realisations)

5.3.13.3 Climate Change Impact Modelling

To investigate the potential impacts of climate change recharge inputs were adjusted to reflect the predicted precipitation using a climate scenario of RCP4.5 (Surface Water Erosion Solutions, 2022 – Appendix E of the SEIS). It is noted that the RCP4.5 predicted rainfall shows an increase in predicted precipitation rather than a reduction. There were notable increase in rainfall intensity or frequency beyond the average rainfall events in the climate change conditions being ~8% greater than the non-climate change scenario. Evapotranspiration rates in the Climate Change scenario were set as the 95% percentile of historical evapotranspiration rates. The 100 calibrated model realisations were then re-run using the predicted climate change precipitations rates. The geometric mean of the predicted drawdown at 5 years, 10 years, 20 years and 40 years post mining are presented in Figure 5-32 and Figure 5-33. The model predictions indicate that under the RCP4 climate change scenario the predicted extent of drawdown >1 m is reduced when compared to the base case simulations. These data suggest that the base case model scenario is conservative in the event of climate change precipitation rates following the RCP4.5 scenario.

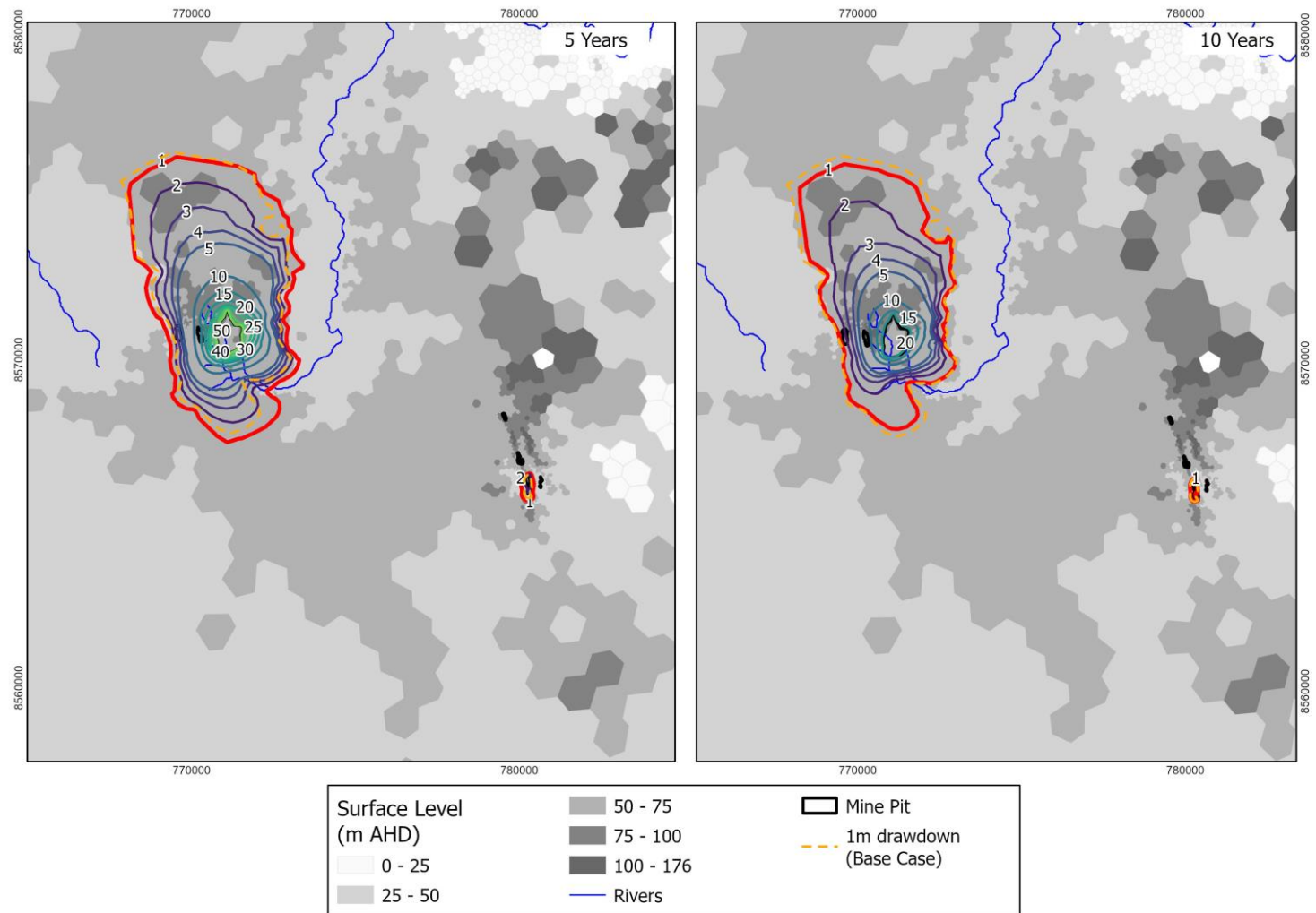


Figure 5-32 Modelled Groundwater drawdowns (m) from the Calibrated Climate Change Model Realisations (geometric mean across the 100 model realisations) for 5 and 10 years post mining. Grey shading shows topographic surface elevation.

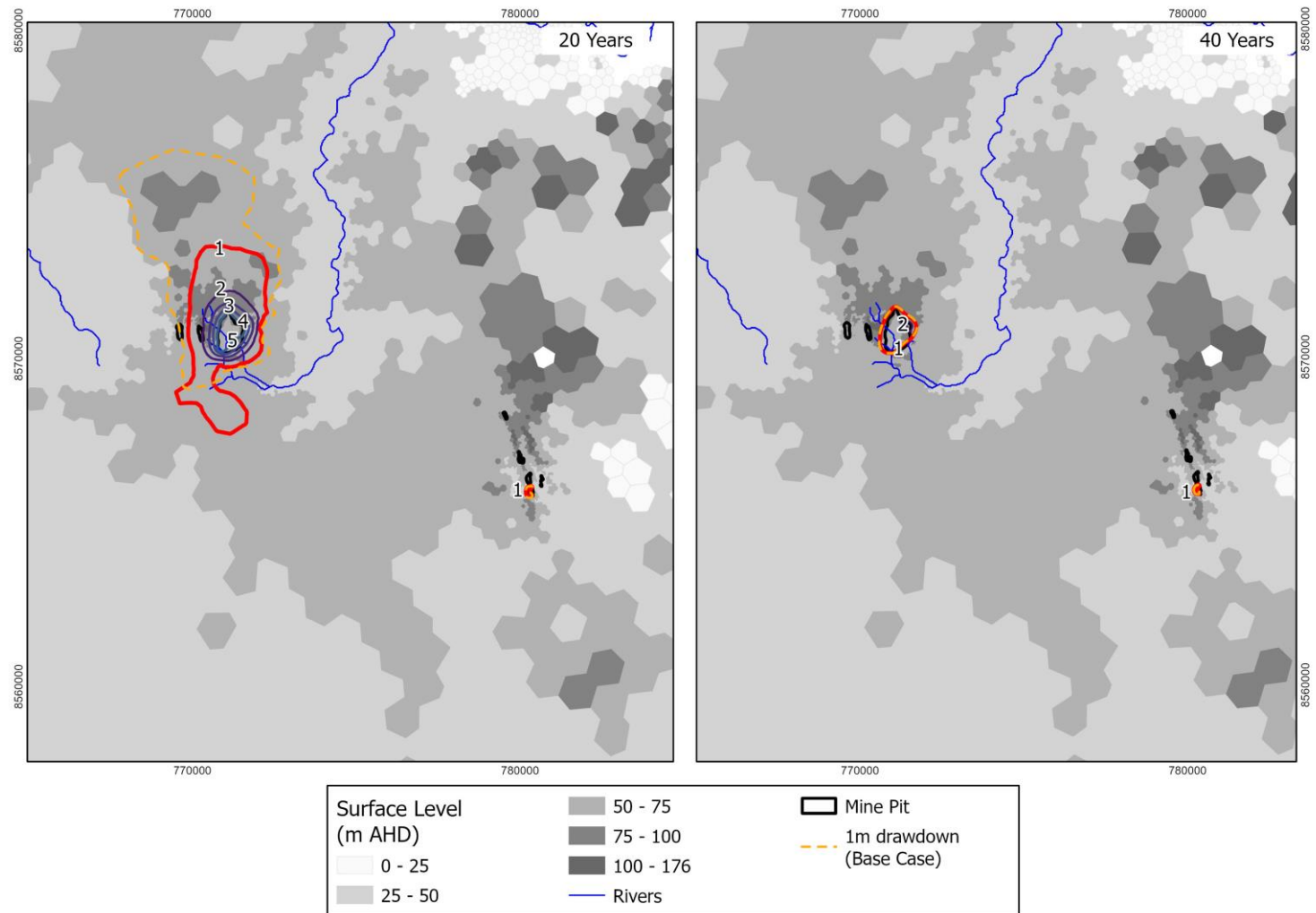


Figure 5-33 Modelled Groundwater drawdowns (m) from the Calibrated Climate Change Model Realisations (geometric mean across the 100 model realisations) for 20 and 40 years post mining. Grey shading shows topographic surface elevation.

5.3.13.4 Reduced Mining Pit Water Level Recovery Rate Simulations

As the post mining pit water levels were specified using the GoldSim water level estimates, there is potential variability in the recovery rates as the GoldSim water levels estimates also have uncertainty attached to them. To determine the range of likely impacts if water levels were to recover at below the mean rate, the 5th percentile of the water level recovery rates was adopted.

Figure 5-34 and Figure 5-35 show the predicted drawdowns for 5th percentile pit water level recovery rates. These data show that there is minimal difference between the base case and the reduced recovery rate case at 5 years post mining, the discrepancy between the two mean modelled drawdowns become notable at 10, 20 and 40 years post mining. The reduced pit water level recovery rates result in the zone of drawdown persisting for an extended period of time. Around the Taipan mining pit the calculated GoldSim water level in the 5th percentile simulation is ~2 m lower than in the 50th percentile simulation. This difference in the stabilised post mining water levels in the GoldSim estimate is evident in the model data where a localised region of depressed groundwater levels persists around the Taipan pit even after 40 years post mining. Similarly, in Rustlers Roost the GoldSim 5th percentile stabilised water levels are ~2.7 m lower than in the 50th percentile simulation. As with the Taipan pit, this lower stabilised water level results in a persistent cone of depression surrounding the Rustlers Roost mining pit. The >1 m drawdown contour around Rustlers Roost extends up to 650 m at 40 years post mining. The >1 m drawdown contour around Taipan and South Koolpin extends up to 400 m at 40 years post mining.

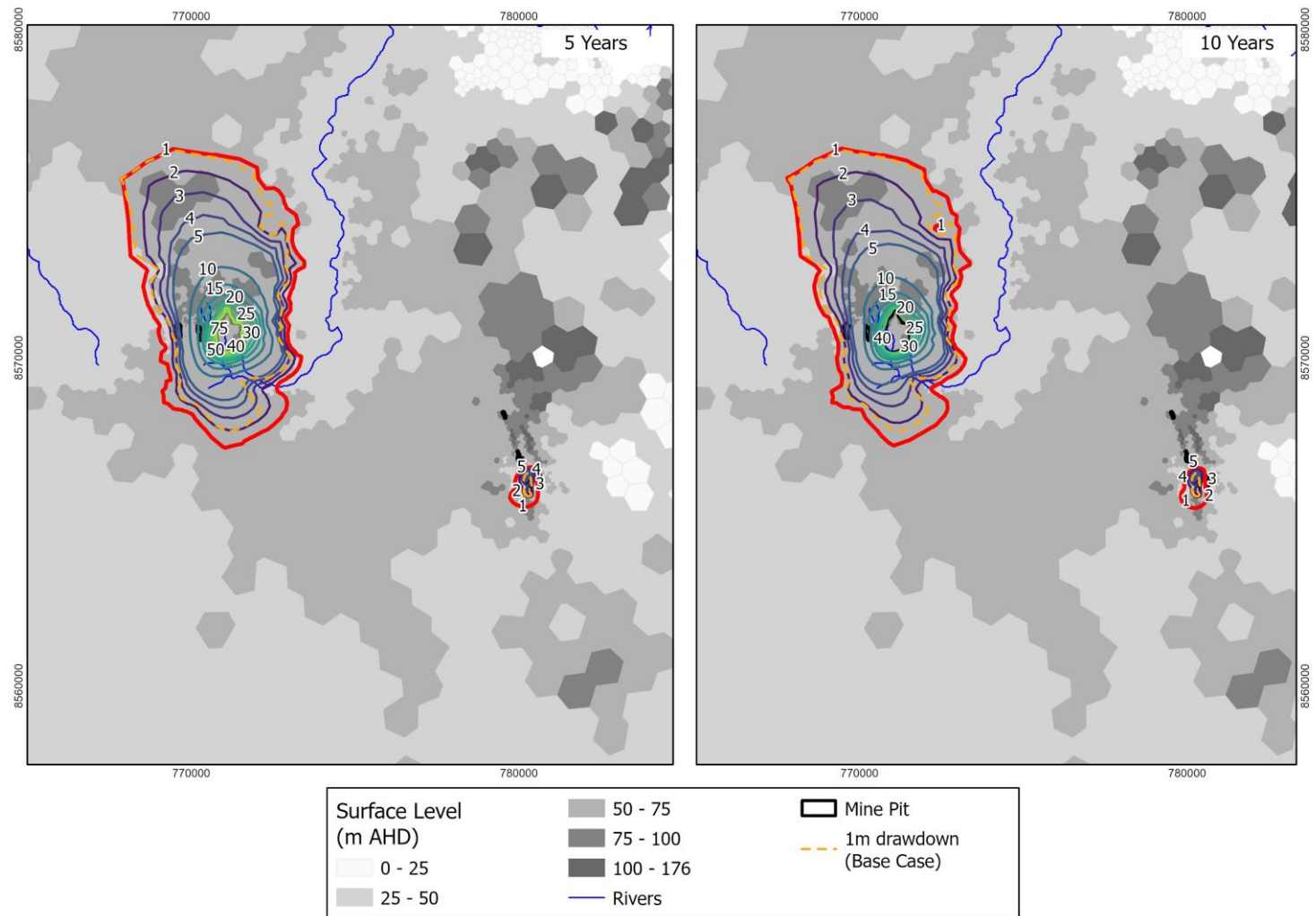


Figure 5-34 Modelled Groundwater drawdowns (m) (geometric mean across the 100 model realisations) from the Calibrated Slow pit recovery (5th percentile) Model Realisations for 5 and 10 years post mining. Grey shading shows topographic surface elevation. Red dashed line shows base case 1 m drawdown contour

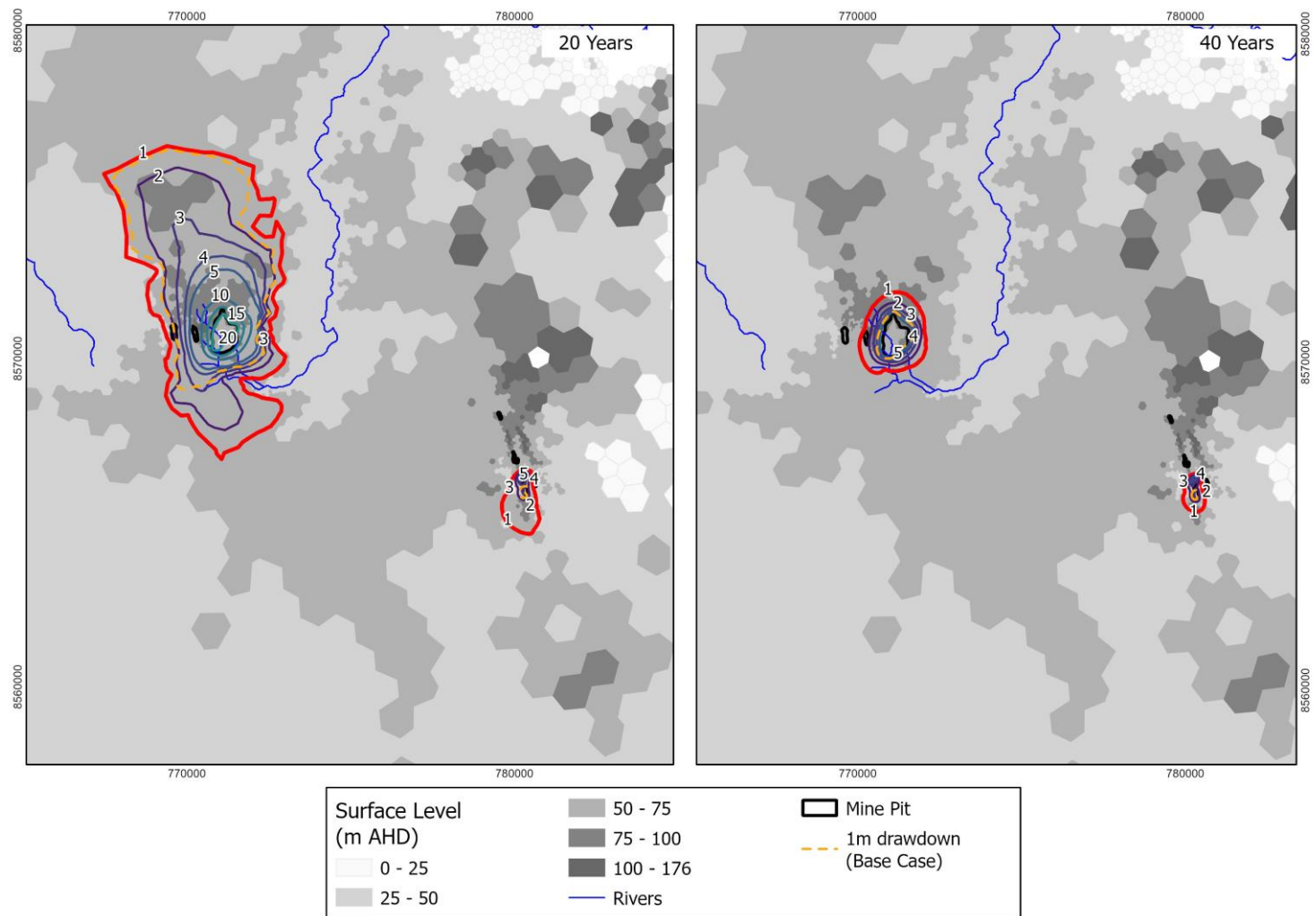


Figure 5-35 Modelled Groundwater drawdowns (m) (geometric mean across the 100 model realisations) from the Calibrated Slow pit recovery (5th percentile) Model Realisations for 20 and 40 years post mining. Grey shading shows topographic surface elevation. Red dashed line shows base case 1 m drawdown contour

5.4 Modelling Summary

A three dimensional, regional-scale numerical groundwater model was developed for the proposed Rustlers Roost and Quest 29 mining activities to estimate the potential drawdown extents induced by the proposed mining pits at the Rustlers Roost and Quest 29 portions of the Project area for the following time periods:

- At the end of mining, which is also when the spatial extent of drawdown is the largest; and
- 10, 20, 30 and 40 years post mining.

A stochastic groundwater modelling approach was used in this study, with the development and transient calibration of 100 different model realisations. The calibration is considered satisfactory with a mean Root Mean Squared Error (RMSE) of 2.1 m and a Scaled RMSE (SRMSE) of 4.2%.

The 100 calibrated model realisations predicted that the extent of the 1 m drawdown contours resulting from the dewatering of the proposed pits would be as follows:

- At Rustlers Roost, groundwater drawdowns of up to 1 m are predicted up to 2.3 km to the east and west, 5.3 km to the north and 3.7 km to the south;
- At Quest 29, groundwater drawdowns appear to be much more radial in nature, with drawdowns of up to 1 metre predicted up to 2 km from the mining pits to the north, south and east, and 4.5km to the west;
- The modelling suggests that the probability of Marrakai Creek, Mary River and McKinlay River being impacted by the proposed pits is minimal; and
- Topography is inferred to have a strong control on the shape and extent, and longevity of drawdown impacts. At Rustlers Roost drawdown predominantly follows a north south topographic high with local water levels modelled to take up to 40 years to recover. A cross groundwater flow component at the Quest29 mining pits is interpreted to explain the relatively quick (<10 year) groundwater recoveries.

Modelled Groundwater inflows to the proposed pits were in general agreeance with the GoldSim estimated values though a reduced regional water level around the Zamu mine pit was noted to have resulted in predicted outflows from the South.

6. Site Water Balance and Solute Transport Modelling

6.1 Overview

A site water and solute balance model was developed using GoldSim® software to estimate:

- The likely dewatering requirements to maintain dry working conditions in the pits and the ability of the water management plan to maintain the dry working environment during the mining phases;
- The ability of the water management plan to prevent uncontrolled spill to the environment during the dry season, acknowledging that controlled releases during the wet season are part of the water management plan;
- The Rustlers Roost and Quest 29 respective pit lake water balance and stabilisation levels post-mining to:
 - Predict post-closure recovery of groundwater levels in the pit lakes
 - Evaluate the overflowing likelihood of the pit lakes
 - Estimate the concentrations of potential contaminants within the pit lake forming post-mining operations.
- The bore field production requirement to respond to the site' water demand.

The site conceptualisation, model construction methodology, data inputs and model results are presented in this section.

6.2 Modelling Conceptualisation Overview

6.2.1 Water Management and Conceptualisation Overview

The water management of the Rustlers Roost and Quest 29 sites consists of:

- Initially dewatering the historical pits lake;
- Maintaining a dry working environment by continuously dewatering pit inflows during mining operation;
- Supplying enough water to respond to the demand of the ore processing, dust suppression activities and other site water demand (drinkable water);
- Surplus water that cannot be stored on site will be disposed to both Mount Bundey Creek catchment and McKinley River catchments (controlled release to the creek during the wet season only); and
- Any water demand shortfall will be supplied by the site bore field.

The water management system is conceptualised as a network of surface water storages (pit lakes, dams, turkeys nest storages), operational processes (pumping) and natural processes (rainfall, runoff, groundwater seepage, evaporation). Each water storage balances its inflows and outflows and is connected to other water storages by transfer of water (pumping). Further detail in relation to water management for the project, including engineering controls to manage water flows and discharges, can be found in the Water Management Plan (Appendix Q of this SEIS).

With respect to the open pits, the mining operations can be divided into 3 phases (Table 6-1):

6 Site Water Balance and Solute Transport Modelling

- Phase 1: pre-mining dewatering of the historical pits;
- Phase 2: mining operation; and
- Phase 3: post-mining pit lake recovery for the pits that are not fully backfilled including Rustlers Roost pit, South and North Koolpin pits, Taipan pit and BHS pit. The Zamu pit, Annie Oakley Pit and Annie's Dam pit are to be fully backfilled after operations.

During Phase 1 and 2, the water balance for each pit consists of inflows from direct rainfall to the pit lake, pit catchment runoff and groundwater seepage (i.e. the flow of groundwater into the pit – groundwater discharge). The outflows consist of evaporation from the residual pit lake surface areas and of dewatering of the pits using sumps. During Phase 3, the dewatering of the open pits will cease and water levels in the pit lakes will recover through a balance of direct rainfall, catchment runoff, groundwater seepage and evaporation. If pit lake water levels rise above the water table post recovery, outflow from the pits to the groundwater can occur (groundwater infiltration or groundwater recharge). This process has not been represented in the Goldsim model.

Table 6-1 Overview of Mining Operation Phases

Phase 1: Pre-Mining Dewatering				Phase 2: Mining	Phase 3: Post-mining	
	Start Date	End date	Note	Start Date	Start Date	Note
Rustlers Roost pit	1/12/2021	30/04/2023	With a pause between 30/04/2022 and 1/12/2022)	1/03/2023	31/10/2031	-
Annie Oakley pit	-	-	Not Applicable	1/02/2024	31/05/2024	Backfilled pit
Annie's Dam pit	-	-	Not Applicable	1/03/2023	31/01/2024	Backfilled pit
Zamu pit	15/12/2024	30/04/2025	maintain empty pit until start of operation	1/07/2025	30/06/2030	Backfilled pit
South Koolpin pit	15/02/2029	30/04/2030	maintain empty pit until start of operation	1/07/2030	30/06/2031	-
North Koolpin pit	15/02/2029	30/04/2030	maintain empty pit until start of operation	1/07/2030	30/06/2031	-
Taipan pit	15/02/2029	30/04/2030	maintain empty pit until start of operation	1/07/2030	30/11/2031	-
BHS pit	15/03/2030	30/04/2031	maintain empty pit until start of operation	1/08/2031	30/11/2031	-

At Rustlers Roost, the water management system comprises the following features/components (Figure 6-1).

- Northern TSF water storage dam (NTSF WSD) is a 6,998 ML storage facility (This feature is within the footprint of the TSF and will eventually become filled with tailings). The NTSF WSD footprint includes the historical Annie's Dam. The NTSF WSD collects the water from the pit's dewatering (after transiting through the Turkey's nest) and the make-up water from the bore field. This make -up water is only to be sourced to maintain the demand of the ore processing plant. The NTSF WSD then feeds the process water dam. Excess water from the NTSF WSD is diverted into the Mount Bunday Creek during the wet season. The NTSF WSD is located within the TSF footprint, and its bathymetry will evolve as tailings are progressively disposed during operations;

6 Site Water Balance and Solute Transport Modelling

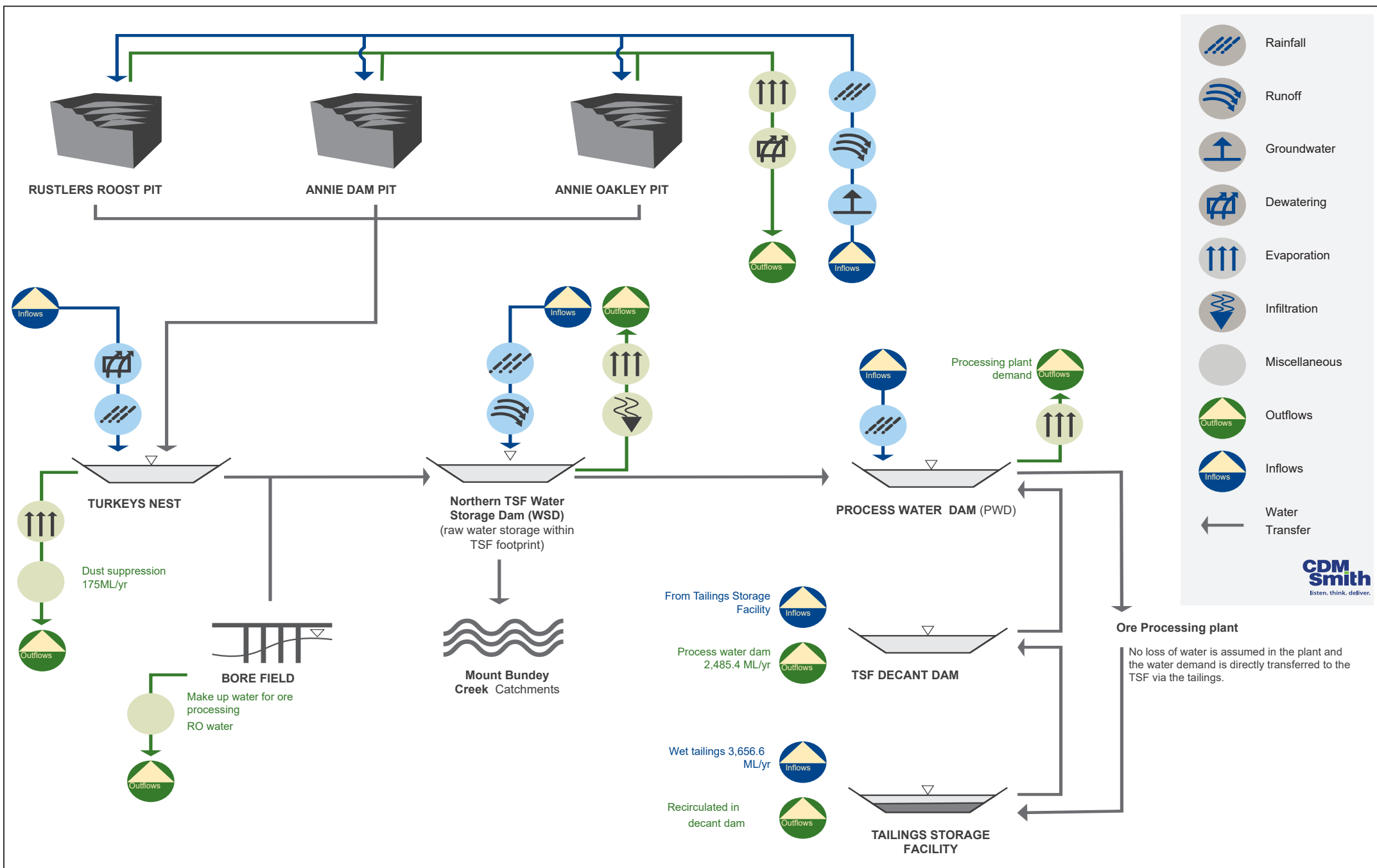
- The Turkey's nest storage facility. The Turkey's nest is a 50 ML water storage facility, collecting water from the Rustlers Roost pit dewatering. A portion of the water collected in the Turkey's nest is used for dust suppression on the site and the remainder is transferred to the Annie's Dam raw water storage facility;
- The process water dam. The process water dam has a capacity of 100 ML and receives the water from the decant dam and from the Annie's Dam water storage facility to maintain the capacity to feed the ore processing plant at the required water demand rate;
- The decant dam. The decant dam collects desorbed water from the TSF. The water of the decant dam is recirculated in the ore processing circuit; and
- A bore field is to be used to supply all the site potable water after a reverse osmosis treatment. It will also provide make-up water when the pit's dewatering rate is unable to sustain the ore processing water demand.

As there is no ore processing ore at Quest 29, the water management system only includes the management of inflow and outflows of the open pits, transfer of water between the pits and discharge into surrounding creeks during the wet season. Dust suppression water will be pumped from Taipan Pit via a pump and standpipe at 500kL/d. The water management schematic for Quest 29 is illustrated on Figure 6-2.

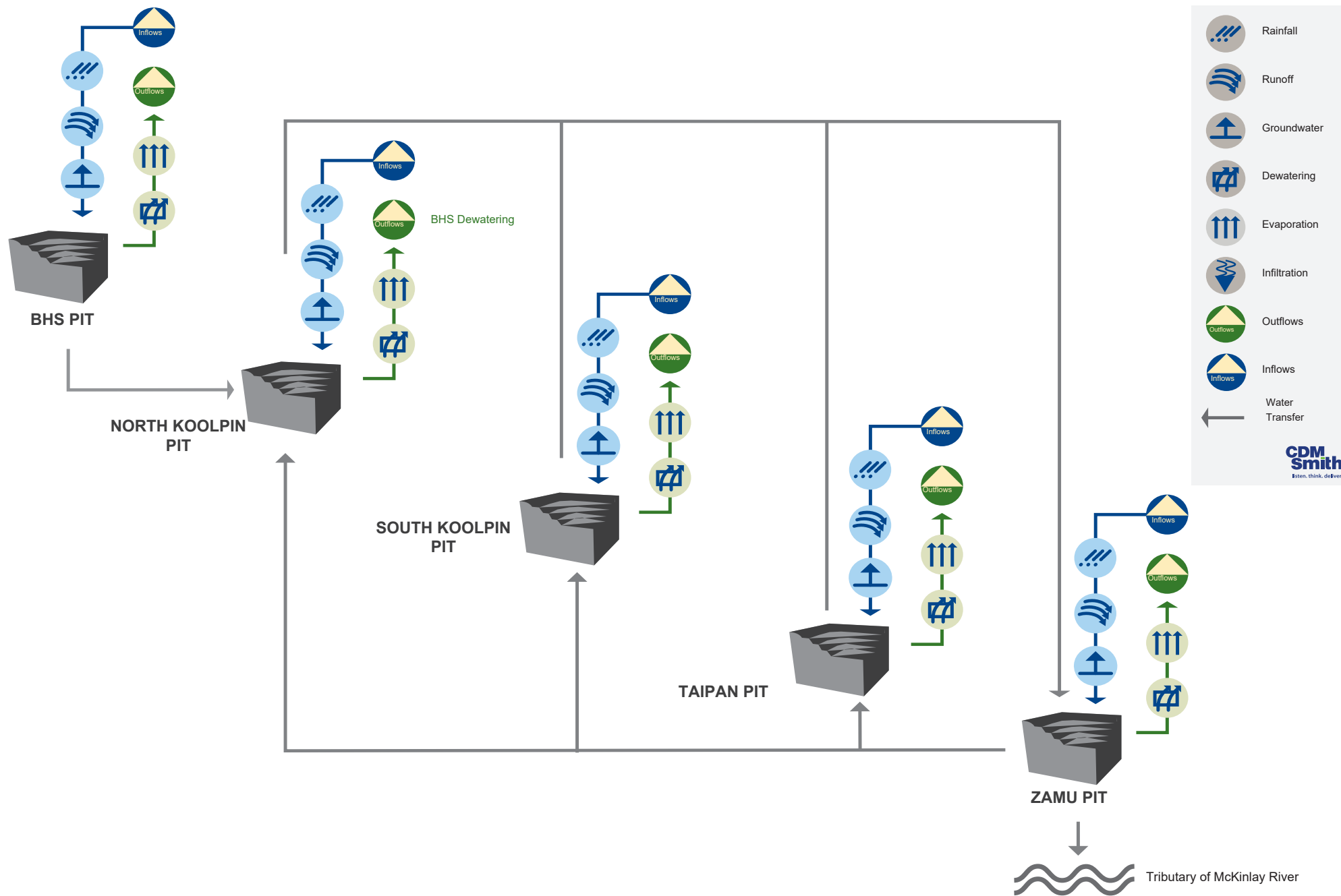
The water balance features inflows and outflows are summarised in the following tables.

- Table 6-2 details the conceptualisation of the inflows as well as their implementation in the model, the data sources, and the related predictive uncertainty;
- Table 6-3 lists the inflows of the water balance model features;
- Table 6-4 details the conceptualisation of all outflows as well as their implementation in the model, the data sources, and the related predictive uncertainty; and
- Table 6-5 lists inflows of all the water balance model features.

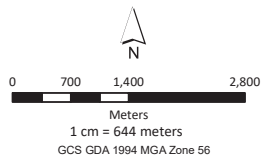
Waste Rock Dumps (WRDs) at Rustles Roost and Quest 29 have not been incorporated in the site water balance models, as their impact/influence on the site's water balance is considered minimal. The impact of the WRDs on the site's hydrology is addressed in detail in the technical report in Appendix E of the Draft EIS (Hydrology Analysis) and the WRD design is provided in Appendix J of this SEIS. Given the small catchment area associated with each WRD, potential runoff from the WRDs will be captured into dedicated decant dams, with the runoff water treated before release to the surrounding creeks.



R	Details	Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.				0 700 1,400 2,800 Meters 1 cm = 644 meters GCS GDA 1994 MGA Zone 56	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. DATA SOURCE NT Government Open Source Data	DESIGNER CDM Smith cdmsmith.com	CLIENT PRIMARY GOLD	FIGURE 6-1 Rustlers Roost Water Management Schematic
1	Final	24/08/21	DESIGNED	VP	CHECKED	JM					
-	-		DRAWN	MM	CHECKED	VP					
-	-		APPROVED	TK	DATE	24/08/21					
-	-		Notes:								
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1	Final	24/08/21	DESIGNED	VP	CHECKED	JM
-	-		DRAWN	MM	CHECKED	VP
-	-		APPROVED	TK	DATE	24/08/21
-	-		Notes:			



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DATA SOURCE
NT Government Open Source Data

DESIGNER

CDM Smith
cdmsmith.com

CLIENT

PRIMARY GOLD

FIGURE 6-2

Quest 29 Water Balance Schematic

DRG Ref: 1001087-EIS-04-4.15

6 Site Water Balance and Solute Transport Modelling

Table 6-2 Inflow Conceptualisation

	Rainfall	Pit Wall Runoff/Pond Surface Flow	Groundwater Inflow to the pit (seepage)	Water Transfer Inflow (Pump)
Conceptualisation and Implementation	Direct rainfall on lake wet surface. The lake input corresponds to 100% of the daily rainfall amount	A runoff coefficient default value of 0.7) is applied to daily rainfall over the pit area that is not covered by the lake. The pit area is defined by a 2-m high bund that is assumed to surround the pit.	Groundwater seeping into the pit (i.e. groundwater discharge) is estimated by a steady state analytical solution (Dupuit Forchheimer). A two-layer seepage model has been used to represent shallow aquifer conditions and deeper aquifer conditions (>80 m depth – only relevant for Rustlers Roost pit). The seepage estimation is mainly controlled by the water table elevation and the aquifer hydraulic conductivity.	Water transferred into the store (water management ponds)
Input Data	SILO data (lat: -12.9, lon 131.5)	Whilst runoff coefficient for pit void walls may vary with rainfall (e.g. from 0.3 for rainfall < 40mm to 0.6 for rainfall >40mm (McCullough <i>et al.</i> , 2013)), as a conservative measure, a value of 0.7 has been adopted.	Available groundwater level data near historical pits (based on data from November 2020 to March 2022). Estimation of aquifer hydraulic conductivity based on field hydraulic conductivity and literature review as per Section 4.4.3.4.	At pumping rate provided by client according to operation schedules.
Limitations and Source of Uncertainty.	Directly proportional to rainfall data accuracy	Applying a factor on rainfall is a simplistic model with a large uncertainty as it fails to account for surface angle, prior rainfall, soil material and vegetation.	The analytical model has many limitations and uncertainty, particularly as there is limited data to constrain (calibrate) the model: • The analytical model is steady state and does not represent the transient inflow which is occurring during mining operations. • The model only simulates horizontal flow and can only represent a single gradient between the aquifer and the pit lake (i.e. pit acts as either a sink or source). Therefore, whilst throughflow (i.e. whereby the lake receives groundwater inflow (seepage) along one portion of its area and water infiltrates out (groundwater recharge) of the pit into groundwater along another other portion (cf. McCullough <i>et al.</i>, 2013)) may occur, the model cannot simulate this complex process. • The aquifer is assumed to be homogeneous and isotropic and is represented by a single value of Kh. For the deepest pit a dual layer model has been implemented which assumes a lower Kh for rock greater than 80 m depth.	Information provided by PGO is preliminary only and based on current plans.
Uncertainty analysis	Run with climate change scenario.	Random sampling of runoff coefficient for the Monte Carlo approach. Sensitivity analysis on the runoff factor (0.4 to 0.8)	Sensitivity on the analytical model parameters (Kh, WT elevation). Random sampling of model parameter for the Monte Carlo approach	NA

6 Site Water Balance and Solute Transport Modelling

Table 6-3 Water Balance Features Inflows

Model Feature/Storage	Rainfall	Pit Wall/Pond Runoff	Groundwater Inflow to the pit (seepage)	Water Transfer Inflow (Pump)
Rustlers Roost pit	Yes	Yes	Yes	N/A
Annie's Dam pit	Yes	Yes	as Rustlers Roost pit	N/A
Annie Okaley pit	Yes	Yes	as Rustlers Roost pit	N/A
Turkey's nest	Yes	NA	NA. Turkey's nest is above the groundwater table	Receives inflow from pit dewatering.
NTSF WSD	Yes	NA	NA. NTSF WSD is above the groundwater table	Receives water from Turkey's nest and from the bore field.
Process water dam	Yes	N/A	NA. PWD is above the groundwater table	Get water from NTSF WSD (controlled by water demand) and from the decant dam (at constant rate during ore processing operations)
TSF	N/A	N/A	NA. TSF is above the groundwater table	Outflow from the Processing plant
Borefield	N/A	N/A	NA	N/A
Zamu pit	Yes	Yes	Yes	Transfer from North Koolpin pit, South Koolpin pit and Taipan pit. Zamu pit is to be used as storage for the dewatering requirement of North Koolpin pit, South Koolpin pit and Taipan pit
South Koolpin pit	Yes	Yes	Yes	Transfer from Zamu pit during Zamu mining operations. The water produced from Zamu pit is to be stored in North Koolpin pit, South Koolpin pit and Taipan pit.
North Koolpin pit	Yes	Yes	Yes	Transfer from Zamu pit during Zamu mining operations and from BHS pit during BHS mining operations. The water produced from Zamu pit is to be stored in North Koolpin pit, South Koolpin pit and Taipan pit.
Taipan pit	Yes	Yes	Yes	Transfer from Zamu pit during Zamu mining operations. The water produced from Zamu pit is to be stored in North Koolpin pit, South Koolpin pit and Taipan pit.
BHS pit	Yes	Yes	Yes	N/A

N/A: not applicable.

6 Site Water Balance and Solute Transport Modelling

Table 6-4 Outflow and Storage Conceptualisation

	Evaporation	Dewatering (Water Transfer to other Water Store)	Groundwater Infiltration (groundwater recharge)	Controlled discharge and overflow	Storage (Bathymetry)
Conceptualisation & Implementation	Evaporation applied to lake wet surface. Implemented by applying a reduction factor on pan ET to account for atmospheric water saturation near the lake surface.	Sump pumps to be used to dewater the pit during the initial phase (pre-mining) and during mine operation	If a pit lake level exceeds the surrounding water table (possibly locally on one side of the pit and temporally during the wet season) some infiltration will occur (leading to a risk of contamination). Leakage could occur from water storages which are not lined. It is assumed that all storages are lined and do not leak.	When the water level reaches the lowest highwall level the water storage (pit or pond) is set to overflow. Discharge to the creeks only occurs during the wet season which is defined as April, May, June and July.	Represent the volume of water stored in
Input Data	Pan ET (SILO data). Pan evaporation factor = 0.7 (D Mc Jannet & al.2019)	Controlled by mining operation schedules and sump pumps capacity (accounting for pump maintenance).	No input data. The model output can indicate a risk of pit lake level exceeding the water table but groundwater recharge via infiltration from pits or storages is not represented in the Goldsim model.	Overflow defined by bathymetry data provided by the client. Discharge to the creeks defined by a no dry season release rule provided by PGO as part of their operational plan. Rates of discharge at Rustlers Roost site set to 300 L/sec. Rates of discharge at Q29 were not limited.	Look up table provided by the table linking, the lake surface area and lake volume with the lake water (discretisation of 1m).

6 Site Water Balance and Solute Transport Modelling

	Evaporation	Dewatering (Water Transfer to other Water Store)	Groundwater Infiltration (groundwater recharge)	Controlled discharge and overflow	Storage (Bathymetry)
Limitations and Source of Uncertainty	Evaporation is controlled by many other climatic and landscape processes (wind, shading) that are not currently represented in the model.	N/A	Groundwater recharge via infiltration from pits or storages is not represented in the Goldsim model.	Relying on provided data accuracy. Relying on discharge rules.	Proportional to the reliability of input data
Uncertainty Analysis	Random sampling of the reduction factor for the Monte Carlo approach. Do a sensitivity analysis on the pan evaporation reduction factor (0.75 to 1.0).	N/A	N/A	N/A	N/A

N/A: not applicable.

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Table 6-5 Water Balance Features, Outflows and Storage

Model Feature/Storage	Evaporation	Dewatering (Water Transfer to other Water Store)	Groundwater Infiltration (groundwater recharge)	Controlled discharge and overflow	Storage (Bathymetry)
Rustlers Roost pit	Yes	Dewatering at maximum 600 L/s toward Turkey's Nest pond during pre-mining and operation phases.	Representation of the water table elevation in the model as a flat surface surrounding the pit does not allow groundwater infiltration to be incorporated into the model.	Overflow point defined as the top of the provided stage height/volume curve.	Historic pit and future pit shell stage height/volume curve. Historical void shape morphology is amended to future pit morphology on first day of mining operation.
Annie's Dam Pit	Yes	Dewatering at 125 L/s toward Turkey's Nest pond	Not applicable as pit is to be backfilled post-mining	Overflow point defined as the top of the provided stage height/volume curve.	Future pit shell morphology assumed at the start of mining
Annie Okaley Pit	Yes	Dewatering at 125 L/s toward Turkey's)	Not applicable as pit is to be backfilled post-mining	Overflow point defined as the top of the provided stage height/volume curve.	Future pit shell morphology assumed at the start of mining
Turkey's Nest	Yes	Diversion to Annie's Dam (raw water dam)	Assumed negligible – not represented	Overflow point defined as the top of the provided stage height/volume curve.	
Northern TSF WSD	Yes	Diversion to Process Water Dam.	Assumed negligible – not represented	Overflow point defined as the top of the provided stage height/volume curve.	
Process Water Dam (PWD)	Yes	Diversion to the Ore Processing plant	Assumed negligible – not represented	Overflow point defined by the PWD maximum capacity	
TSF	Implicit in the TSF water balance provided by Knight Piesold (KP) (2022)	Rates provided by TSF water balance outputs (KP, 2022)	Implicit in the TSF water balance provided by KP (2022)	NA	

6 Site Water Balance and Solute Transport Modelling

Model Feature/Storage	Evaporation	Dewatering (Water Transfer to other Water Store)	Groundwater Infiltration (groundwater recharge)	Controlled discharge and overflow	Storage (Bathymetry)
Borefield	N/A	Demand is controlled by the RO demand,	NA	NA	
Zamu Pit	Yes	Dewatering at 125 L/s to North Koolpin, South Koolpin and Taipan pit	Not applicable as pit is to be backfilled post-mining	Defined at top of the provided stage height/volume curve	Historic pit and future pit shell stage height/volume curve received in local datum. In the model, historical stage height/volume curve is shifted to future pit stage height/volume curve on first day of mining operation.
South Koolpin pit	Yes	Dewatering at 125 L/s to Zamu pit	Representation of the water table elevation in the model as a flat surface surrounding the pit does not allow groundwater infiltration to be incorporated into the model.	Defined at top of the provided stage height/volume curve	Historic pit and future pit shell stage height/volume curve received in local datum. In the model, historical stage height/volume curve is shifted to future pit stage height/volume curve on first day of mining operation.
North Koolpin pit	Yes	Dewatering at 125 L/s to Zamu pit	Representation of the water table elevation in the model as a flat surface surrounding the pit does not allow groundwater infiltration to be incorporated into the model.	Defined at top of the provided stage height/volume curve	Historic pit and future pit shell stage height/volume curve received in local datum. In the model, historical stage height/volume curve is shifted to future pit stage height/volume curve on first day of mining operation.
Taipan pit	Yes	Dewatering at 125 L/s to Zamu pit	Representation of the water table elevation in the model as a flat surface surrounding the pit does not allow groundwater infiltration to be incorporated into the model.	Defined at top of the provided stage height/volume curve	Historic pit and future pit shell stage height/volume curve received in local datum. In the model, historical stage height/volume curve is shifted to future pit stage height/volume curve on first day of mining operation.

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Model Feature/Storage	Evaporation	Dewatering (Water Transfer to other Water Store)	Groundwater Infiltration (groundwater recharge)	Controlled discharge and overflow	Storage (Bathymetry)
BHS pit	Yes	Dewatering at 125 L/s to North Koolpin pit	Representation of the water table elevation in the model as a flat surface surrounding the pit does not allow groundwater infiltration to be incorporated into the model.	Defined at top of the provided stage height/volume curve	Historic pit and future pit shell stage height/volume curve received in local datum. In the model, historical stage height/volume curve is shifted to future pit stage height/volume curve on first day of mining operation.

N/A: not applicable.

6.3 GoldSim Water Balance Model

6.3.1 Model Structure

The water balance model structure consists of the numerical translation of the water management schematic provided in Figure 6-1 and Figure 6-2 into GoldSim features. The model simulates the water management from the start of operations, commencing with the dewatering of the historical Rustlers Roost pit (Phase 1) until stable steady state conditions are re-established post-mining (Phase 3). The water balance model concurrently simulated all the pits and site water storage facilities to allow for a seamless transfer of water between the model features.

The model uses daily time step to progress through the simulation. All inflows, outflows and water transfer between the various features are calculated using a daily time step.

6.3.2 Model Approach

There are two main types of modelling approaches available in GoldSim:

- A deterministic approach: With a deterministic approach, the model input parameters are determined exactly, and the outcome of the simulation is a unique set of results. This approach is appropriate if the input parameters are well known or for testing some definite condition as for instance the best estimate parameter; and
- A probabilistic approach (Monte Carlo analysis): With a probabilistic approach, the uncertainty of the input parameters is accounted for to determine the likelihood of the outcome. A Monte Carlo analysis consists of describing the uncertainty of model predictions based on the quantification of the input parameter uncertainty (i.e. values selected within realistic parameter bounds). The methodology involves running the models a large number of times (realisations). For each realisation, inputs are sampled randomly and at the end of all model realisations, the outputs are aggregated to determine their distribution. Many of the model parameters (e.g. aquifer representative hydraulic conductivity, average water table elevation, pan evaporation reduction factor, runoff coefficient) are not well defined by field or other data assessment. This uncertainty in the model input parameters leads to an uncertainty of the model outputs. The modelling approach adopted here accounts for model parameter uncertainty through a Monte Carlo analysis. For the analysis, 100 realisations were generated by GoldSim.

As some parameters controlling the site water management were not well known or defined, the probabilistic approach has been adopted for the study. Each of the model components and parameters included in this analysis are described in the following sub-sections. The parameter distributions used in the Monte Carlo analysis are summarised in Table 6-10 and Table 6-14.

6.3.2.1 Monte Carlo Output Figures

The results of the Monte Carlo simulations (i.e. results of 100 model realisations) are presented as probabilistic time series results. The outcomes of the simulations are tabulated or plotted as time series of statistical parameters of the simulations, including the bounds (i.e. minimum and maximum), the median and the 5th, 25th, 75th and 95th percentiles of the simulations. Figure 6-3 provides an example of a Monte Carlo result figure.

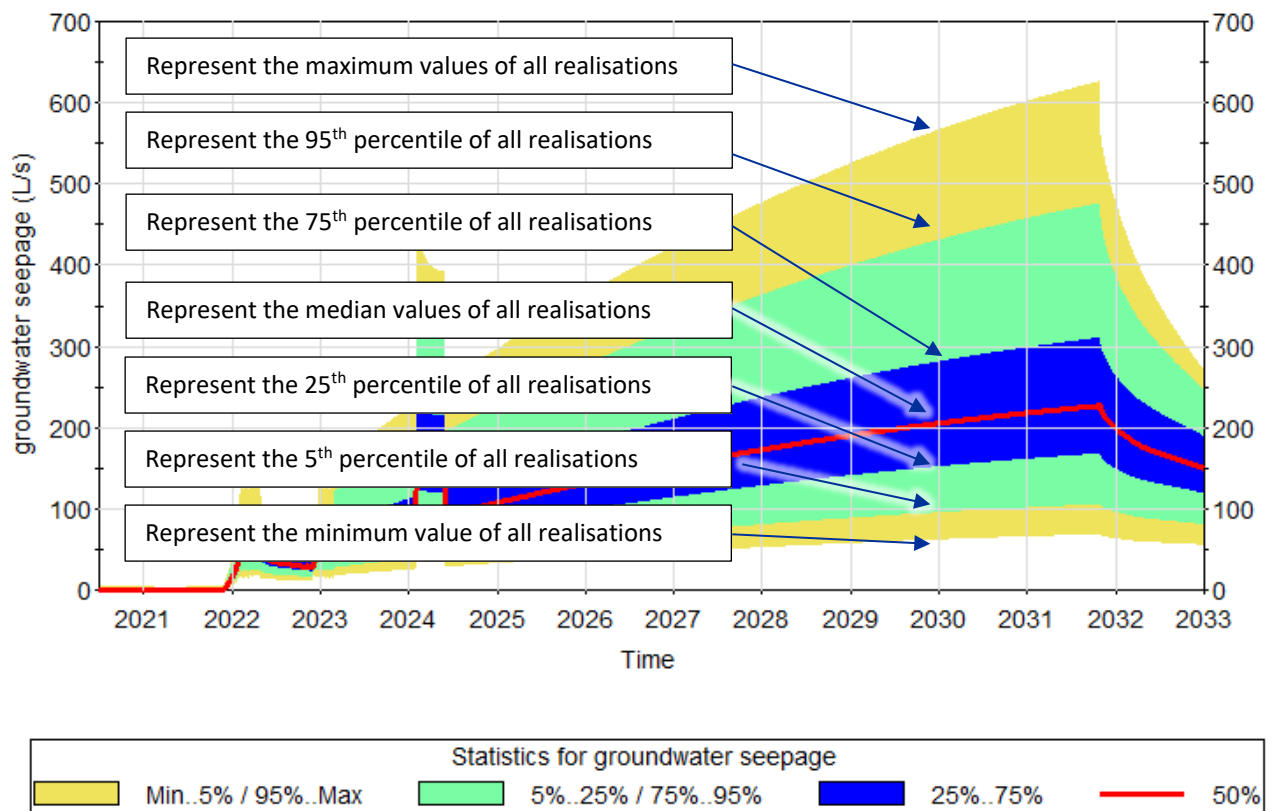


Figure 6-3 Example of Monte Carlo Probabilistic Time Series Output

6.3.3 Model Construction

This section details how the components of the water balance are implemented in the model, describing the inherent assumptions and simplification required to numerically represent the real system.

6.3.3.1 Rainfall and Runoff

Natural inflow to all the pits consists of rainfall and runoff. The surface water catchment for each pit was estimated to be equal to the maximum pit extent, as it is assumed that the pits will be bunded. The catchment of each pit is provided in Table 6-6.

100% of rainfall is accounted for over the wet surface of any pit lake or water storage (Turkey's nest, NTSF WSD, Processing dam). Over the rest of the pit/feature catchment areas, runoff was estimated using a runoff coefficient to account for the soil interception. Pit slopes are steep, and a significant amount of rainfall is expected to run-off.

Whilst runoff coefficient for pit void walls may vary with rainfall (e.g. from 0.3 for rainfall < 40mm to 0.6 for rainfall >40mm (McCullough *et al.*, 2013)), as a conservative measure, a default value of 0.7 has been adopted. A range of 0.4 to 0.8 has been adopted for the Monte Carlo simulations.

Future rainfall has been sourced from Surface Water and Erosion Solutions (2022), who developed a future rainfall model for the hydrologic and hydraulic modelling. The 100y SILO rainfall from 1921 to 2021 was increased relative to the climate change model in accordance with the percentages provided by the ARR Data hub (Babister, Trim, Testoni, & Retallic, 2016).

6 Site Water Balance and Solute Transport Modelling

6.3.3.2 Pits

The deepening of the pits from their historical shape to their full extent at the end of operations is a progressive mining process that continuously changes some parameters controlling the pit water balance (e.g. inflows, outflows, runoff, evaporation, etc.).

As a pit external limit extends, its catchment extends, and more rainfall water is collected by runoff. As a pit depth increases, the gradient with the regional water table increases and the groundwater seepage/inflow is also expected to increase. As the pit shape changes, the retention lake changes form which affects evaporation.

For modelling purposes, it was assumed that the transition from the historical pit catchment to the final pit catchment occurs immediately at the start of mining (i.e. the start of Phase 2). During the mining phase, as the dewatering is designed to maintain a dry environment in the pit, there is no pit lake formation and hence the adopted stage/volume relationship in the model has no effect. However, the pit depth (which controls the modelling of the groundwater seepage/inflow) was assumed to increased linearly from the historical pit depth to the final depth for the whole period of scheduled mining (whole of Phase 2). Both assumptions (on catchment size and pit depth) are considered conservative in terms of estimating the pit inflows.

The pit catchment areas were considered equal to the maximum extent of the pits at surface, as the pits are considered bunded to prevent excess runoff flooding the pits. The historical and maximum extents of the pit catchments are summarised in Table 6-6, with respective maximum depths summarised in Table 6-7.

The representation of the physical shape of the pits' lake is expressed by a stage height/volume curve. In line with the assumptions regarding the final pit shape and depth,

- Rustlers Roost Pit and Quest 29 site pits (Zamu pit, Taipan pit, South Koolpin pit, North Koolpin pit and BHS pit) – during the dewatering period (Phase 1), the pit shape used in the mass balance correspond to the historical pit shape and from the start of the proposed mining operation of each pit (Phase 2), the pit shape and associated stage height/volume curve is swapped to the planned final pit shape at the end of mining. The pit depth / pit lake volume relationship for those pits is illustrated in Figure 6-4 and the pit depth / pit lake area relationship is illustrated in Figure 6-5; and
- Annie Okaley pit and the Annie's Dam pit – These pits do not exist during Phase 1 of the mining operations. For Phase 2 of the operations, a stage height/volume curve matching the final pit shape was adopted immediately at the start of Phase 2. At the end of mining, both pits are to be fully backfilled. The stage/pit lake area/pit lake volume relationship for those two pits assumes a linear relationship between the pit depth, area and volume at completion.

Table 6-6 Historic and Planned, Maximum Surface Catchment Areas of Pits

Pit	Historical Pit [m ²]	Planned Pit [m ²]
Rustlers Roost	276,000	598,000
Annie Okaley	NA	62,000
Annie's Dam	NA	42,000
Zamu	14,000	91,600
South Koolpin	12,000	32,200
North Koolpin	6,300	32,600
Taipan	16,700	31,200
BHS	3,500	13,700

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Table 6-7 Historic and Planned, Maximum Depth of Pits

Pit	Historical Pit [mbgl]	Planned Pit [mbgl]
Rustlers Roost	32	187
Annie Okaley	NA	50
Annie's Dam	NA	40
Zamu	15	62
South Koolpin	18	39
North Koolpin	9	32
Taipan	11	47
BHS	10	24

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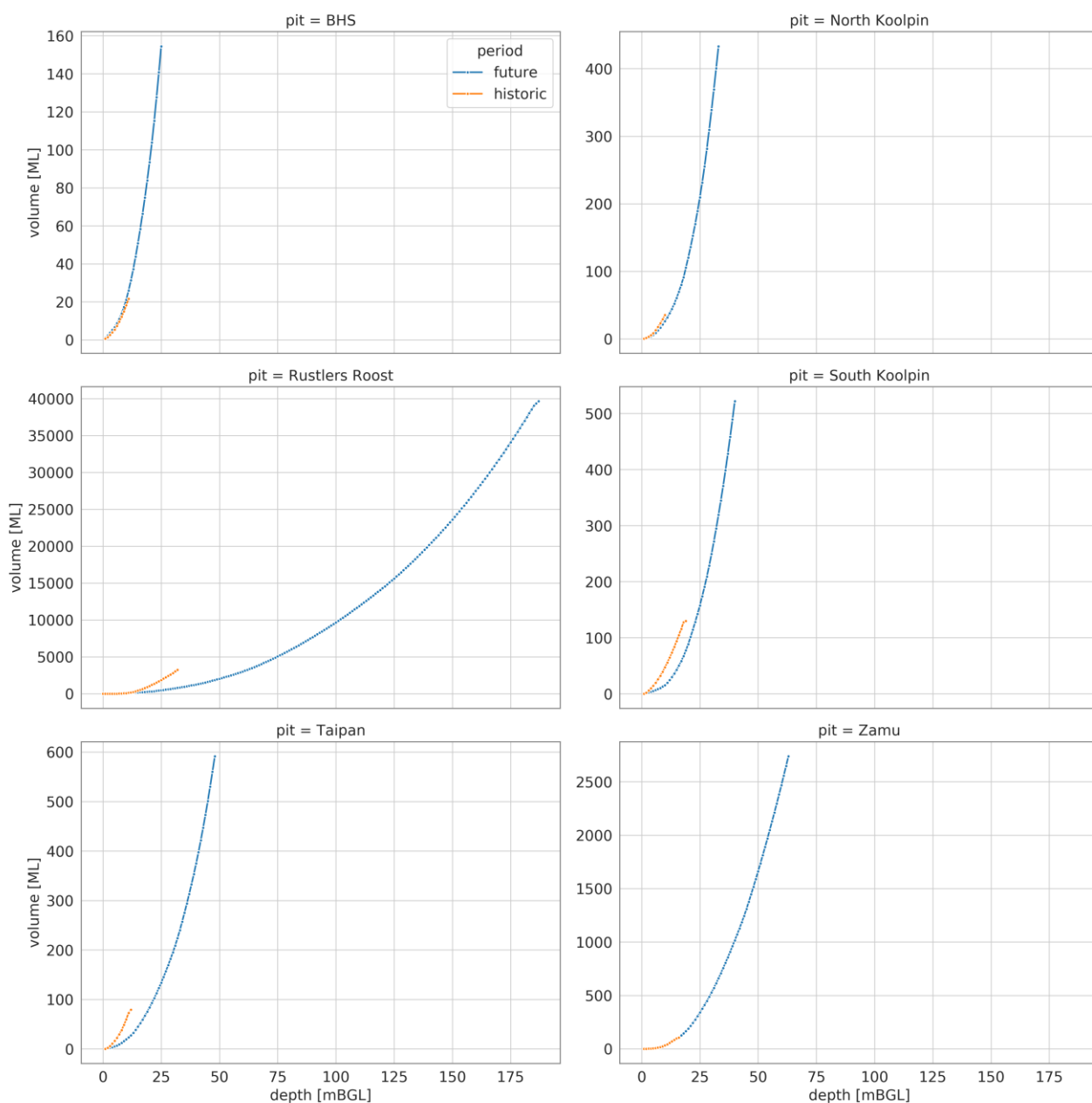


Figure 6-4 Pit Depth/Pit Lake Volume Relationship Adopted in the Model

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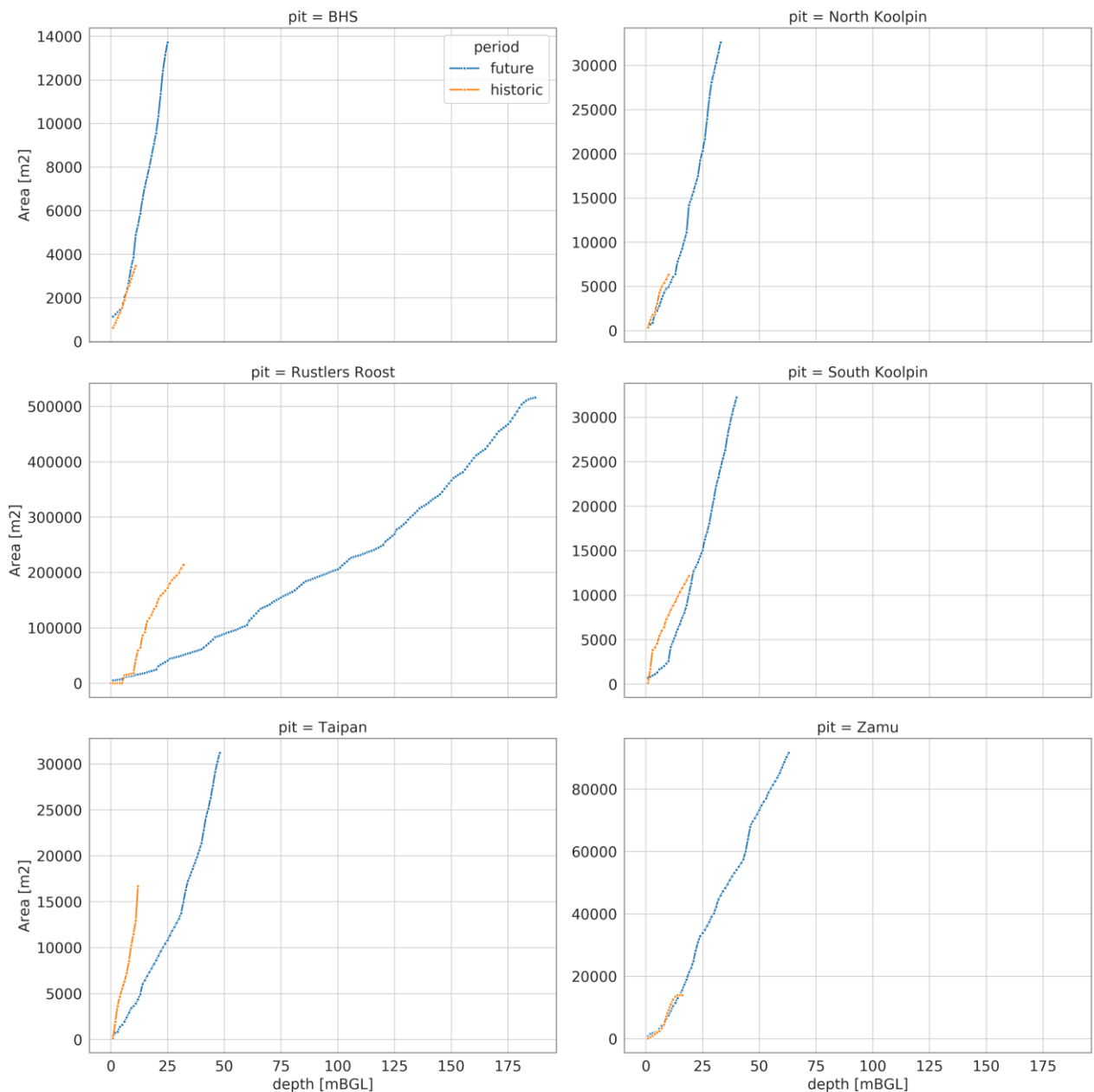


Figure 6-5 Pit Depth/Pit Lake Area Relationship Adopted in the Model

6.3.3.3 Groundwater Seepage (groundwater inflow to pits)

Groundwater seepage (groundwater inflow to pit or groundwater discharge) is controlled by the hydraulic properties of the bedrock and the hydraulic gradient between the pit lake level and the surrounding aquifer (Figure 6-6). In the water balance model, the groundwater seepage is simulated using the Dupuit-Forcheimer equation using a GoldSim package documented on the Goldsim website¹.

¹ (<https://support.goldsim.com/hc/en-us/articles/115012610927-Groundwater-Inflow-to-a-Mine-Pit>).

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The seepage model requires one unique value of hydraulic conductivity to characterise the aquifer and one unique value for the water table elevation (which is therefore assumed to be flat). Finding both representative values is challenging as the actual distribution of hydraulic conductivities is complex and not well documented (cf. Section 4.4.3) and the hydraulic gradient is also variable all around a pit.

With this model, the mine pit is simplified, geometrically, to a cylinder of radius effectively equivalent to its irregular size and shape. The regional groundwater seepage to the open pit is estimated using the method first developed by Dupuit (1863), improved by Forchheimer (1930) and described as the Dupuit-Forchheimer equation for radial flow conditions for an unconfined aquifer. The conceptualisation of inflow in the Dupuit-Forchheimer equation is illustrated in Figure 6-6, with pit inflow calculated as:

$$Q = \pi K \frac{(h_0^2 - h_w^2)}{\ln \left(\frac{R + r_w}{r_w} \right)}$$

where:

- K is the hydraulic conductivity of the rock mass;
- h_0 is the pre-mining groundwater level above the base of the aquifer;
- h_w is the base of the pit floor above the base of the aquifer;
- r_w is the pit diameter; and
- R is the radius of influence.

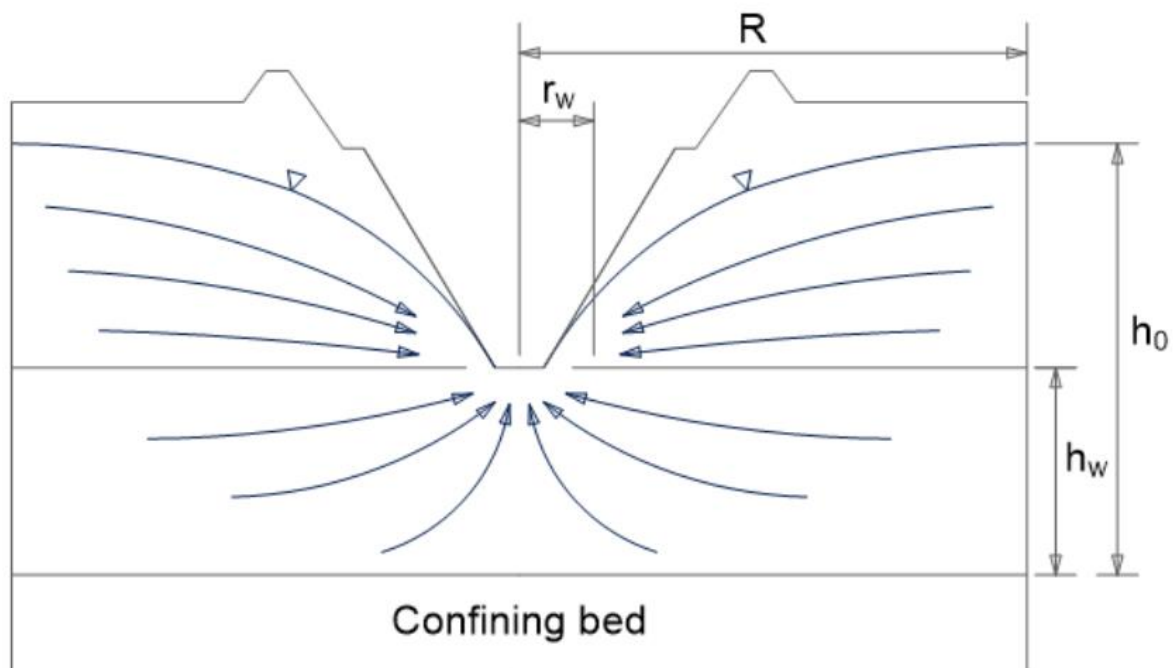


Figure 6-6 Conceptualisation of the groundwater seepage to the pit using the Dupuit-Forchheimer Equation to Estimate Inflow (from Goldsim)

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The hydraulic conductivity of the rock mass is an important factor in the calculation of groundwater seepage into the open pits. To gain a better understanding of the possible range of the hydraulic conductivity, the historical recovery of water levels in the Rustlers Roost open pit was simulated using Goldsim.

As no field data regarding the recovery of this pit water level was available, online available imagery was used to assess the timeframe within which the pit water levels recovered. Mining at Rustlers Roost ceased in 1998. A 2004 satellite imagery available on Google Earth (the earliest available image post 1998) shows that the 2004 pit lake extent matches the current extent, suggesting that the maximum recovery of water levels in the open pit was already complete by 2004.

The recovery of the pit water levels since the historical mining finished in 1998 was modelled using Goldsim using a range of hydraulic conductivities for the rock mass, with the results presented in Figure 6-7. These results indicate that with an assumed hydraulic conductivity of 0.5 m/d or more, the pit lake had fully recovered by 2004. With a hydraulic conductivity between 0.5 m/d and 0.2 m/d, the pit lake was nearing full recovery by 2004, and with a hydraulic conductivity of less than 0.1 m/d, the pit lake was decades away from a full recovery.

The results suggest that a representative hydraulic conductivity would be at least 0.1 m/d but more likely 0.2 to 1 m/d. This estimation is in line with the literature review of nearby mining operations and longer term hydraulic tests in similar geologies (the short term slug testing undertaken at the site is not likely to represent bulk hydraulic conductivity) where bulk hydraulic conductivity is estimated to be between 0.1 and 5 m/d. Results of numerical model calibration of the nearby Toms Gully mine suggests bulk hydraulic conductivity around 0.001 and 1 m/day. The numerical model calibration for this site (Section 5.3.12.1) suggests that hydraulic conductivity of the rock mass around the pits is likely to be between 0.2 m/d and 1.1 m/d.

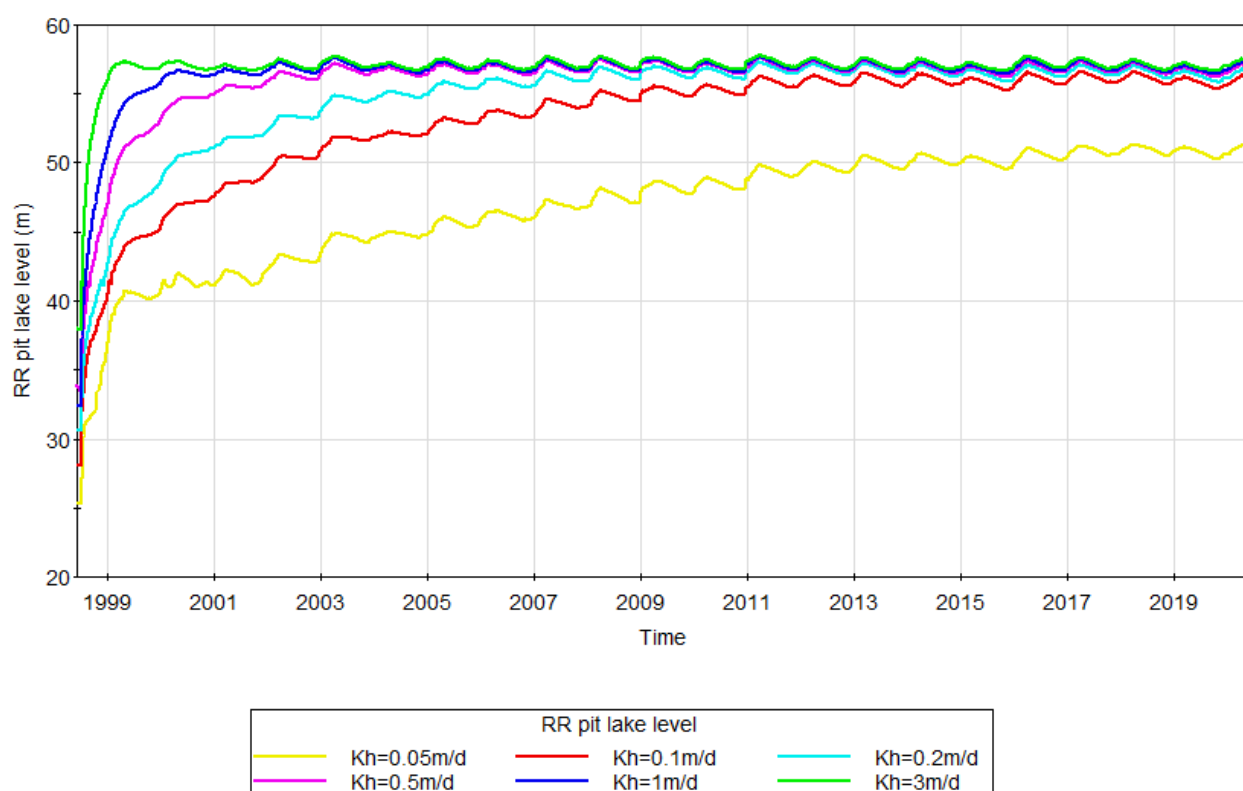


Figure 6-7 Modelled Pit Lake Water Level Increase for Rustlers Roost Historic Pit

The above estimation of hydraulic conductivity is only valid for the first 30 meters of the aquifer (i.e. the depth of the historical pit) and as hydraulic conductivity in fractured rock is expected to decline with depth (refer Section 4.4.3.4), a

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lower value of hydraulic conductivity can be considered to represent the deeper parts of the aquifer that would contribute to inflow into the open pit. Based on the literature review and hydraulic parameters presented in Section 4.4.3.4, the aquifer has been separated into two zones, a more permeable shallow aquifer zone and a less permeable deep aquifer zone. The depth between the two zones has been set at 80 m based on the available data. Therefore, the contribution from the deeper zone is only relevant for the Rustlers Roost pit, with all other pits being competed in the more permeable shallow aquifer zone.

For the Rustlers Roost pit, the Goldsim analytical formula simulates two pits, one for the shallow more permeable zone and one for the deeper less permeable zone and combines the outputs to get total inflow volumes from groundwater seepage.

6.3.3.4 Pit Dewatering Capacity

The mining schedule for each pit is summarised in Table 6-1. Dewatering of each pit is required during Phase 1 and Phase 2 of the mining operations. Based on available Project information, the in-pit sump pumping units used for pit dewatering rate are assumed to have a capacity of 125 L/s each. Therefore, the Goldsim model assumes initially a dewatering capacity of 125 L/s. The number of dewatering units are then scaled up if necessary (i.e. increasing dewatering capacity by 125 L/s steps), to provide dry working environment. The resulting dewatering requirements are presented in the model results in Section 6.3.5.

6.3.3.5 Water Demand

The Rustlers Roost and Quest 29 Gold Project requires approximately 175 ML per year of non-potable water (Primary Gold, 2021), which will be sourced from the Turkeys Nest storage facility during the mining operation (from December 2021 to December 2032). The water is assumed to be suitable for dust suppression in the pit, on the road and other site infrastructure.

The ore processing plant (operating from February 2024 to April 2032) has an average water demand of 3,656.6 ML/yr (Knight Piesold, 2022). The majority of this water demand is to be covered by recirculation from the TSF (Primary Gold, 2021), with the balance to be provided by pit dewatering. If the pit dewatering is not able to provide the balance, make-up water will be sourced from the bore field. The Goldsim water balance model was used to calculate the bore field water requirement.

The potable water demand (394.2 ML per year) is to be sourced from the bore field and treated with reverse osmosis and was included in the water balance model.

6.3.3.6 Processing Plant and TSF Representation

The ore processing plant and the TSF are key elements of the Rustlers Roost site water management balance. The water demand of the ore processing plant was estimated at 3,656.6 ML/yr (average annual demand). It was also estimated that water losses in the processing plant will be negligible and that the 3,656.6 ML/yr are to be disposed in the TSF as tailings water content. This water will then be recycled to be used in the processing plant. However, not all TSF water is available to be recycled due to physical processes within the TSF, including:

- Evaporation;
- Infiltration to underlying groundwater (TSF is planned to be lined and therefore infiltration will be negligible);
- Retention within TSF tailings/sediment; and
- Seepage of water at the toe of the TSF. This seepage water will be collected at the decant dam at the foot of the TSF and recirculated to the PWD.

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The modelling of the TSF processes is out of scope of the Goldsim model and has been modelled as part of the TSF Feasibility Design (Knight Piesold, 2022) which is included as Appendix G of the SEIS. A summary of the TSF water balance is provided below, as well as how these estimates have been included in the Goldsim model.

TSF Water Balance Summary

The TSF water balance was completed by KP using a monthly timestep. Tailings behaviour parameters were incorporated into the model using KP's in-house tailings density modelling software. The model allows for the build-up of tailings solids and area, then calculates the tailings densities, supernatant release, and water losses from within the TSF due to evaporation, infiltration etc (KP, 2022). Inflows and outflows to and from the TSF are shown in Figure 6-8.

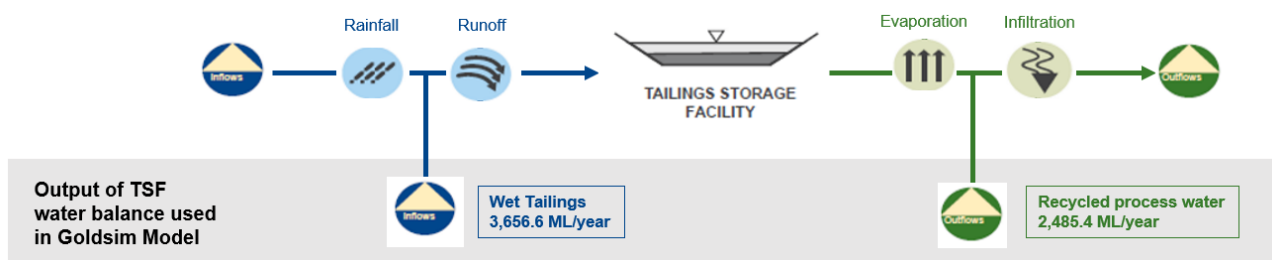


Figure 6-8 Schematic summary of TSF water balance

KP modelled three design rainfall scenarios: average conditions, wet conditions, dry conditions and ran the model assuming a commissioning date for storage of 01/09/2023 and a commissioning date for operation of 01/10/2023. The model predicts annual water inflows in the form of water in tailing slurry and annual water volumes recycled out of the TSF back to the processing plant for each year of operation.

The results of the modelling indicate that inflows were the same for all design rainfall scenarios (i.e. the process water use and therefore water in slurry is the same no matter the climate) whereas the volume of water that could be recycled varied. When compared to average conditions, in the dry conditions 10% to 24% less water could be recycled each year (average of 18% less water) whereas in the wet conditions 8% to 36% more water was available for recycling (average of 17% more). For the purpose of the Goldsim model, the average rainfall conditions have been used and a single annual rate based on the average annual rates from 2025 to 2033.

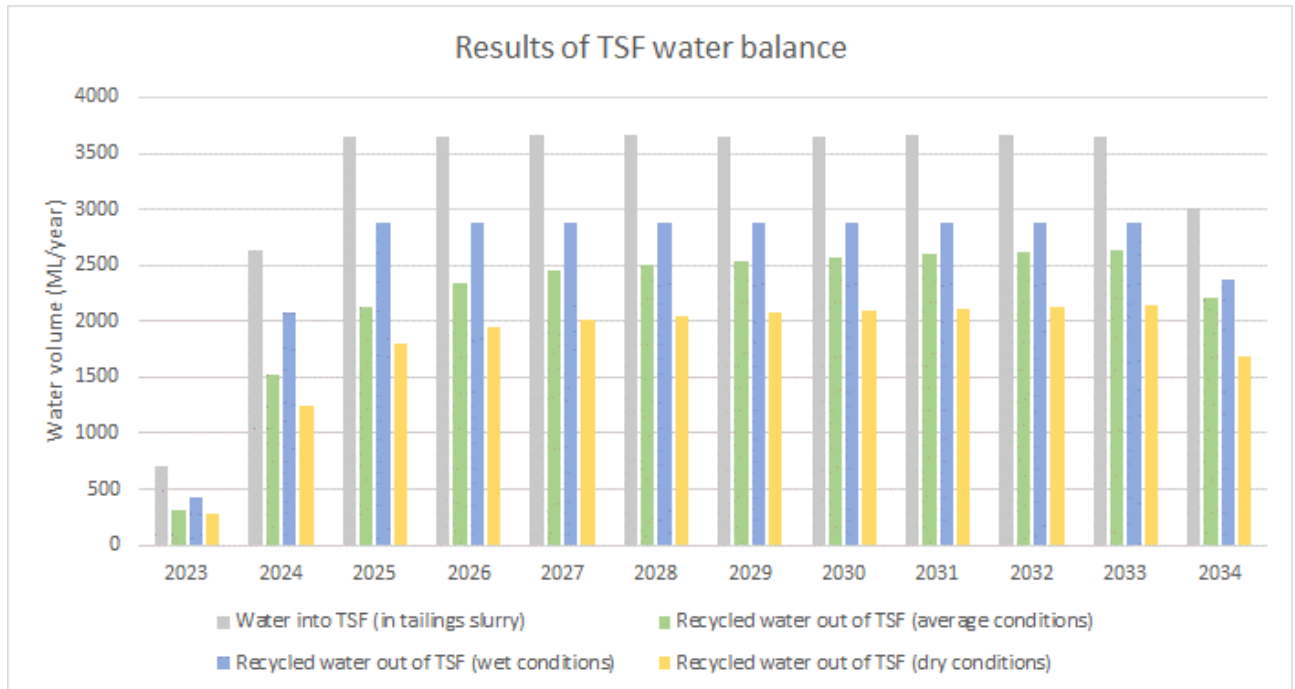


Figure 6-9 Results of TSF water balance that are relevant to the Goldsim site wide Water Balance

In the Goldsim model, the Processing Plant/TSF link is represented as:

- An output from the Process water dam to the TSF at the nominal rate of 3,656.6 ML/yr during the whole ore processing period (water goes to the processing plant where no losses occur and then to the TSF in tailings); and
- An inflow to the Process water dam from the TSF of 2,485.4 ML/L (water recycled from tailings) based on recovery during the average climate scenario run by KP.

6.3.3.7 Infiltration (Leakage)

Where the surface water level of any of the water management feature is located above the water table, there is a possibility of water leakage seeping to groundwater (i.e. groundwater recharge).

The Turkey's nest, process water dam and TSF (including the NTSF WSD) are engineered to minimise water loss by leakage and infiltration is assumed negligible and therefore omitted from the water balance model.

6.3.3.8 Evaporation

Simulated evaporation is based on a proportion of pan evaporation and applied over the entire wet area of pit lakes and all water storage facilities. Mean daily evaporation used for the model (Table 6-8) was sourced from BOM site Middle Point Rangers from 1965 to 1998.

A commonly used factor of 0.7 (D Mc Jannet & al.2019) is applied to pan evaporation rates to account for water saturation (i.e. where relative humidity is 100% and no evaporation can occur) over the pits' lake.

Table 6-8 Mean Daily Evaporation for BoM Station 014090 Middle Park Ranger

Month	Evaporation (mm)
January	5.26
February	5.06
March	5.20

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Month	Evaporation (mm)
April	5.75
May	5.90
June	5.81
July	6.09
August	6.77
September	7.46
October	7.63
November	6.76
December	5.88

6.3.3.9 Pit Starting Volumes

For the simulation, it is assumed that the water storage infrastructures were empty and that the historical pits started as the current estimated volume as summarised in Table 6-9.

Table 6-9 Pit Starting Volumes

Pit Lake	Initial Volume [m ³]
Rustlers Roost	3,160,000
Annie Okaley	NA
Annie's Dam	NA
Zamu	80,000
South Koolpin	73,000
North Koolpin	3,000
Taipan	37,000
BHS	15,000

6.3.3.10 Controlled Release to Creeks

The Water Management Plan includes a provision for release of water from the site into the surrounding watercourses. A key aspect of the Water Management Plan is to release water to the creeks only during the dry season. To define the dry season for the model, the following analysis was completed:

- Future predicted daily streamflow was provided for Mount Bunday Creek, the McKinlay River, Charles Creek and the Mary River for 2030 to 2121 by Surface Water and Erosion Solutions;
- Monthly flows were tabulated and analysed to report frequency of dry months per year. This analysis indicated:
 - Mount Bunday Creek has on average 4 dry months a year with the most frequent dry months of May, June, July and August
 - The McKinlay River has on average 3.5 dry months a year with the most frequent dry months of April, May, June and July
 - Charles Creek has on average 4 dry months a year with the most frequent dry months of March, April, May, and June

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- The Mary River has on average 3 dry months a year with the most frequent dry months of June, July and August.
- To define dry season for the model the combined statistics for Mount Bunday Creek, Charles Creek and the McKinlay River were used and indicate a dry season of 4 months from April to July inclusive.

The controlled release is managed by pumping out of storages at a defined rate as follows:

- At the Rustlers Roost site water is pumped from the NTSF WSD into Mount Bunday Creeks at a maximum rate of 300 L/sec; and
- At Quest 29 water is pumped from whichever pit is being used for dry season storage which varies over the LOM. From December 2024 to June 2030 Zamu pit is dewatered and the water stored in the other pits on site. From July 2030 to November 2031 Zamu pit is used as a water storage. At the Quest 29 site no limit on pumping rates was applied because storage is more limited at this site. Water is pumped to a tributary of the McKinlay River at Quest 29.

6.3.4 Summary of Model Parameters

The model parameters, including the range of values used in the Monte Carlo analysis, are summarised in Table 6-10, Table 6-11, Table 6-12 and Table 6-13.

A summary of the model parameter ranges used for the sensitivity and stochastic approach is presented in Table 6-14.

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Table 6-10 Summary of the Model Parameters - Pits

Pit	Initial Pit Lake Volume	Initial Pit Water Level	Surrounding Groundwater Level	Pan to Lake Evaporation Factor	Runoff Coefficient	Pit Equivalent Radius (for groundwater seepage modelling)	Historical Maximum Volume	Future Pit Maximum Volume
	m ³	mAHD	mAHD	-	-	m	m ³	m ³
Rustlers Roost pit	3,160,000	57.0	57.0	0.70	0.70	440	3,999,000	39,648,923
Annie Dam pit	N/A	N/A	N/A	0.70	0.70	115	N/A	290,000
Annie Okaley pit	N/A	N/A	N/A	0.70	0.70	140	N/A	290,000
Zamu pit	80,000	37.5	35.5	0.70	0.70	170	103,812	2,738,395
South Koolpin pit	73,000	40.5	37.0	0.70	0.70	100	129,728	521,767
North Koolpin pit	3,000	53.0	49.0	0.70	0.70	100	35,278	433,136
Taipan pit	37,000	39.0	37.0	0.70	0.70	100	79,253	591,343
BHS pit	15,000	71.0	69.0	0.70	0.70	66	21,637	154,485

Table 6-11 Summary of the Model Parameters - Landforms

Landform	Capacity (Storage Volume)	Water Storage Area
	m ³	m ²
Turkey's nest	50,000	5,000
NTSF WSD	6,998,400	466,560
Process water dam	100,000	10,000

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Table 6-12 Summary of the Model Parameters - Feature

Feature	Water Demand During Operation	Water Output
	ML/yr	ML/yr
Ore processing	3,656.6	
Dust suppression	175.0	
RO water (drinkable water) - from bore field	394.2	
Decant dam (of TSF)		2,485.4

Table 6-13 Summary of the Model Parameters – Climate and Aquifer

Parameter	Unit	Value
Climate Data		
Rainfall	mm/d	Daily time series of future rainfall with a climate change factor applied (from Surface Water and Erosion Solutions, 2022)
Pan evaporation	mm/month	Use monthly average of pan ET
Aquifer Data		
Hydraulic conductivity (shallow permeable aquifer zone)	m/d	0.2
Hydraulic conductivity (deep less permeable aquifer zone)	m/d	0.02
Depth of interface between shallow and deep zones	m	80
Aquifer recharge	mm/d	0
Aquifer base	mAHD	-200
Soil thickness	m	3
Kv soil	m/d	0.0034

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Table 6-14 Summary of the Model Parameters Range for the Sensitivity and Stochastic Approach

Parameter	Unit	Mean Value	Minimum Value	Maximum Values	Note
Hydraulic conductivity (shallow permeable aquifer zone) (Kh)	m/d	0.2	0.01	0.5	Highest values based on field estimates of bulk hydraulic conductivity as per Section 4.4.3.4, while lower values derived from model calibrations.
Hydraulic conductivity (deep less permeable aquifer zone) (Kh)	m/d	0.02	0.001	0.05	Literature review suggests a reduction of hydraulic conductivity with depth in similar geologies of 1 to 2 orders of magnitude when greater than 50 m deep. The values for the shallow zone have therefore been reduced by 1 order of magnitude. The depth transition (80 m) has been based on the results of the historical pumping test at Rustlers Roost which suggested there was still some fracture permeability at 60 m depth (Section 4.4.3.4).
Pan to lake evaporation factor (reduction factor to account for humidity saturation in a lake compared to pan evaporation)	-	0.7	0.6	0.8	-
Water table elevation	mAHD	Ref	Ref value -2	Ref value +2	Defining the representative water table elevation is an uncertainty in the model as the water table elevation is not constant around each pit whereas the model demands only one value. In addition, there is only limited groundwater level monitoring data is available for most of the site (bores drilled in 2020) and therefore the values collected may not be representative.
Runoff coefficient (Multiplier to the rainfall amount to account or the portion that is evaporated or infiltrated before reaching the water store)	-	0.7	0.4	0.8	-

6.3.5 Model Results

The Monte Carlo results of 100 Goldsim model realisations are described below, including discussion of:

- The site water balance summing up the inflows into the water management system comprising rainfall, runoff, bore field production and pit groundwater seepage (groundwater discharge), and the outflows of the system through evaporation, infiltration, or disposal into the Mount Bunday Creeks and Quest 29 Creek;
- The groundwater seepage into the open pits;
- The water disposal to creeks;
- The borefield production requirements;
- The pit lakes stabilisation level and volume post-mining due to the balancing of the pit lakes inflows and outflows; and
- The evolution of the concentration of a nominal chemical of potential concern into each of the final pit lakes.

The model was run for a period of 300 years from beginning of mining operation (i.e. start of Phase 1). However, the water levels in the open pit lakes stabilise within the first 60 years post-mining for all model simulations. Therefore, the time series results do not show the simulation results of the entire 300 years, but only focus on the transition period to steady-state water levels, to better visualise the results. Some figures are also focusing on the mining period only, as this is the only time some processes (e.g. pit dewatering) occurs.

6.3.5.1 Site Water Balance

The site water balance during mining operations (from beginning of pit dewatering in December 2021 to the end of the stock-piled ore processing in December 2032) is summarised in Table 6-15.

Median inflows to be managed amounts to about 5,100 ML/yr for the 11 years of operations. About 4,000 ML/yr are predicted to be generated from groundwater seepage (groundwater discharge) into the open pits (i.e. 77% of all inflow into the water management system). The second largest contributor to the pit inflows is runoff with an average of 610 ML/yr (i.e. 12% of all inflow). Direct rainfall into the pits' lake and the water storage facilities (Turkey's nest, processed water dam and the NTSFD WSD) accounts for 4% (185 ML/L) and the bore field production accounts for about 7% (365 ML/yr).

Around 3,400 ML/yr (or 69%) of the water produced on site is expected to be disposed into the Mount Bunday Creek or creeks/surface water drainages at Quest 29. A total of 19% of the water produced (or 905 ML/yr) is expected to be consumed by the TSF (portion that is not recovered by the decant dam). The production of potable water (treated by reverse osmosis) represents 7.5% of the outflows (370 ML/yr), and water used for dust suppression amount to 175 ML/yr (3.5%). The evaporation of surface water within pit lakes and water storage facilities are predicted to be 70 ML/yr or 1.5% of all outflows.

The minor imbalance between the total inflows and total outflows can be attributed to two reasons. The first reason is that the median values of the water balance components within the Monte Carlo approach are not from the same simulation but the median value for each component across all simulations. The second reason is due to the change of storage in the water balances features (mainly the pits' lake).

Considering the current uncertainties in the model controlling parameters, the sum of all inflows is anticipated to range somewhere between 5,000 ML/yr to 10,000 ML/yr. Most of the uncertainty arises from range of hydraulic conductivity assigned for the aquifer, which given the heterogeneity implicit in fractured rock aquifers, is difficult to constrain.

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Table 6-15 Water Management Site Inflows and Outflows During Operation (from beginning of operation in 2021 to end of ore processing in December 2032)

	Median Value	Minimum	Maximum	Portion of Total Inflows/Outflows
Inflow	ML/yr	ML/yr	ML/yr	%
Groundwater seepage (discharge)	3,950	1970	8,190	77.3
Runoff	610	403	910	12
Bore Field production	365	367	380	7
Direct rainfall	185	165	240	3.7
TOTAL INFLOW	5,110	2,905	9,720	100
Outflow				
Disposal	3,360	1,550	6,960	69
TSF loss (TSF evaporation, infiltration and adsorption combined)	905	905	905	18.5
Potable water (reverse osmosis water)	370	370	370	7.5
Infiltration (groundwater recharge)	0	0	0	0
Evaporation	70	55	90	1.5
Dust Suppression	175	175	175	3.5
TOTAL OUTFLOW	4,880	3,055	8,500	100
Change in storage				
All pit and feature storage (negative values indicates that the final volume stored is smaller than the initial and vice versa).	230	-150	1,220	

6.3.5.2 Groundwater Seepage (groundwater discharge to the pits)

The groundwater seepage (discharge of groundwater to the pit) into the open pits is the largest contributor to the water balance inflow as it amounts for about 77% of all inflows. Figure 6-10 illustrates the groundwater seepage into the combined Rustlers Roost pits (Rustlers Roost pit, Annie Oakley pit, Annie Dam pit), and Figure 6-11 shows groundwater seepage into the combined Q29 pits (Zamu pit, Southern Koolpin pit, North Koolpin pit, Taipan pit and BHS pit).

The groundwater seepage is expected to increase as the pits deepen during mining operation. At the Rustlers Roost mine site there are three pits with deepening works happening at different times; Rustlers Roost pit begins operation in March 2023 and is active for the rest of the operation period whereas deepening of Annie Oakley pit and Annie Dam pit only occurs for 4 months and 10 months respectively, in 2023 and 2024. At the end of the mining operations, groundwater seepage (discharge) into the Rustlers Roost pits would be 100 L/s. However, uncertainty analysis suggests that this inflow could vary between 30 L/s and 270 L/s.

For the Q29 pits operations start in July 2025 at Zamu pit which is mined until end of June 2030, followed by operations in South Koolpin, North Koolpin and Taipan pits from July 2030 and BHS pit from August 2032. This means that the maximum groundwater seepage rate occurs around April 2031 where an estimated inflow of 200 L/s for all Q29 pits is expected, although with an uncertainty range from 60 L/s to 370 L/s.

Total combined groundwater seepage is expected to be at its maximum in April 2031 at 290 L/s, with an uncertainty range from 90 L/s to 360 L/s. Monitoring of groundwater seepage during the initial phase of mining operation would greatly reduce the uncertainty.

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Figure 6-12 illustrates the cumulative amount of seepage into all pits. At the end of the mining operations (in October 2031), a cumulative amount of approximately 46 GL of groundwater is estimated to have seeped into the open pits. Based on the uncertainty analysis, this amount ranges from 23 GL (for a lower end hydraulic conductivity range) to 95 GL (for the higher end hydraulic conductivity range).

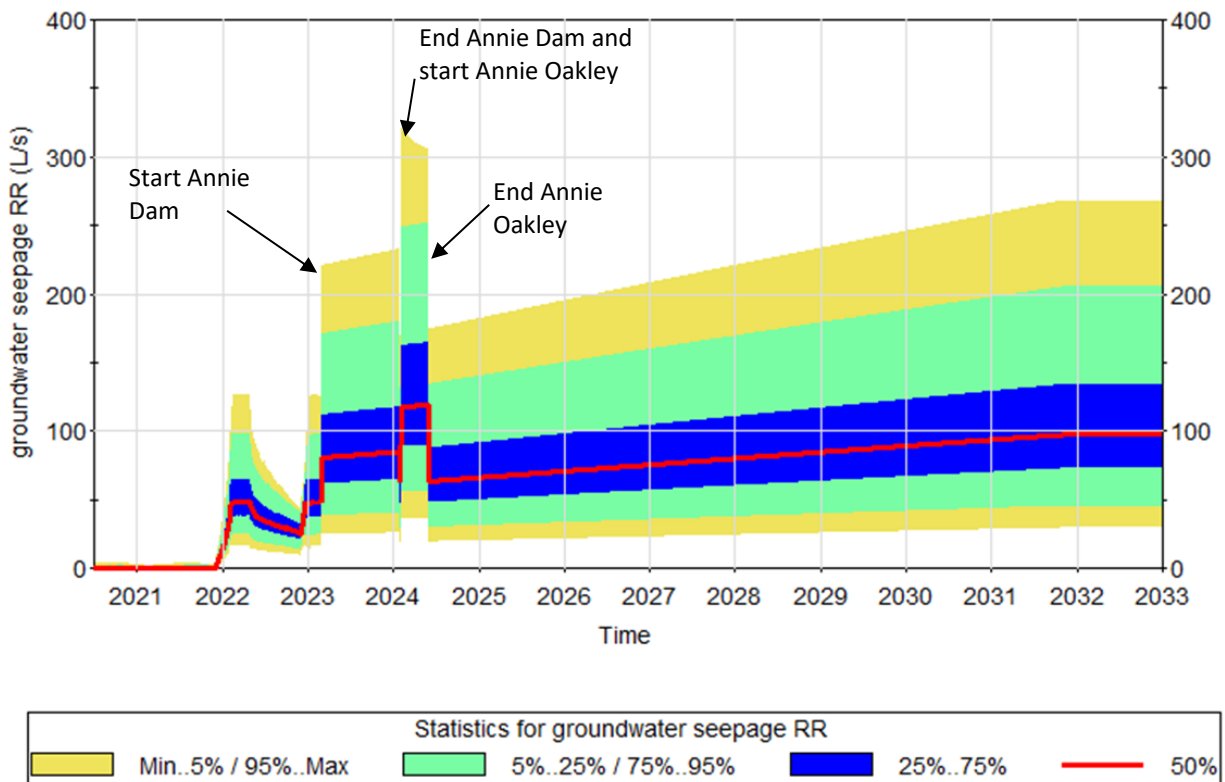


Figure 6-10 Predicted Total Amount of Groundwater Seepage from the Rustlers Roost pits combined over Time

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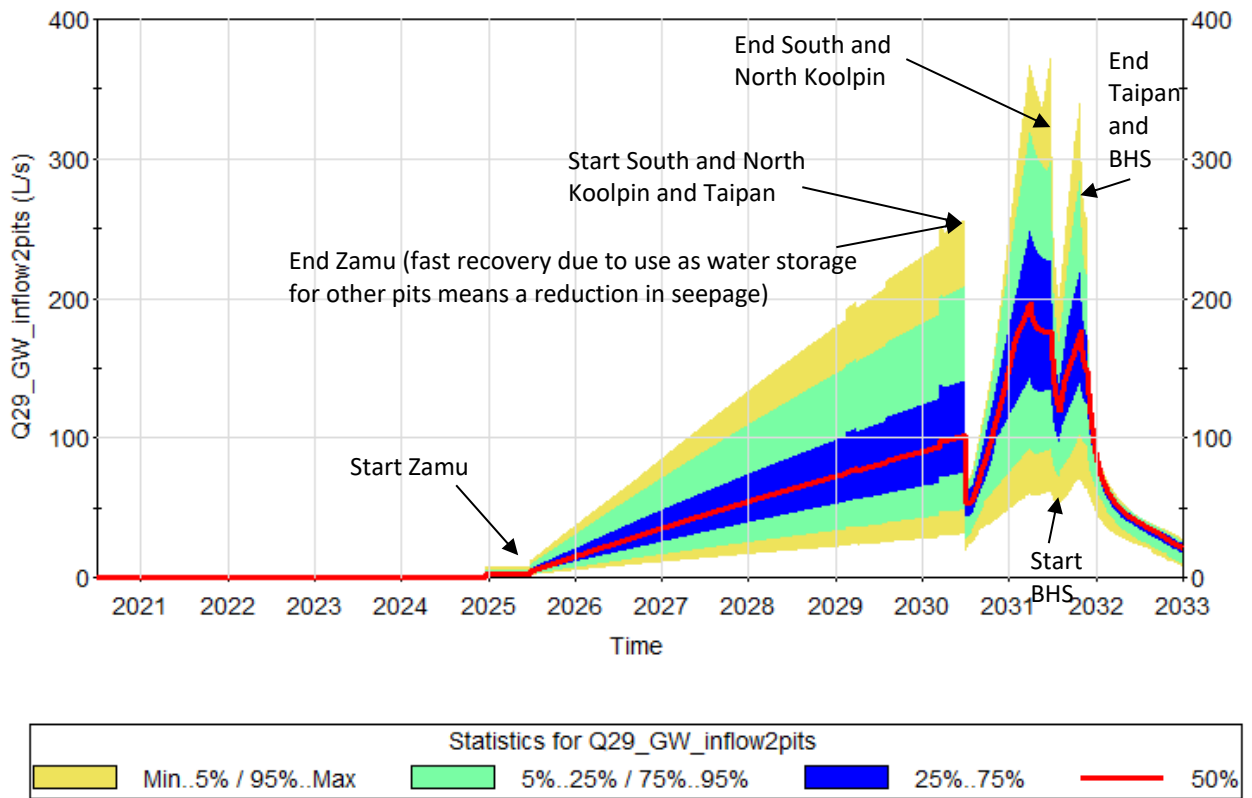


Figure 6-11 Predicted Total Amount of Groundwater Seepage from the Q29 Pits Combined over Time

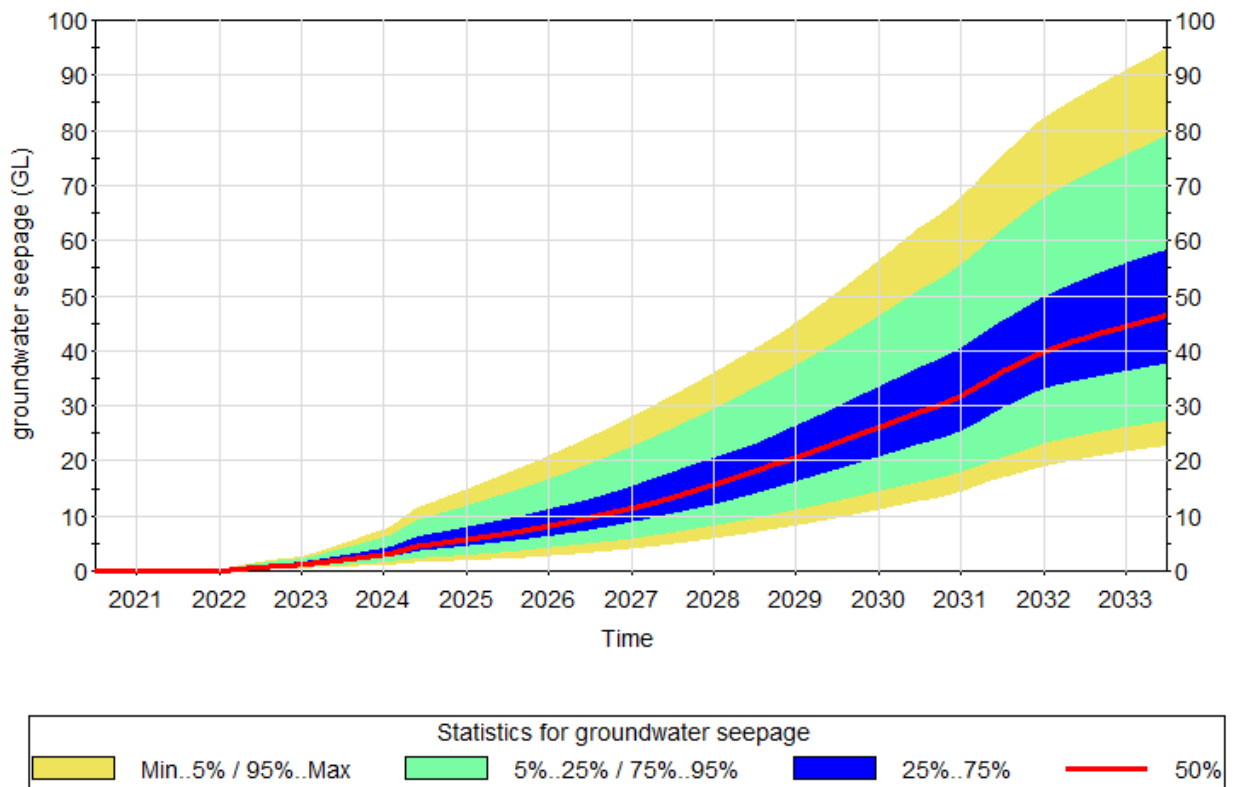


Figure 6-12 Cumulative Groundwater Seepage from all Pits over Time

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6.3.5.3 Pit Dewatering Requirements

The pit dewatering requirements comprise the groundwater seepage into the pits and any rainfall and runoff (less evaporation) that falls within the pit catchments. These estimates are summarised in Table 6-16. For the five Quest 29 pits, the average dewatering rate is less than 52 L/s and hence a single 125 L/s capacity sump pump would be sufficient to maintain dry pit environment.

For the Rustler Roost pit, according to current hypothesis in term of uncertainty of the controlling parameters, the dewatering requirement is 103 L/s on average, with a maximum dewatering capacity of 600L/s required to maintain a dry working environment during operations. The maximum rate is used for 2 months at the beginning of dewatering to empty the current pit lake.

Table 6-16 Pits Dewatering Requirement

	Rustler Roost Pit	Zamu Pit	South Koolpin Pit	North Koolpin Pit	Taipan Pit	BHS Pit
Mean daily dewatering rate [L/s]	103	52	32	15	36	13
Number of days of dewatering	3,407	2,024	501	501	654	230
Maximum dewatering rate [L/s]	600	125	125	125	125	125

6.3.5.4 Water Disposal to Creeks

The Water Management Plan includes a provision for water to be released from the site during the wet season into the surrounding creeks, while during the dry season the water is stored on site (predominately in the NTSF WSD at Rustlers Roost and in non-worked pits at Quest 29). Figure 6-13 and Figure 6-14 illustrate the controlled release during the wet season and potential uncontrolled release during the dry season if there is insufficient storage on site. During the wet season the storages are emptied so that there is maximum storage capacity available at the beginning of each dry season. Figure 6-13 and Figure 6-14 show the water released to the environment at Rustlers Roost and Quest 29 over the life of mine. The median (red line) represents the most likely of the 100 models.

Table 6-17 shows the average release rates for each month for Rustlers Roost and Quest 29. For 95% of model runs there is no uncontrolled release during the dry season (i.e. there is sufficient storage on site). For the 95th percentile and maximum scenarios (i.e. high hydraulic conductivity and high runoff) there is some dry season release. The model is set up to maintain 5% storage in the storages to allow for water reuse in the dry season and lowering this threshold may negate the requirement for dry season release in these unlikely scenarios. The cumulative amount of environmental water release is illustrated on Figure 6-15. About 36 GL of water is required to be released (with an uncertainty range from 17 GL to 78 GL).

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Table 6-17 Average pumping rates during environmental releases per month

Month	Rustlers Roost site monthly average release rate (L/s)							Q29 site monthly average release rate (L/s)						
	Min	5%	25%	50%	75%	95%	Max	Min	5%	25%	50%	75%	95%	Max
Jan	154	174	199	213	229	241	270	17	26	52	73	94	142	163
Feb	83	99	120	134	150	190	228	20	28	51	76	96	148	165
Mar	-	-	-	-	-	-	77	18	27	46	75	96	154	179
Apr	-	-	-	-	-	6	109	-	-	-	-	-	1	14
May	-	-	-	-	-	93	157	-	-	-	-	-	6	84
Jun	-	-	-	-	-	128	174	-	-	-	-	-	28	139
Jul	-	-	-	-	-	158	190	-	-	-	-	-	37	67
Aug	-	-	-	-	-	256	288	82	103	129	142	155	180	197
Sep	-	-	-	-	212	284	302	34	57	79	111	131	158	185
Oct	-	-	-	161	240	276	287	20	46	80	98	139	169	212
Nov	-	-	151	237	279	300	297	18	39	78	95	119	164	178
Dec	87	117	192	202	217	251	242	18	27	59	76	97	144	185

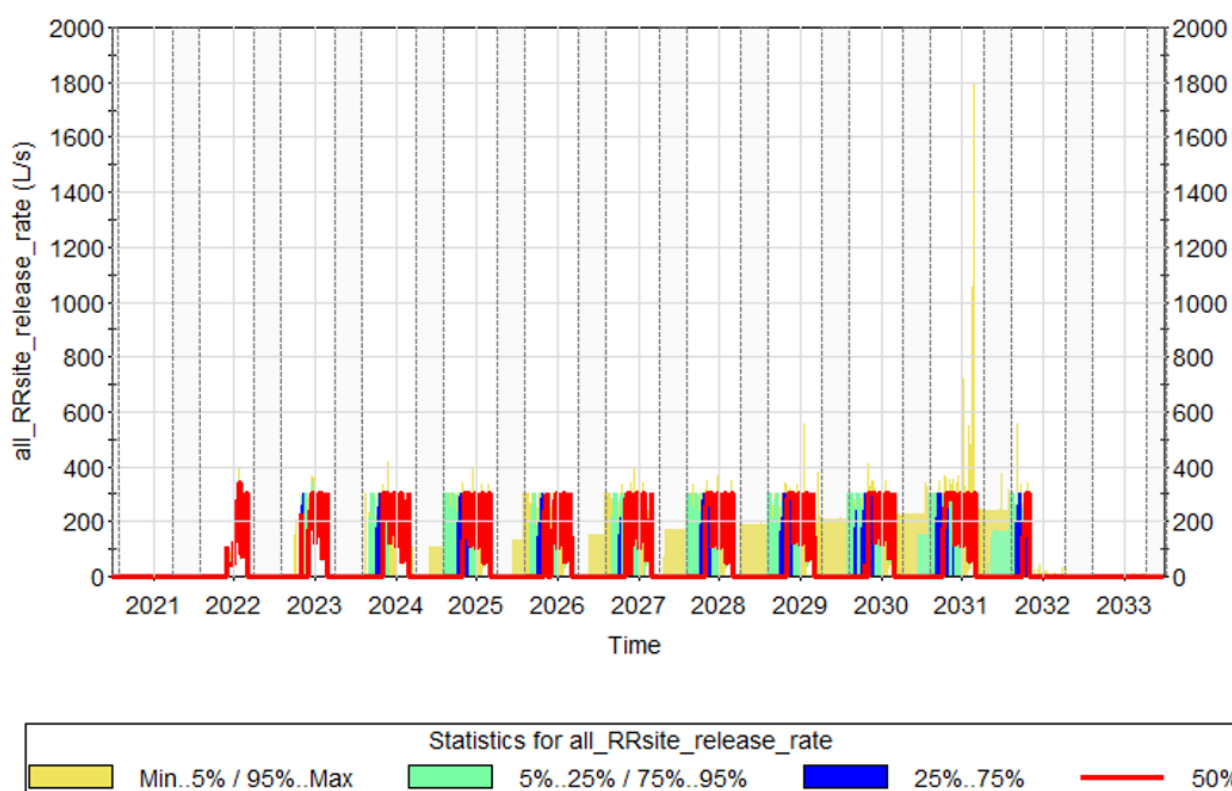


Figure 6-13 Water release to the Environment from the Rustlers Roost site (shaded periods represent dry season)

6 Site Water Balance and Solute Transport Modelling

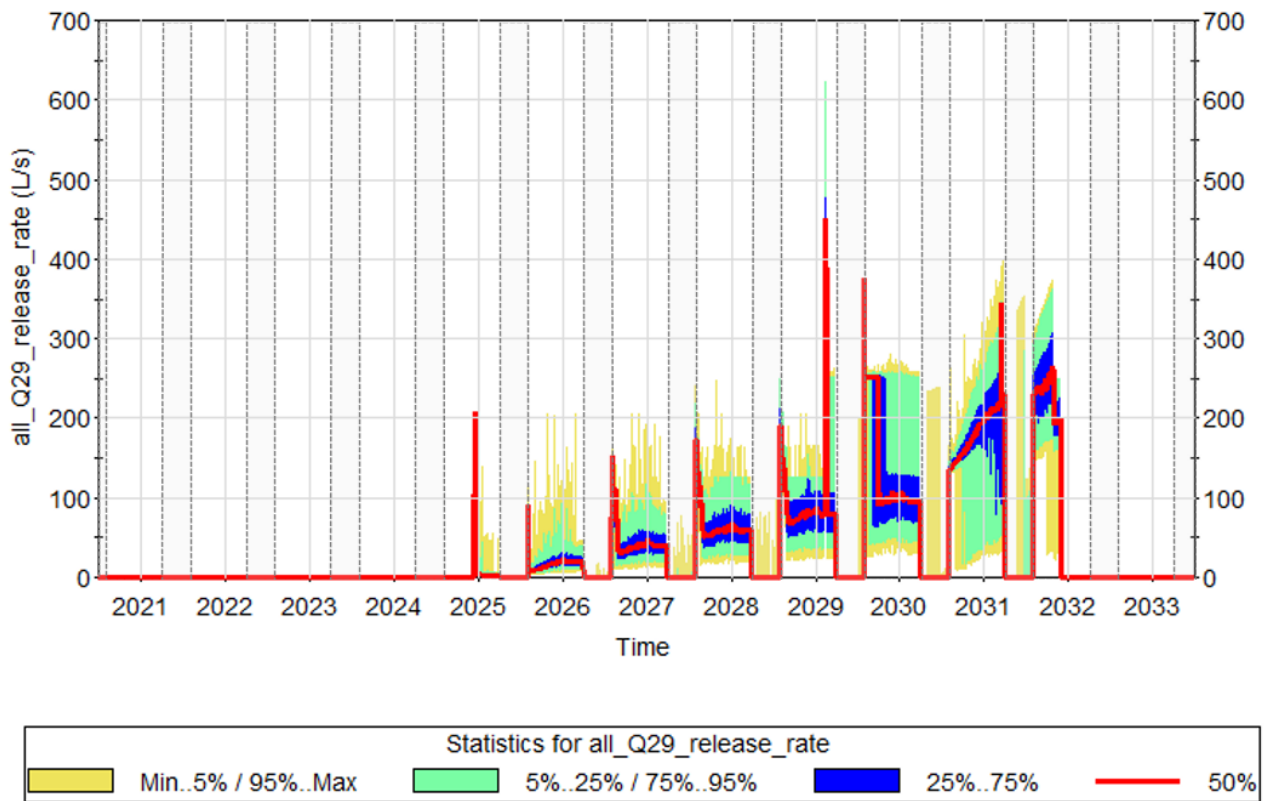


Figure 6-14 Water release to the environment from the Quest 29 site (shaded periods represent dry season)

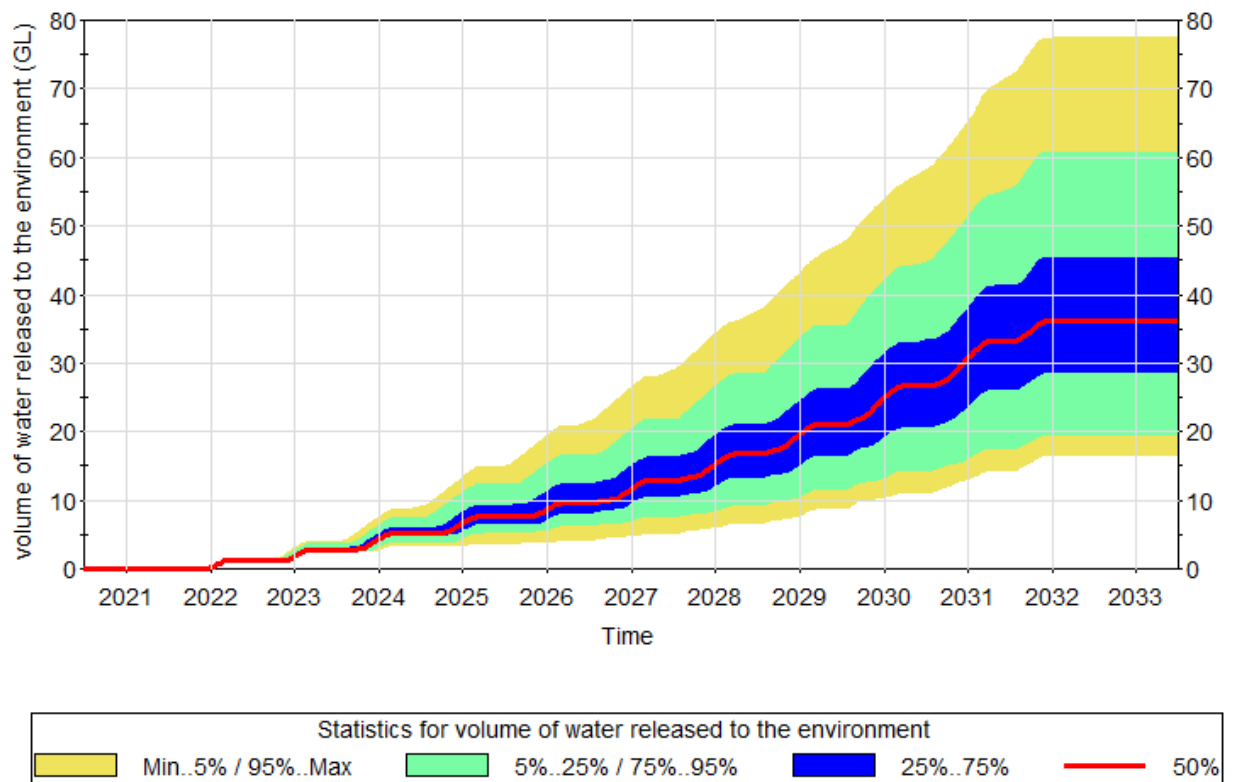


Figure 6-15 Cumulative Volume of Water Release to the Environment

6.3.5.5 Borefield Production Requirement

Borefield production requirements are illustrated on Figure 6-16 with the cumulative bore field production illustrated on Figure 6-17. For the median case, the borefield water production is limited to the production of potable water (reverse osmosis water) at a rate of 12.5 L/s for the life of mine. Only 5 % of models indicate a requirements for more than 12.5 L/sec in the second half of 2032 where 55L/sec is required for make up water.

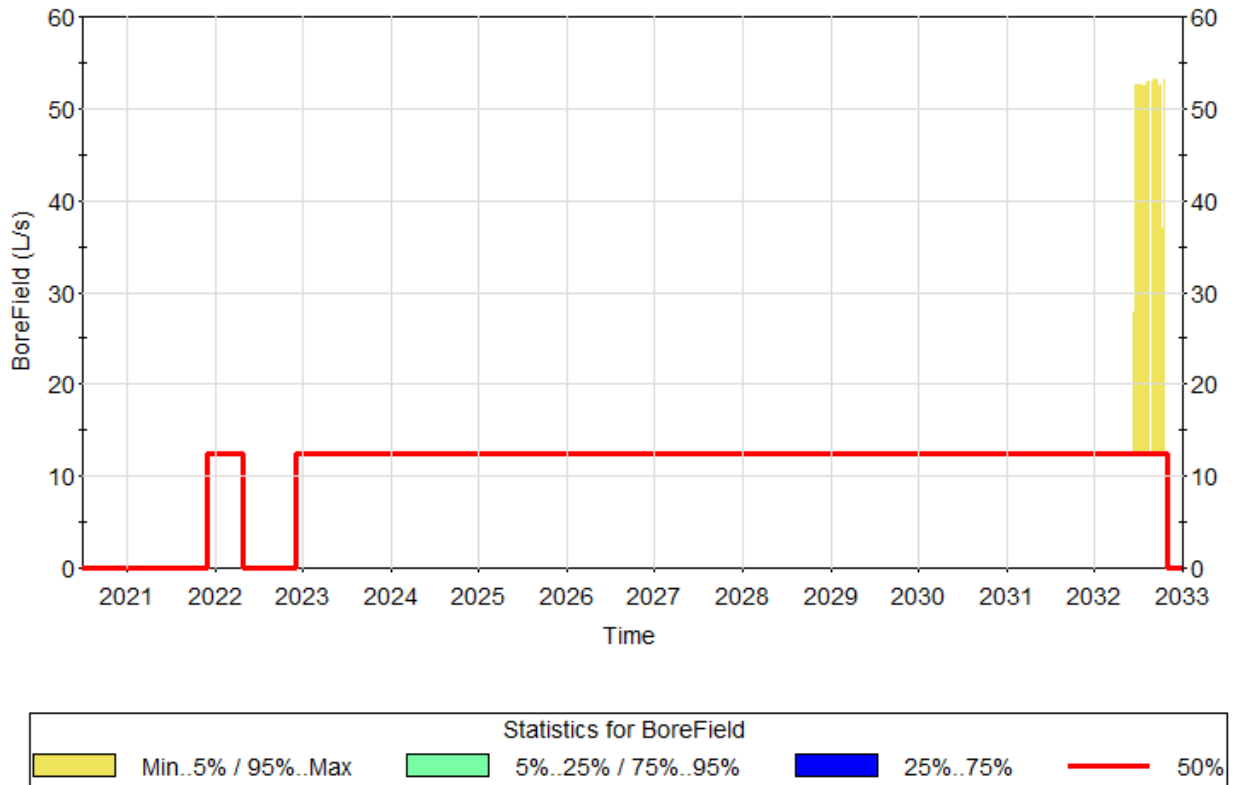


Figure 6-16 Proposed Borefield Production over Time

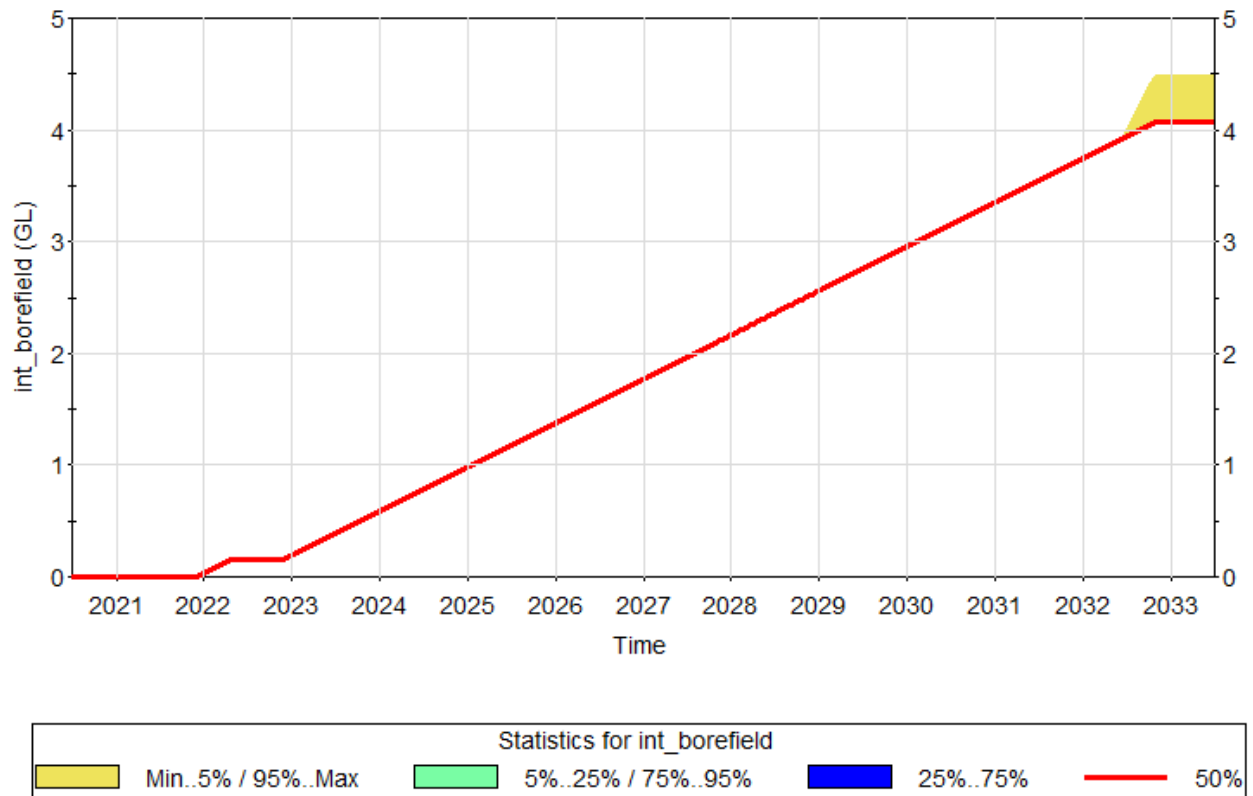


Figure 6-17 Predicted Cumulative Borefield Production over Time

6.3.5.6 Post-mining Pit Lake Recovery and Pit Lake Overflow Likelihood

Post-mining, pit lakes are created by the balancing effect of inflows (groundwater seepage, direct rainfall into the lake and runoff on the pit catchment) and outflows (evaporation and potential water infiltration if the lake level rises above the water table elevation although this is not represented in the Goldsim model). Table 6-18 summarises the long-term pit lake stabilisation levels and the water table elevation that was estimated and adopted in the model.

The type of interaction between the lake and the groundwater is determined by the gradient between the water table and the pit lake level. There are three possible cases:

- The lake water level stabilises above the water table. The net interaction between the lake and the groundwater aquifer is toward a net recharge of the aquifer. This is the case for the North Koolpin pit lake;
- The lake water level stabilises at or near the water table. Due to the seasonal variation of the lake water level (which is likely to respond to the seasonal variation faster than the groundwater levels), the interaction is likely to alternate between net seepage during the dry season (groundwater discharge to the pit) and net infiltration during the wet season (groundwater recharge from the pit). The Rustlers Roost pit lake, Taipan pit lake and BHS pits are predicted to be in this situation; and
- The lake water level stabilises beneath the water table. In this case, the pit lake acts as a sink to the regional groundwater and a net groundwater infiltration (recharge to groundwater) dominates. South Koolpin pit is in this category; however, due to the small hydraulic gradient, the interaction between the open pit and the groundwater is limited.

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As discussed before, the modelling of the interaction between the pit lake and the groundwater is limited by the representation of the water table as a flat surface (parameterised by a single value in the model). With this representation, the possibility for a pit lake to become a through flow (i.e. receiving groundwater inflow on one side and releasing water to groundwater on the other side) is not represented. Given the position in the catchment of the pits (with higher elevation ground to one side and lower to the other), it is likely they will act as throughflow features.

Pit lake infiltration to the groundwater is not represented in the Goldsim model.

Table 6-18 Pit Lake Stabilisation Levels and Water Table Elevation

Pit	Estimated representative water table elevation [mAHD]	Predicted pit lake stabilisation level (median case)	Comment
Rustlers Roost	57 to 61	59	The pit lake stabilises within the seasonal water table elevation range. Groundwater interaction with the pit lake is expected to be limited with potential seasonal variation (groundwater seepage into the pit during the dry season and pit lake infiltration to the groundwater during the wet season).
Taipan	35 to 39	37	The pit lake stabilises within the seasonal water table elevation range. Groundwater interaction with the pit lake is expected to be limited with potential seasonal variation (groundwater seepage into the pit during the dry season and pit lake infiltration to the groundwater during the wet season).
South Koolpin	38 to 48	41	The pit lake stabilises at the lower end of the water table elevation range. For some of the time the pit will act as a sink for groundwater with some potential for seasonal contribution from the pit to the groundwater during wet periods.
North Koolpin	41 to 50	55	The pit lake stabilises significantly above the water table. No groundwater seepage is expected, and a net lake infiltration to the groundwater is to be expected.
BHS	67 to 72	70	The pit lake stabilises within the seasonal water table elevation range. Groundwater interaction with the pit lake is expected to be limited with potential seasonal variation (groundwater seepage into the pit during the dry season and pit lake infiltration to the groundwater during the wet season).
Zamu	35 to 39	NA	Zamu pit will be backfilled

Rustlers Roost Pit Lake Recovery

Figure 6-18 shows Rustlers Roost pit lake water level during and post-mining operations. The red line shows the median case, while the various colour bands show the confidence intervals. It is anticipated that by 2060 (about 30 years post

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mining) the pit lake level would have returned near the currently observed level at 58 mAHD (with a seasonal variability of 1 m). The uncertainty band is relatively narrow, and for most cases, the stabilised level is at 58 mAHD $\pm$ 1 m. Uncertainty in our current conceptual understanding suggests that the recovery process to equilibrium could take somewhere between 10 years and 50 years to complete. The pit is not predicted to overflow and instead to act in the same way as current pit lake.

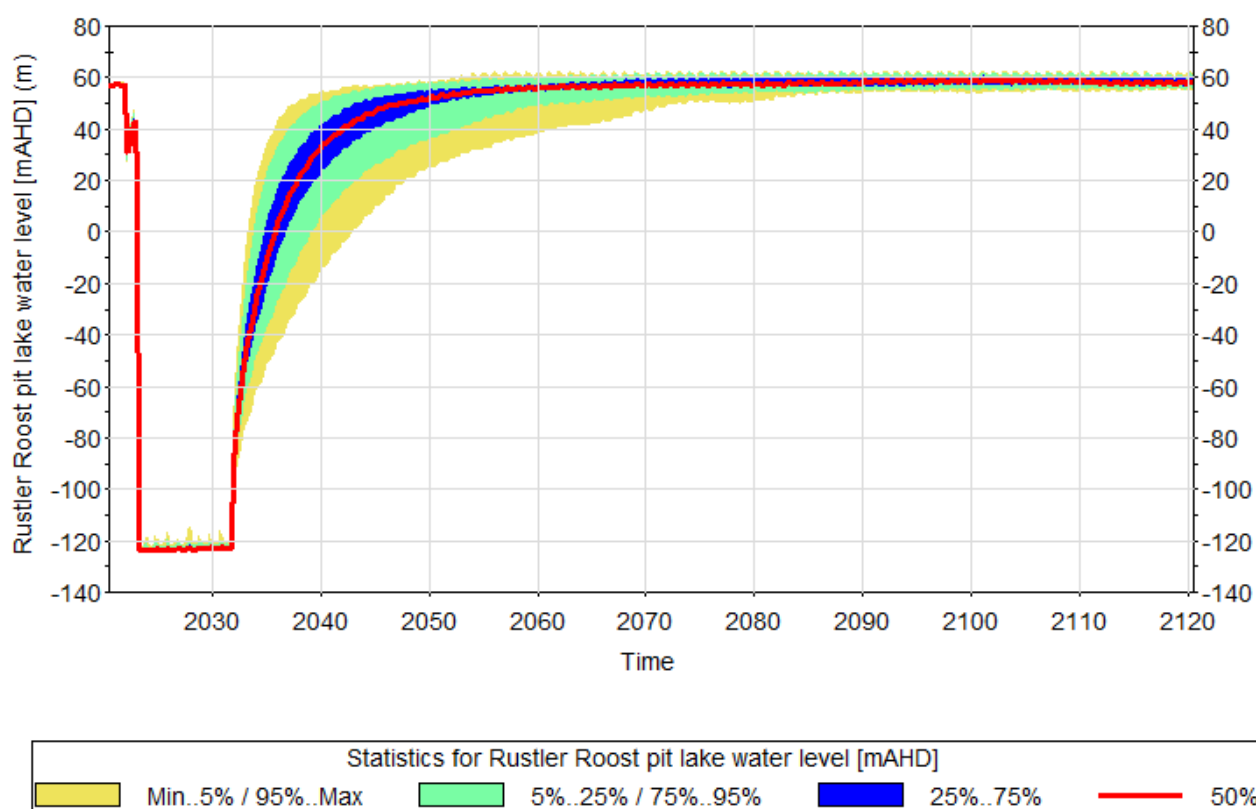


Figure 6-18 Modelled Rustlers Roost pit lake water levels recovery

Zamu Pit Lake Recovery

Figure 6-19 shows Zamu pit lake water level during and post-mining operations. The Zamu pit will be fully backfilled after mining of the other Quest 29 pits. The model shows a variable recovery due to the plan of using Zamu pit as the discharge point for the dewatering of the Taipan, South Koolpin and North Koolpin pits. The proposed pit is also expected to have a lower spill level than the historical pit and the model predicts that, with the disposal of dewatering water from the Taipan, South Koolpin and North Koolpin pit, there is a small risk (<25%) of the pit overflowing in 2031 (with a <5% chance of overspill in 2029 and 2030), as illustrated in Figure 6-20.

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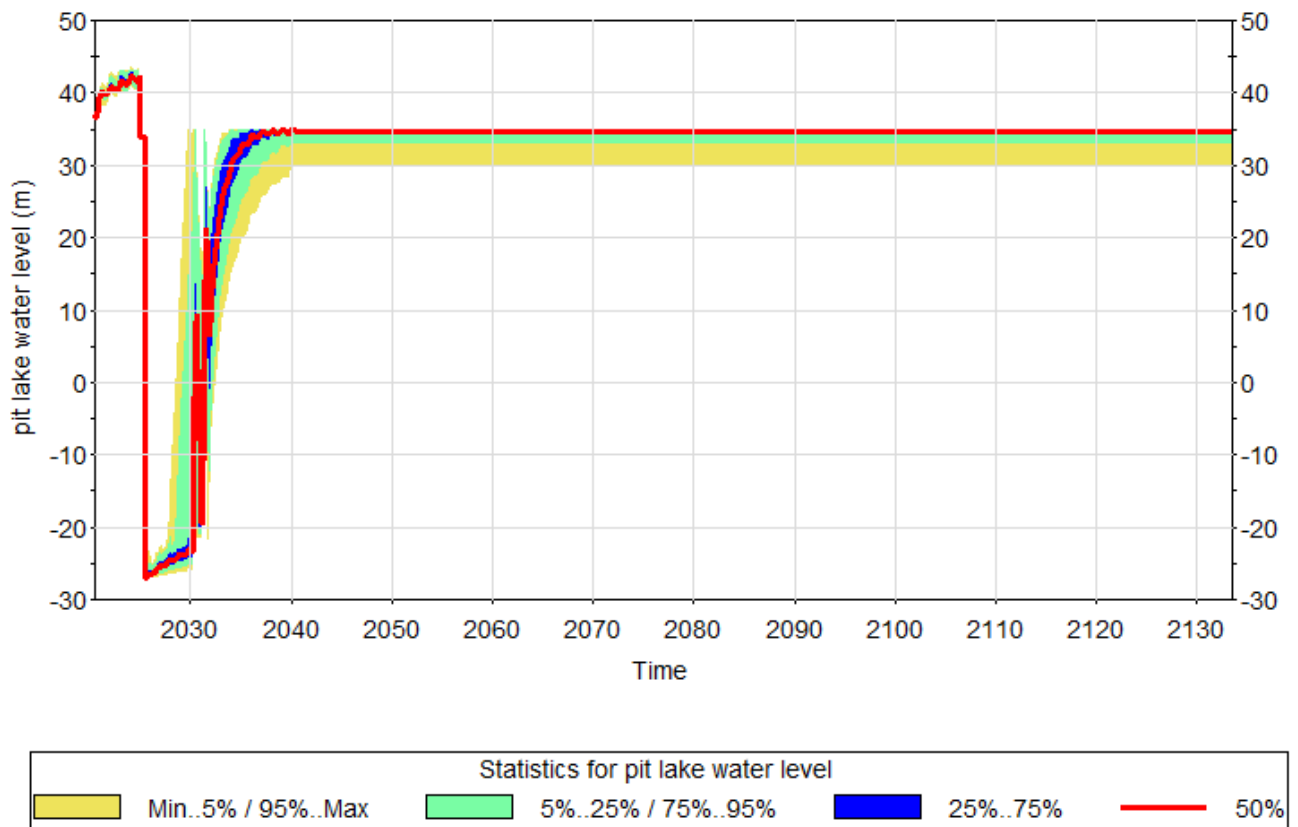


Figure 6-19 Predicted Zamu Pit Lake Water Level Recovery

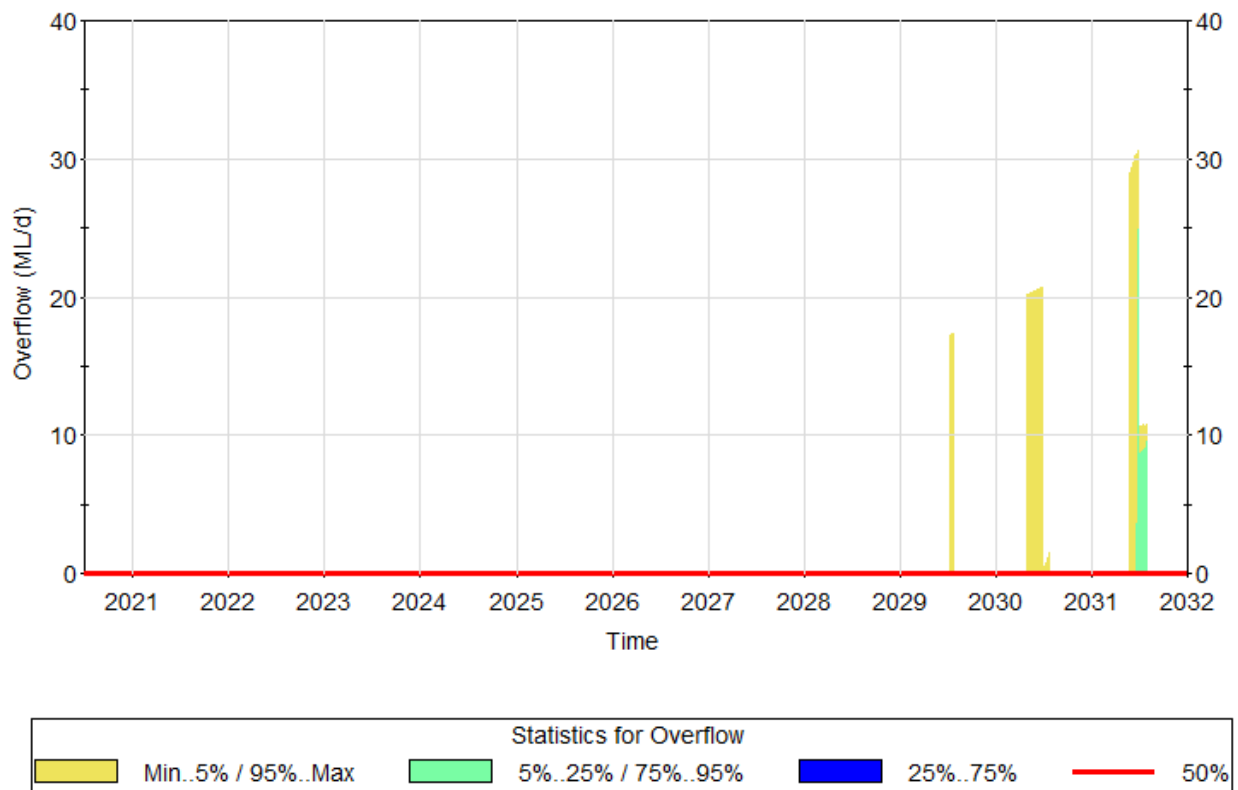


Figure 6-20 Predicted Zamu Pit Overflow over Time

Taipan Pit Lake Recovery

Figure 6-21 illustrates the Taipan pit lake water level during and post-mining operations. Taipan pit water levels are predicted to increase from 2025 to 2028 during the dry season as this pit is to be used as a dry season storage for dewatering of the Zamu pit, before the dewatering of the historical Taipan pit starts in 2029. The pit lake recovery is expected to occur over a brief period of up to a couple of years. According to current uncertainty analysis, there is <5% of chance for the pit to overflow during the Zamu pit dewatering period as illustrated in Figure 6-22.

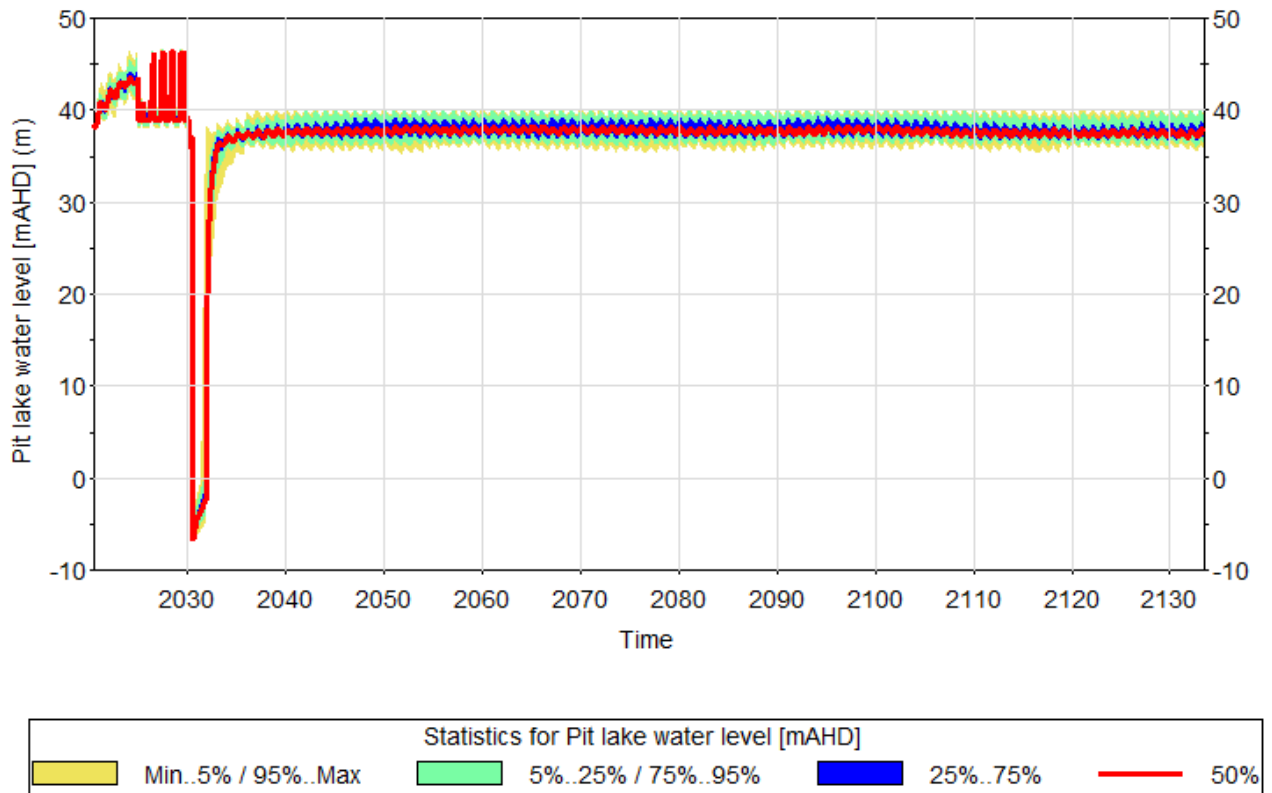


Figure 6-21 Predicted Taipan Pit Lake Level Recovery over Time

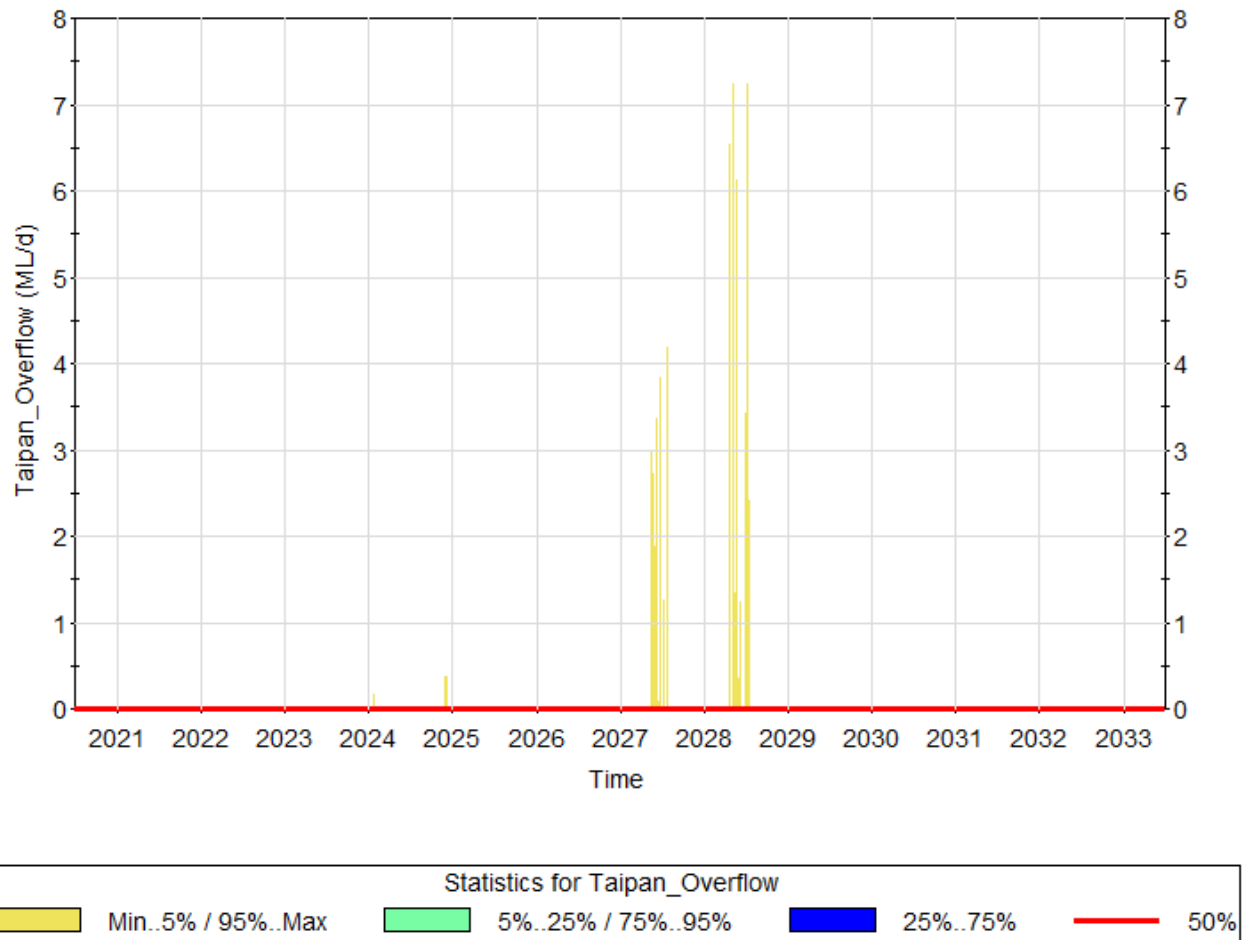


Figure 6-22 Predicted Taipan Pit Lake Overflow Rates over Time

South Koolpin Pit Lake Recovery

As for the Taipan pit lake, the South Koolpin pit lake levels increase seasonally due to the Zamu pit dewatering between 2025 and 2029 (Figure 6-23). According to current uncertainty analysis, there is <5% probability of the pit overflowing during its time as a dry season storage for the Zamu pit dewatering (Figure 6-24).

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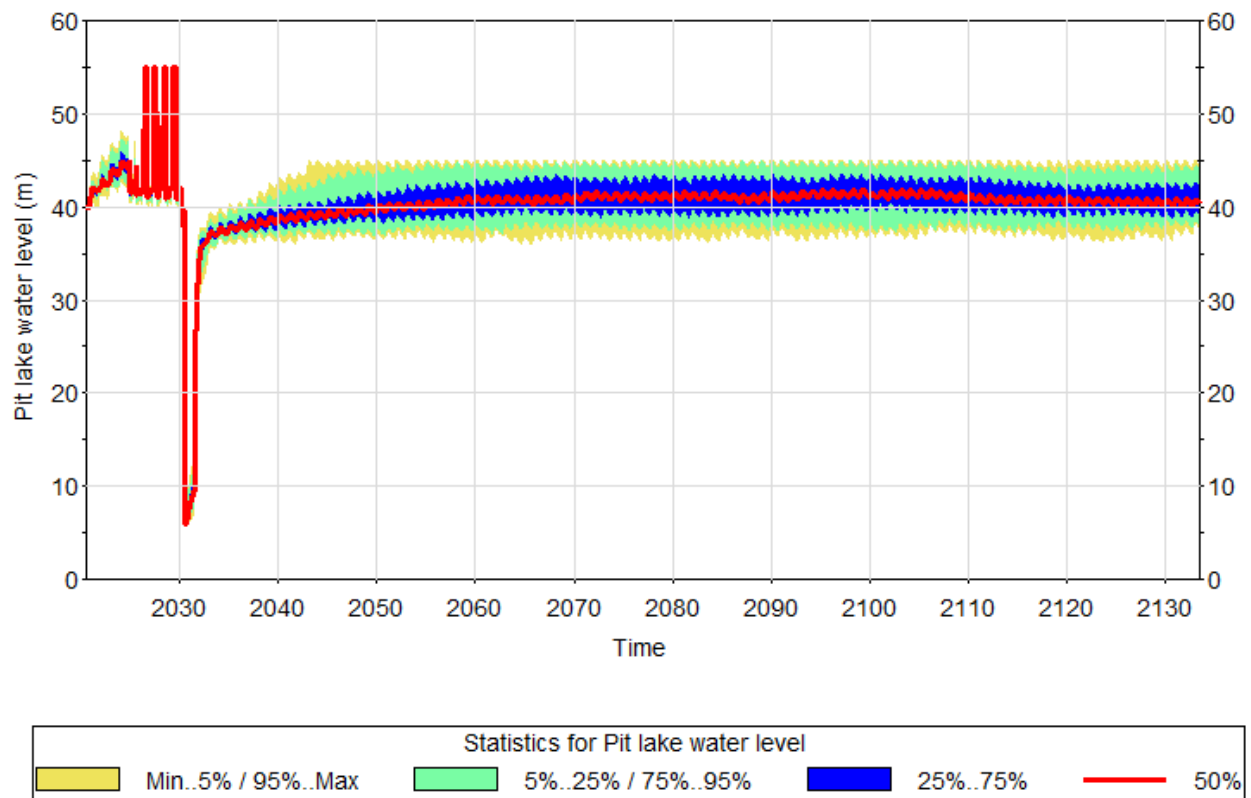


Figure 6-23 Predicted South Koolpin Pit Lake Level over Time

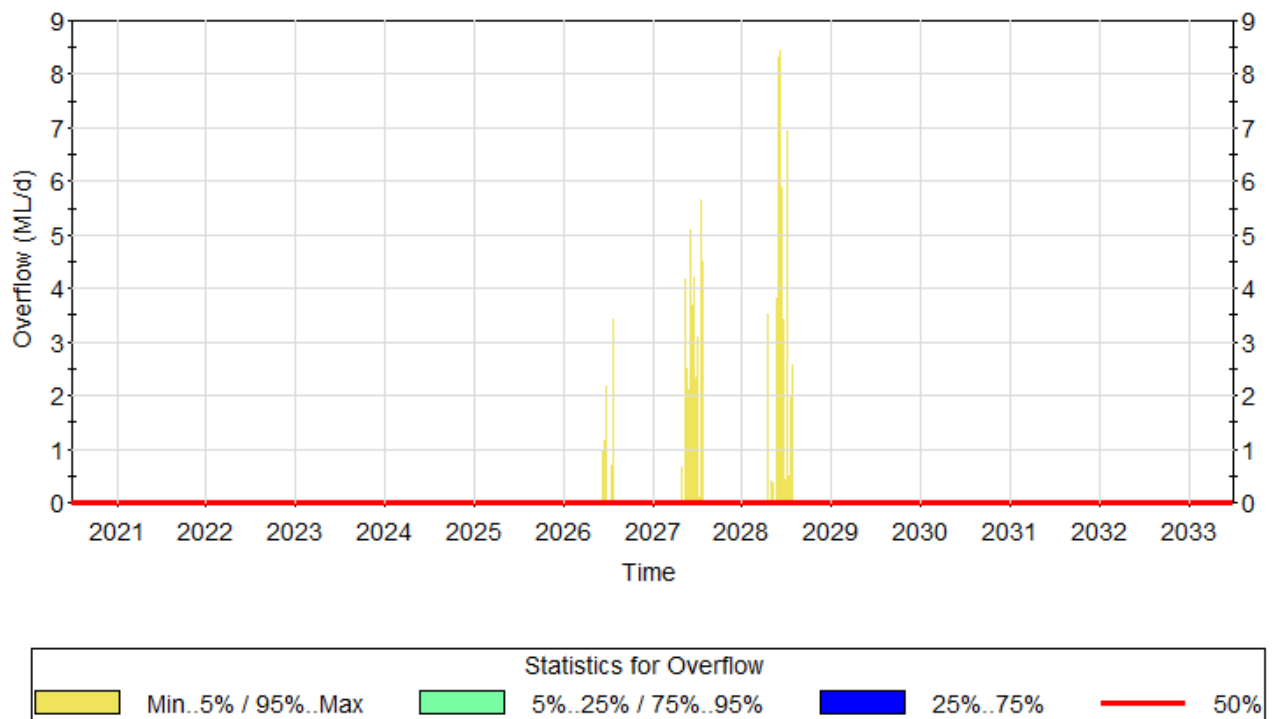


Figure 6-24 Predicted South Koolpin Pit Overflow Rates over Time

North Koolpin Pit Lake Recovery

As for the Taipan and South Koolpin pit lakes, the North Koolpin pit lake levels increase due to the Zamu pit dewatering between 2025 and 2029 (Figure 6-25). According to current uncertainty analysis, the pit has <5% probability of overflowing during this period (Figure 6-26).

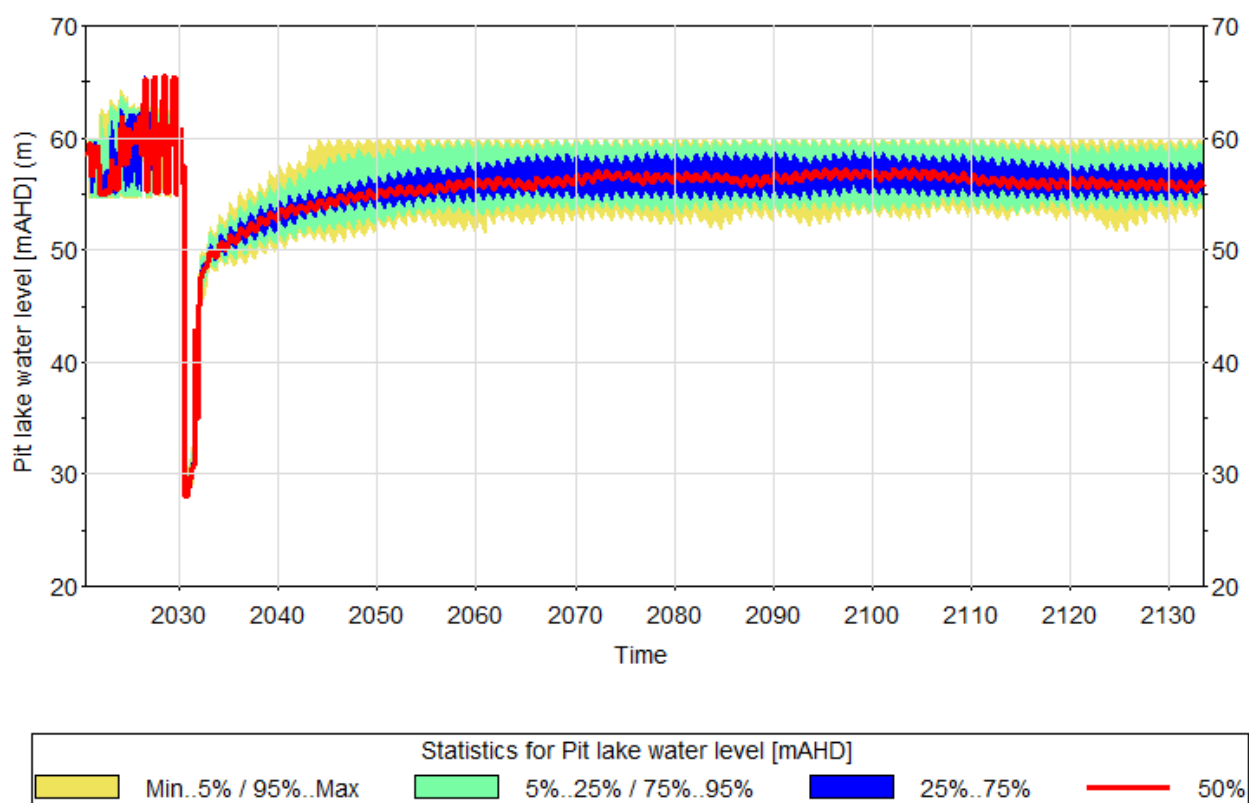


Figure 6-25 North Koolpin Pit Lake Water Level

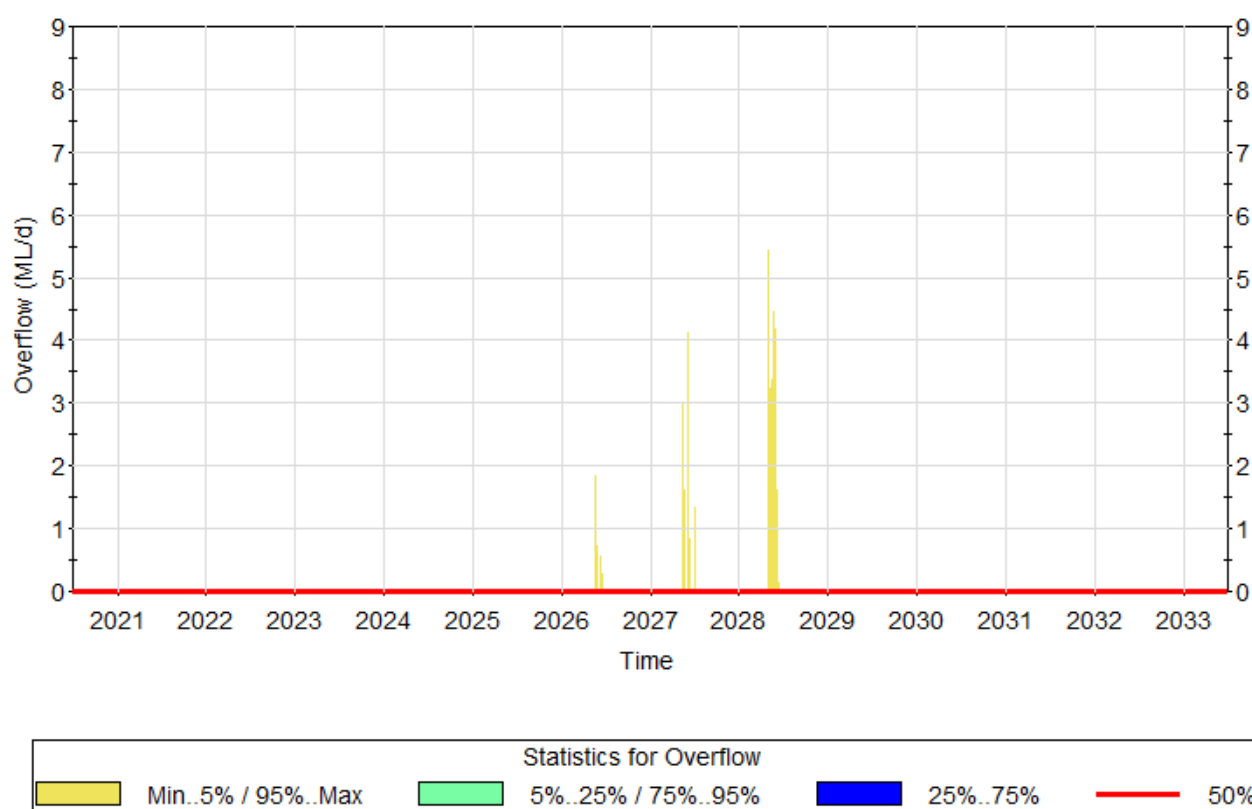


Figure 6-26 North Koolpin Pit Overflow

BHS Pit Lake Recovery

As for the other Quest 29 pit lakes, the BHS pit lake levels increase due to the Zamu pit dewatering between 2025 and 2029 (Figure 6-27). According to current uncertainty analysis, the pit has <5% probability of overflowing during this period (Figure 6-28).

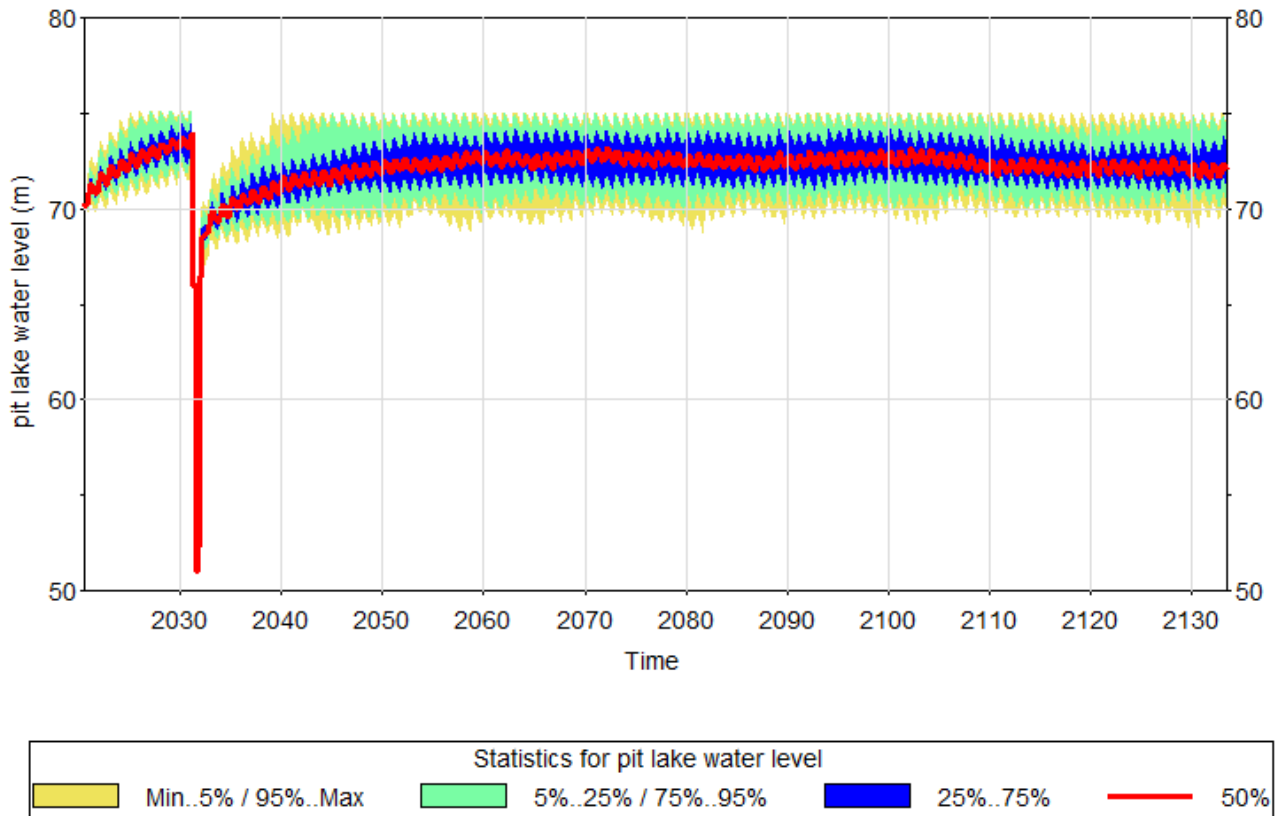


Figure 6-27 BHS Pit Lake Level Recovery

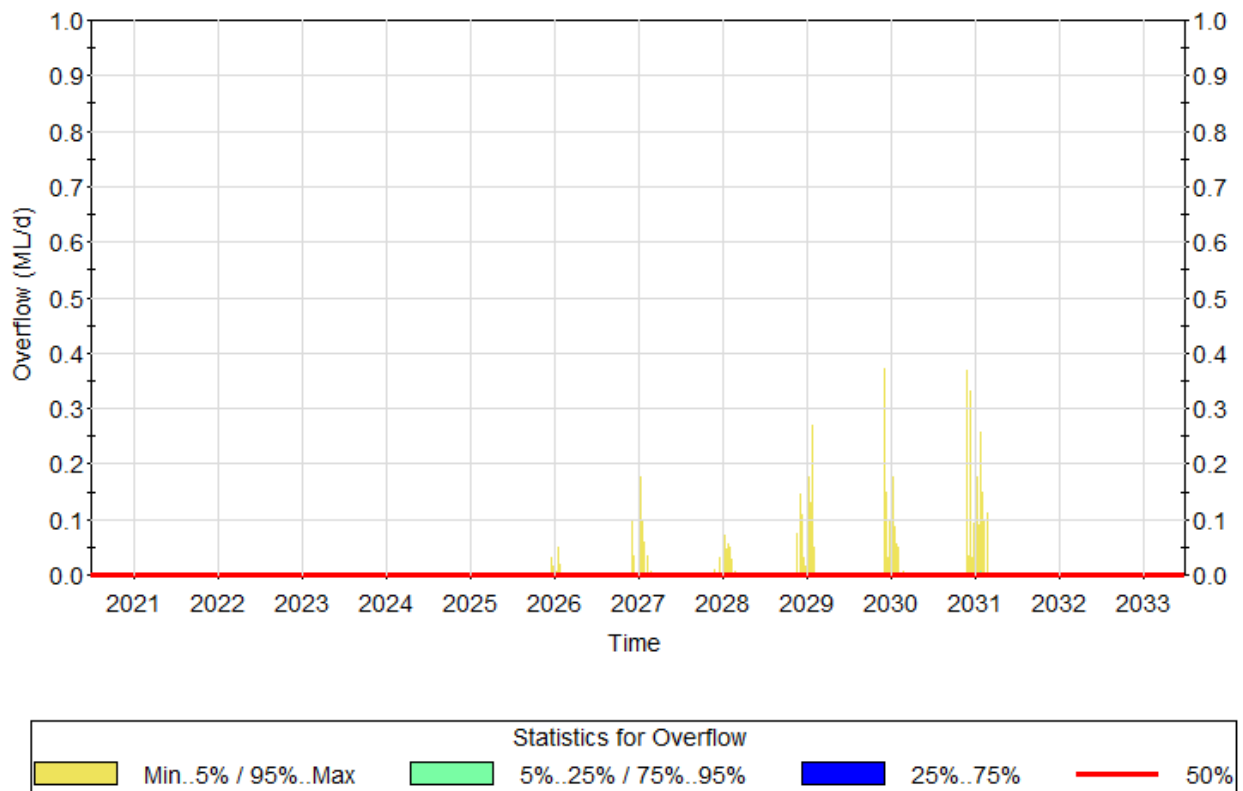


Figure 6-28 BHS Pit Overflow

6.4 Goldsim Solute Balance Model

6.4.1 Overview

A non-reactive solute balance was paired with the water balance model to estimate the concentrations of potential contaminants in the Rustlers Roost and Quest 29 mine pits. The modelling is conservative, such that there is no decay or transformation of the source water components into other compounds and no precipitation due to geochemical reactions or dissolution from rock material. The modelling approach is a normalised approach that can be applied to any potential contaminant under the assumption that the natural surface water environment has no background concentration of that contaminant. The source for the model is exclusively due to the mining and processing operation (e.g. through groundwater inflow into the mined pit). Identifying and modelling contamination sources such as runoff from waste rock dumps or processes relating to acid rock drainage are out of the scope of this model.

A prediction of the concentrations of a contaminant of potential concern (CoPC) can be obtained by multiplying the normalised concentration value at a future time (assumptions described below) by the estimate of the potential contaminant source-term concentration.

6.4.2 Method

As an initial assessment, for the CoPC estimation, groundwater is assumed to be the sole source of contaminant with a hypothetical concentration of 100mg/L (or by analogy 100%) while other inflows (rainfall or runoff²) have no presence of contaminant (i.e. CoPC concentration is at 0 mg/L or 0%). The initial pit lake concentration is irrelevant as the pit lake will be emptied during the initial dewatering phase. Therefore, the assessment is only concerned by the long-term evolution of water quality within the pit lakes as a result of groundwater inflow, rainfall, runoff and evaporation. With those assumptions, the concentration of a CoPC in the pit lake due to groundwater seepage (groundwater discharge) increases by direct evaporation from the pit water surface and decreases by the dilution provided by direct rainfall and runoff into the pit.

To calculate the chemical concentration at a given time, the source concentration from groundwater is adjusted in accordance with the relationship presented in the result figures provided in the following sections.

6.4.3 Model Results

6.4.3.1 Rustlers Roost Pit

The predicted concentration evolution of the Rustlers Roost pit for 200 years post-mining is illustrated in Figure 6-29. The median case prediction shows a stable CoPC concentration in the pit lake, with the pit lake CoPC concentration after 200 years being slightly less than the CoPC concentration in the groundwater. The uncertainty analysis suggests that at most the pit lake concentration of a CoPC would be 1.5 as much of its concentration in the groundwater.

² The WRDs leachates are not directed toward the pit lake in current site design. The runoff is therefore limited to the pit walls and the source of contamination for the runoff is therefore limited and negligible.

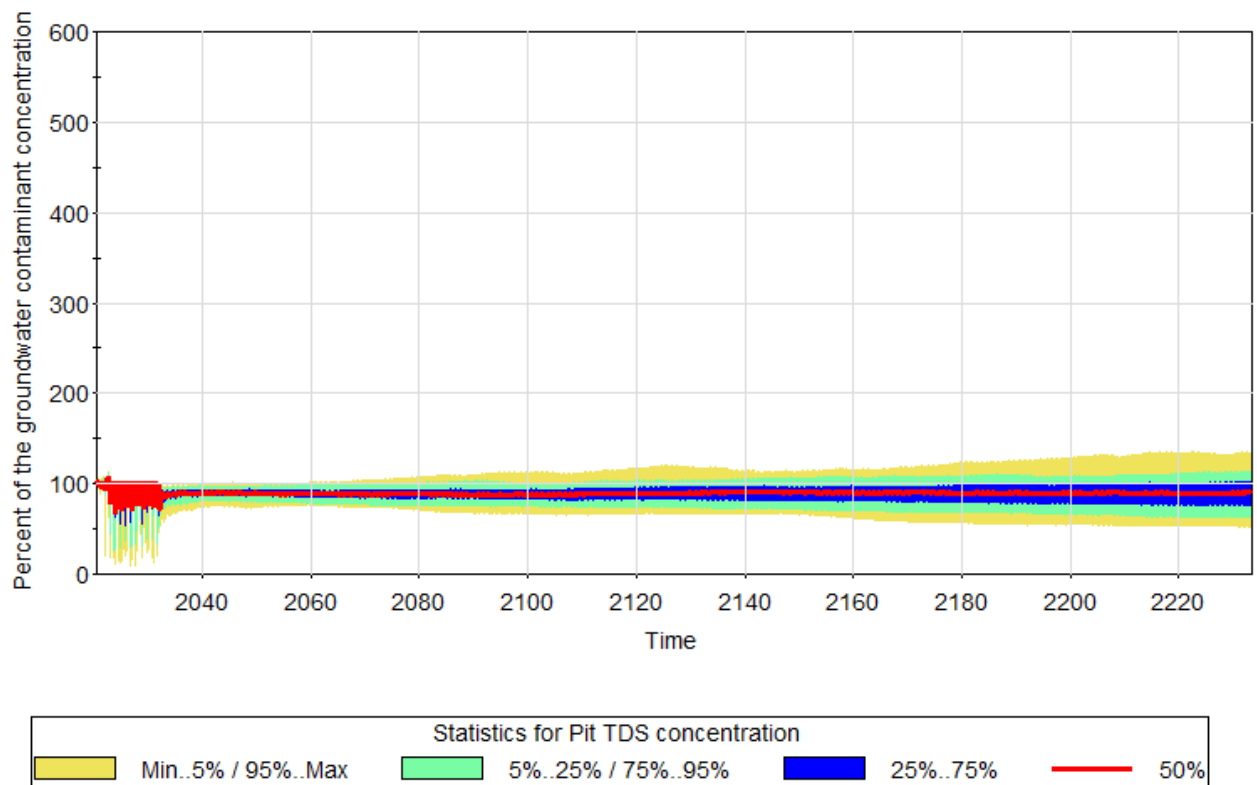


Figure 6-29 Rustlers Roost Pit Lake Concentration

The resulting concentration estimates (in accordance with the relationship presented in Figure 6-29) 50 years post-mining and 100 years post-mining are summarised in Table 6-19. A very conservative assumption is made by assuming that the groundwater concentration is equal to the maximum measured concentration at any of the bores (2020 to 2021).

6 Site Water Balance and Solute Transport Modelling

Table 6-19 Current and Predicted Concentration of Water Chemical Elements after 50 and 300 years in Rustlers Roost Pit

Parameter	Maximum Concentration in Groundwater ³	50 years	100 years
TDS (mg/L)	200	175	179
Hardness (mgCaCO ₃ /L)	120	105	107
Total Alkalinity as CaCO ₃ (mg/L)	140	123	125
Calcium (mg/L)	31	27	28
Chloride (mg/L)	15	13	13
Magnesium (mg/L)	13	11	12
Potassium (mg/L)	9	8	8
Sodium (mg/L)	28	25	25
Sulfate (mg/L)	31	27	28
Aluminium (mg/L)	4.4	4	4
Arsenic (mg/L)	0.09	0.08	0.08
Copper (mg/L)	0.04	0.04	0.04
Iron (mg/L)	6.6	6	6
Zinc (mg/L)	0.28	0.25	0.25

6.4.3.2 Quest 29 Pits

Taipan Pit

The predicted concentration evolution of the Taipan pit for 200 years post-mining is illustrated in Figure 6-30. The median prediction shows an increasing trend, with the CoPC concentration in the pit lake after 200 years being 1.5 times the CoPC concentration in the groundwater. There is a large uncertainty range suggesting that 5% of the realisations have a concentration 2.5 times of the groundwater concentration and up to a maximum of 3 times the groundwater concentration.

³ The maximum concentration in any of the site borehole.

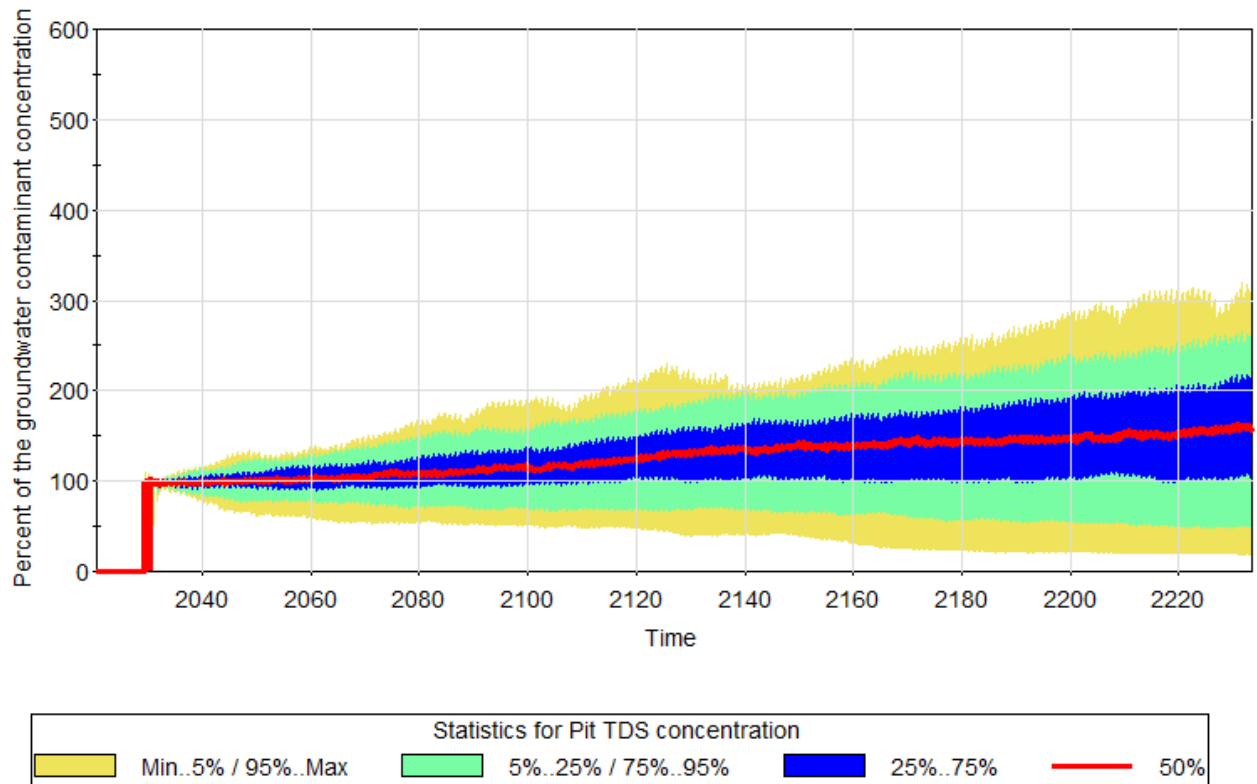


Figure 6-30 Taipan Pit Lake Concentration

South Koolpin Pit

The predicted CoPC concentration in the South Koolpin pit for 200 years post-mining is illustrated in Figure 6-31. The median prediction shows a decreasing trend with the CoPC concentration in the pit lake after 200 years being half the CoPC concentration in the groundwater. The uncertainty band suggests that 5% of the realisations have a pit lake CoPC concentration the same as the groundwater concentration.

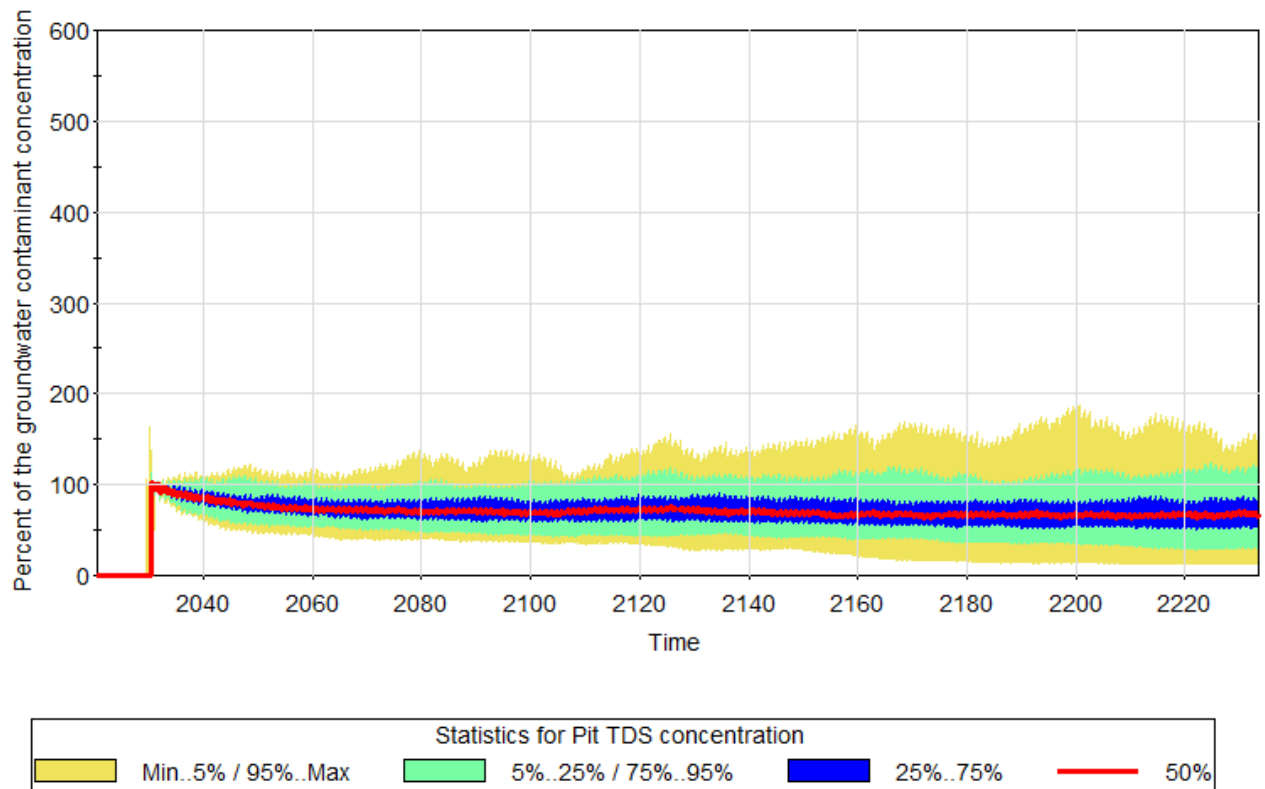


Figure 6-31 South Koolpin TDS over Time

North Koolpin Pit

The predicted CoPC concentration in the North Koolpin pit for 200 years post-mining is illustrated in Figure 6-32. The median prediction shows a very stable CoPC pit lake concentration at about half the CoPC groundwater concentration.

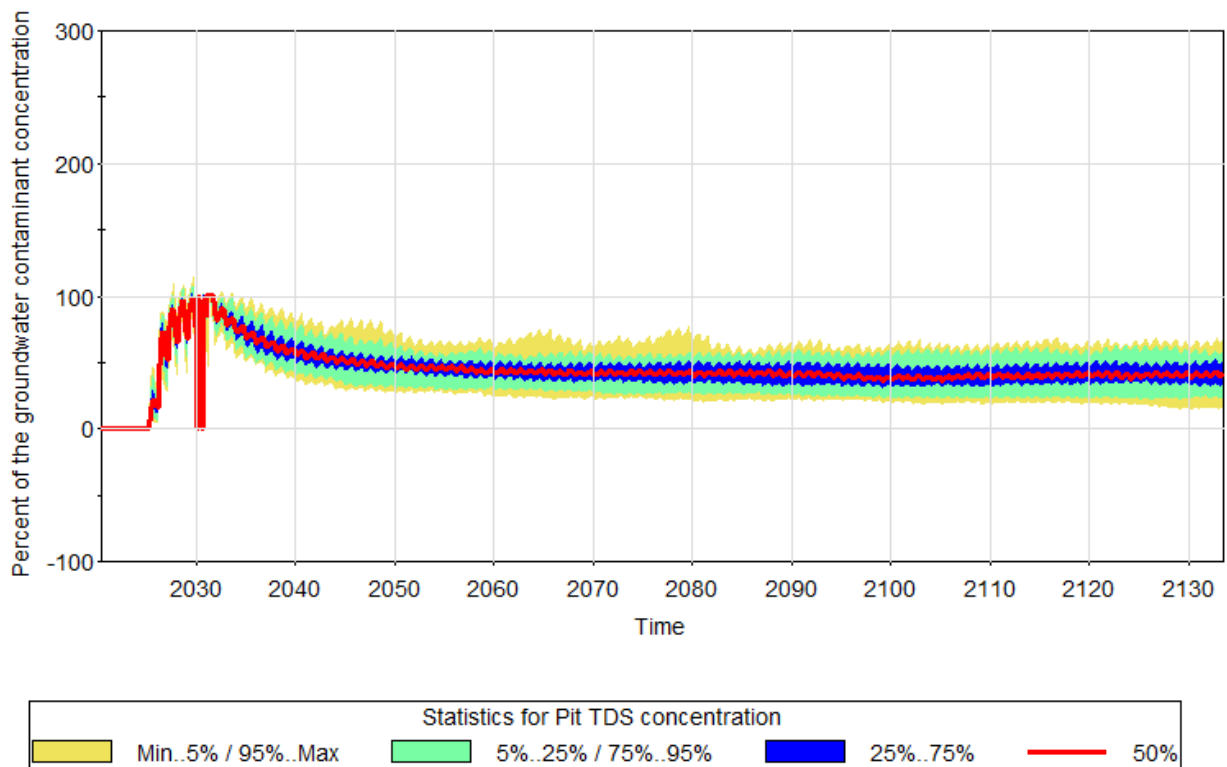


Figure 6-32 North Koolpin Pit Lake Concentration

BHS Pit

The predicted CoPC concentration in the BHS pit for 200 years post-mining is illustrated in Figure 6-33. The median prediction shows a decreasing trend of CoPC pit lake concentration with being half the CoPC concentration in the groundwater. The uncertainty band suggests that 5% of the realisations have a CoPC pit lake concentration of the same as the groundwater concentration.

6 Site Water Balance and Solute Transport Modelling

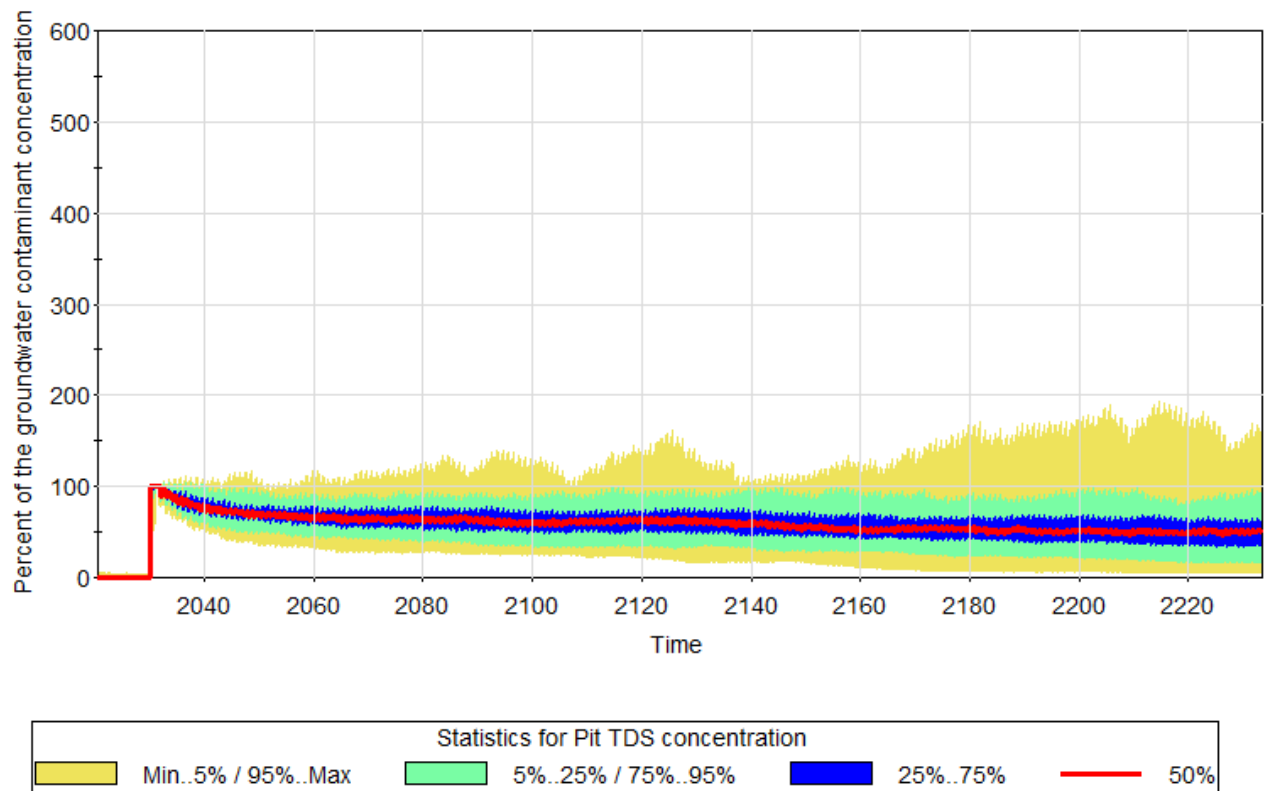


Figure 6-33 BHS Pit Lake Concentration

Summary

Table 6-20 and Table 6-21 summarise the predicted CoPC pit lake concentration at Quest 29 after 50 years and 300 years, respectively. As for the Rustlers Roost pit approach, a very conservative assumption is made by assuming that the groundwater concentration is equal to the maximum measured concentration at any of the site bore.

6 Site Water Balance and Solute Transport Modelling

Table 6-20 Current and Predicted Concentration of Water Chemical Elements after 50 years in Quest 29 Pits

Parameter	Maximum Concentration in Groundwater ⁴	Taipan	South Koolpin	North Koolpin	BHS
TDS (mg/L)	1000	1076	704	425	624
Hardness (mgCaCO ₃ /L)	455	490	320	193	284
Total Alkalinity as CaCO ₃ (mg/L)	210	226	148	89	131
Calcium (mg/L)	140	151	99	59	87
Chloride (mg/L)	14	15	10	6	9
Magnesium (mg/L)	108	116	76	46	67
Potassium (mg/L)	13	14	9	6	8
Sodium (mg/L)	172	185	121	73	107
Sulfate (mg/L)	560	603	394	238	350
Aluminium (mg/L)	1.6	1.7	1.1	0.7	1.0
Arsenic (mg/L)	0.28	0.30	0.20	0.12	0.17
Copper (mg/L)	0.06	0.06	0.04	0.03	0.04
Iron (mg/L)	19	20	13	8	12
Zinc (mg/L)	0.38	0.41	0.27	0.16	0.24

⁴ The maximum concentration in any of the site borehole.

6 Site Water Balance and Solute Transport Modelling

Table 6-21 Current and Predicted Concentration of Water Chemical Elements after 100 years in Quest 29 Pits

Parameter	Maximum Concentration in Groundwater ⁵	Taipan	South Koolpin	North Koolpin	BHS
TDS (mg/L)	1000	1340	707	416	618
Hardness (mgCaCO ₃ /L)	455	610	322	189	281
Total Alkalinity as CaCO ₃ (mg/L)	210	281	148	87	130
Calcium (mg/L)	140	188	99	58	86
Chloride (mg/L)	14	19	10	6	9
Magnesium (mg/L)	108	145	76	45	67
Potassium (mg/L)	13	17	9	5	8
Sodium (mg/L)	172	230	122	72	106
Sulfate (mg/L)	560	750	396	233	346
Aluminium (mg/L)	1.6	2.1	1.1	0.7	1.0
Arsenic (mg/L)	0.28	0.38	0.20	0.12	0.17
Copper (mg/L)	0.06	0.08	0.04	0.02	0.04
Iron (mg/L)	19	25	13	8	12
Zinc (mg/L)	0.38	0.51	0.27	0.16	0.23

6.5 Pit Lake Post Mining Conceptualisation

The pit lake water levels are predicted to reach equilibrium within a few decades. During mining and before equilibrium is reached post mining, the pits will act as overall groundwater sinks as groundwater inflow refills the pit lakes (Figure 6-34).

⁵ The maximum concentration in any of the site borehole.

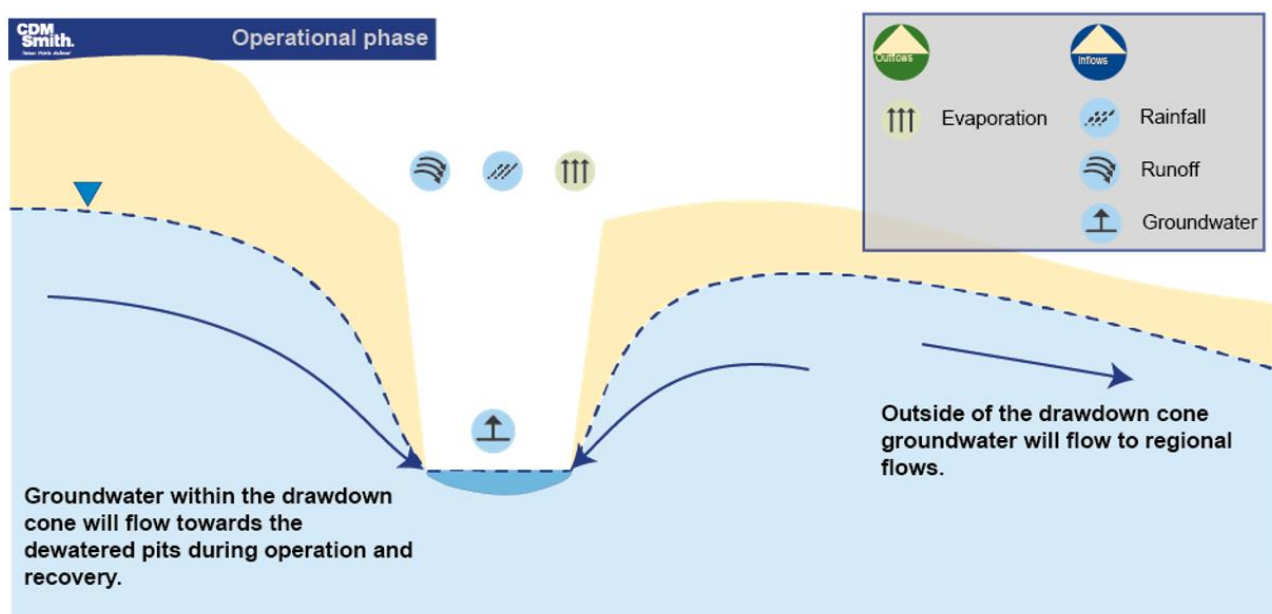


Figure 6-34 Operational phase pit conceptualisation – pits act as sinks whilst they are dewatered and during recovery (10 to 30 years)

Once the pits lakes have reached equilibrium, they will likely behave similarly to the way they currently behave. The predominant pit lake-groundwater interaction will be seasonal, with high evaporation and low rainfall during the dry season resulting in lower pit lake levels (inflow of groundwater to the pits) and higher rainfall and lower evaporation during the wet season resulting in higher pit lake levels (outflow of pit water to the groundwater) (Figure 6-35). Note, groundwater outflow from the pits is not represented in the Goldsim model.

During times of equilibrium, the groundwater-pit lake relationship will depend on the regional groundwater flow. At the Rustlers Roost site the pit is located on a groundwater divide with regional flow generally away from the pit (pit lake will act as a source to groundwater). The Quest 29 pits are located on a regional groundwater flow path and will be more likely therefore to act as throughflow features.

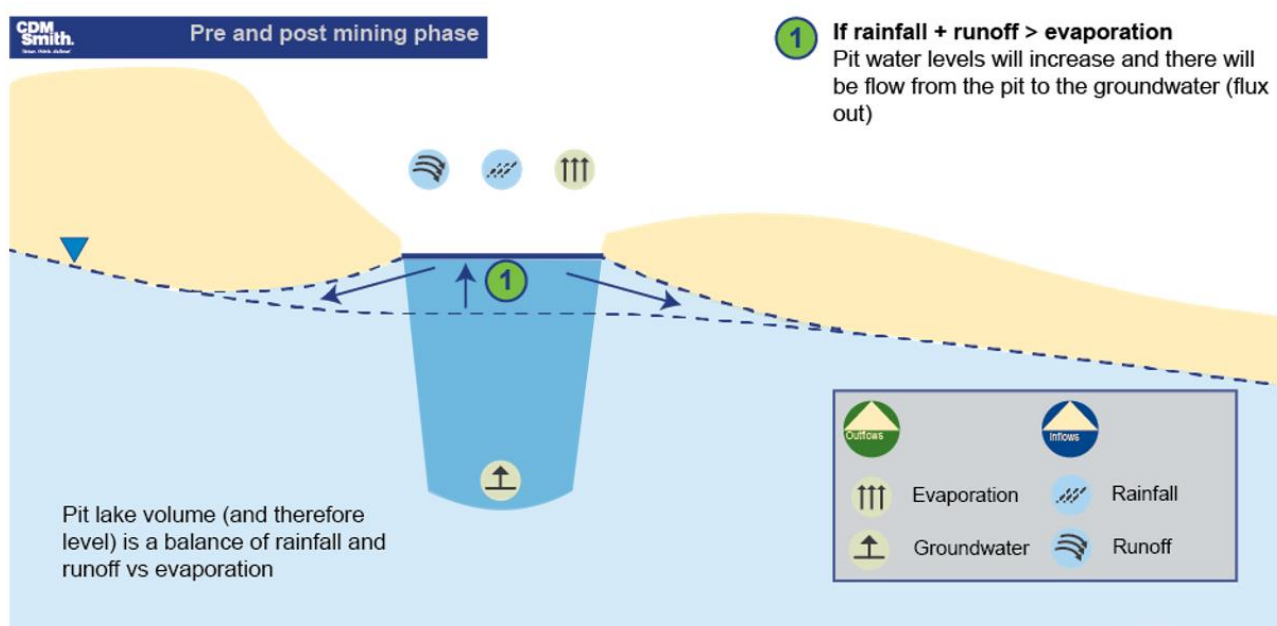


Figure 6-35 Pre mining and post mining (equilibrium) phase pit conceptualisation – throughflow can occur but if pit inflows exceed outflows, pit will recharge groundwater

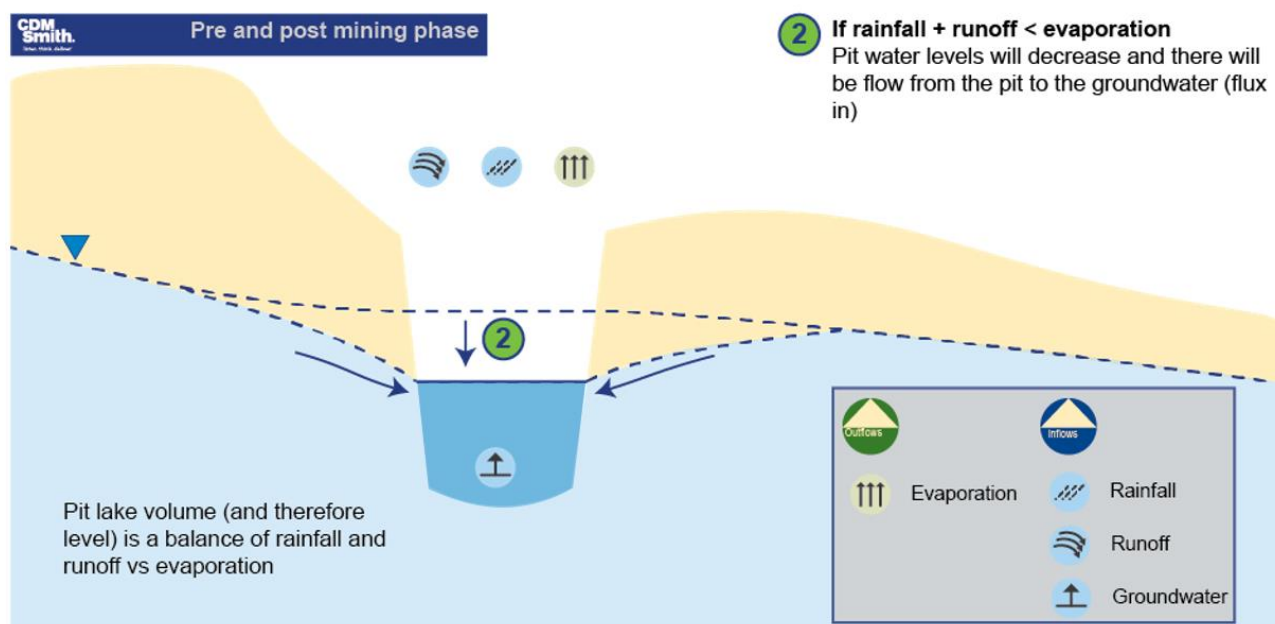


Figure 6-36 Pre mining and post mining (equilibrium) phase pit conceptualisation – throughflow can occur but if pit outflows exceed inflows, groundwater will recharge pit lake

Given this, it is possible that there will be some migration of pit lake water into the groundwater and down hydraulic gradient in the times when the lakes are acting as groundwater sources. The pit lake concentrations indicate that pit lake water quality will generally be of higher quality than the surrounding groundwater (lower concentrations of CoPCs) based on the water balance. Therefore, any migration off site may not have a discernible impact on groundwater quality. Further groundwater modelling would be required, in conjunction with geochemical modelling, to confirm this conclusion.

6.6 Water Balance and Water Quality Modelling Key Findings

The site water balance was modelled with Goldsim software to estimate the water production and management related to the mining activities on site (pit dewatering, ore processing and other water consumption on site). The model was run in a stochastic mode to account for the parameter uncertainties that are controlling the water production. The model shows that:

- The groundwater seepage (groundwater discharge) into the pits is the main inflow into the water management system as it constitutes an average of 77% of all inflows to the system with an average of 4,000 ML/yr for the life of mining operations. It is also the most uncertain contributor due to the lack of data to constrain the representative value of hydraulic conductivity of the regional aquifer (and implicit heterogeneity of fractured rock aquifers). Pit dewatering volume should be monitored during operations to provide constraints on the hydraulic conductivity and refine the predictions, especially Rustlers Roost pit and any variation with depth. The uncertainty in the hydraulic conductivity results in uncertainty for the volume of water to manage and for the period for complete recovery of pit water levels. It has however, little influence on the final pit lake stabilisation levels which approximate the groundwater table level;
- During mining operations excess water will be discharged to the creeks during the wet season and stored on the site during the dry season. An estimated amount of 36 GL of water will need to be released to the local creeks during mining operation during the wet season. According to current uncertainty analysis, this amount could comprise between 17 GL and 78 GL.

6 Site Water Balance and Solute Transport Modelling

The water management system on the site can accommodate the dry season storage in almost all model runs, with only the very highest hydraulic conductivity scenarios resulting in temporary dry season discharge (i.e. 5% of modelled scenarios).

- Post-mining, the pit lakes are unlikely to overflow. The water level for all pit lakes stabilised around the groundwater table levels, suggesting that the pit lakes interaction with groundwater will vary seasonally, sometimes acting as a sink and sometimes as a source. The degree of throughflow depends on the lakes position in the catchment;
- As excess water is produced during mining operations, the bore field is only required to supply the demand of drinkable water (reverse osmosis water). Only 5 % of models indicate a requirements for more than 12.5 L/sec in the second half of 2032 where 55L/sec is required for make up water. The model has assumed this water is to be supplied by the bore field, but it could also be sourced from an extension of the Rustlers Roost pit dewatering; and
- Post-mining, the Rustlers Roost pit lake is predicted to stabilise within 30 years post-mining (median estimate) to a level similar to the current one. The likelihood of overflow is very small (regardless of the uncertainty on model parameters including aquifer hydraulic conductivity).

The water balance model was coupled with a mass balance to quantitatively compare relative risk of potential contaminant to build up in the final void and be potentially released in the environment.

6.7 Limitations and Recommendations

The Goldsim model balances inflows and outflow of the water management systems. However, the accuracy of the predicted inflows and outflows is limited by two main sources of uncertainty:

- Parameter uncertainty. The model uses parameters that are impossible to know precisely (particularly as the model parameters are representing an average of the heterogenic real system properties). The parameter uncertainty controls the predictive uncertainty which was quantified by running the model in a stochastic mode. Hence the model results were not provided as a single prediction but as a range of plausible outcomes based on conservative assumptions; and
- Structural uncertainty. It reflects the extent to which a given model differs from the real system it is intended to represent. The water table is represented by a single value for each pit and with this assumption, preventing the model to potentially function as a through flow. As the pit lakes are predicted to stabilise near the water table elevation, the potential for the pit lake to function as through flow becomes significant. However, by ignoring the potential pit lake leakage related to through flow conditions, the model tends to overestimate the pit lake stabilisation level rather than underestimating it.

The limitations of the model in representing inflows and outflows are listed in Table 6-22.

6 Site Water Balance and Solute Transport Modelling

Table 6-22 Inflows and Outflows Model Representation Limitations

Process	Limitations
Rainfall	The rainfall used for future scenario assumes historical data. Future rainfall including a provision for changing climate was provided by Surface Water and Erosion Solutions (2022)
Pit wall (/pond) Runoff	A single runoff coefficient is applied to rainfall to derive the estimated runoff. The intensity of rain event, the seasonality or the nature of the soil are not considered. To overcome those simplifications, a wide range of runoff coefficient was used in the stochastic modelling approach.
Groundwater seepage into pits (groundwater discharge)	The groundwater seepage (groundwater discharge) is represented through an analytical model that has several limitations: • The analytical model is steady state and doesn't represent the transient inflow which is occurring during mining operations. • The model assumes a horizontal water table and can't therefore represent a groundwater through flow across the pit lake. • The aquifer is assumed to be homogeneous and isotropic and is represented by a single value of Kh. For the deepest pit a dual layer model has been implemented which assumes a lower Kh for rock greater than 80 m depth. A wide range of hydraulic conductivity has been adopted in the stochastic approach to overcome this limitation.
Water transfer inflow (pump)	Based on the planning provided by PGO.
Evaporation	Evaporation applied to lake wet surface is implemented by applying a reduction factor on pan ET to account for atmospheric water saturation near the lake surface. Evaporation is controlled by many other processes (wind, shading) that are not currently represented in the model. A wide range of evaporation factor was used in the stochastic approach to overcome this limitation
Dewatering (/water transfer to other water store)	Relying on PGO's claim of dewatering capacity.
Infiltration to groundwater (groundwater recharge)	Infiltration to groundwater (groundwater recharge) from water storages is not currently represented in the model as the storages are planned to be lined. The model has shown that long terms pit lakes stabilisation levels at the site are near the water table elevation, and seasonally exceeding it. Some infiltration of water from the pits to the groundwater may occur in those instances but not representing this in the model is a conservative assumption with regards to the volumes of water to be managed at the site.
Overflow	The overflow is assumed at the upper end of the provided stage height/volume curve data.
Storage (stage height/volume curve)	Proportional to the reliability of input data.
Catchment area	Based on provided shapefile of pit catchments.

7. Technical Summary

7.1 Hydrogeological Conceptualisation

The hydrogeological conceptualisation for the Rustlers Roost Mine site and the Quest 29 Mine Site is described below.

- **Climate**

The site is located in a tropical monsoonal area, with two distinct seasons: a summer wet season and winter dry season, with two subsidiary transitional periods between them. The average annual rainfall at Middle Point Rangers station (BoM 014090) is 1,420 mm, with the highest monthly rainfall occurring in January (mean monthly rainfall of 350 mm). SILO monthly evapotranspiration is between 140 mm (February) and 230 mm (October). Climate change has been incorporated into this assessment using the projected rainfall model developed for the hydrologic and hydraulic modelling (Surface Water and Erosion Solutions, 2022), which uses the RCP scenario 4.5.

- **Geology**

The geology of the project area is within the northern flank of the Pine Creek Orogeny, consisting of transgressive marine sequence dominated by folded shallow marine sediments of the Early Proterozoic South Alligator Group. The group includes the Koolpin Formation, Geowrie Tuff and Mount Bonnie Formation and the intrusive Zamu Dolerite at the Quest 29 site.

The Rustlers Roost Gold Mine is predominantly underlain by folded greywacke and mudstone units. The greywacke units vary between 20 and 50 metres thick within individual beds and have upward fining sequences ranging from 0.5 to 10 metres. Individual beds are usually massive, weakly jointed, relatively soft and erode preferentially to form drainage features parallel to the bedding.

The Koolpin Formation and Zamu Dolerite occupy the majority of the Quest 29 portion of the Project area (Primary Gold, October 2020). Regionally, the Koolpin formation averages 100 m in thickness but ranges up to 200 m in fold hinges. The Koolpin formation is intruded in areas by the Zamu dolerite (massive quartz dolerite).

- **Aquifers**

The regional groundwater system comprises of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks (Tickell, 2019). Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments. Regional scale mapping indicates expected bore yields of 1-3 L/s in the metasediments and <0.75 L/s in the Mt Bunday Granite (Tickell, 2019). Higher permeabilities are likely associated with structural deformation within the metasediments/dolerite (Sirocco, 1999) and at local scale. At Rustlers Roost, aquifers are typically associated with increased structural deformation within the metasediments.

- **Groundwater Flow**

The degree to which groundwater can flow through the rock (hydraulic conductivity of the aquifers) will be dependant on the frequency and connectivity of fractures. Where weathering or structural processes result in highly connected fractures a higher local hydraulic conductivity could be expected, compared to the overall bulk hydraulic conductivity of the rock. The shallower portions of the aquifers are expected to have the highest hydraulic conductivity, with deeper portions likely to have much lower permeability associated with a lower density of interconnected fractures.

Groundwater flow in the unconfined aquifers will generally follow topography, from high elevations to lower elevations. At Rustlers Roost there is a topographical divide that is likely to be reflected in the groundwater, with local flow towards the north and south, generally away from the main pit which is located within the expected groundwater divide. At Quest 29 there is also a groundwater divide north-south based on topography.

▪ Recharge and Discharge

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 (Primary Gold, 2019). During high rainfall and runoff events localised recharge from creek beds may also occur when groundwater levels are below the base of the creek. Groundwater recharge from small dams located within the lease area may also occur to a much lesser extent. These dams would give localised groundwater “highs” which are superimposed on the regional flow pattern (Environmental and Earth Sciences Pty Ltd, January 1993).

Local groundwater discharge is mainly through seepage within the existing open pits and more regionally through discharge into creeks and surface water drainages/bodies.

▪ Groundwater Quality

Groundwater at Rustlers Roost showed low dissolved element levels indicating that there is minimal elemental dissolution from the rock and that a high level of meteoric rainfall infiltration into the folded and fractured turbidite sediments is occurring. The groundwater quality monitoring has shown groundwater is typically fresh, acidic to near neutral and has exceedances of aquatic ecosystems guideline values (GVs) for some metals and nutrients at some sampling occasions and locations. The elevated phosphorus and metal concentrations may be associated with underlying mineralogical deposits entailing weathered zones.

The groundwater at Quest 29 is acidic to neutral and fresh. Exceedances of the adopted aquatic freshwater trigger values were observed for several analytes in all monitoring wells. All monitoring bores, except for Q29MB01 and Q29MB02, showed similar water chemistry with small variations indicating limited impacts from previous mining activities.

▪ Beneficial Uses and Environmental Values

Based on the Beneficial Use Declarations for the area, beneficial uses for the receiving environment include agricultural and stock water supply, environmental and riparian and cultural.

7.2 Numerical Modelling

A three dimensional, regional-scale numerical groundwater model was developed to estimate the potential drawdown extents induced by the proposed mining pits at the Rustlers Roost and Quest 29 portions of the Project area for the following time periods: at the end of mining (which is also when the spatial extent of drawdown is the largest); and 10, 20, 30 and 40 years post mining.

A stochastic groundwater modelling approach was used in this study, with the development and transient calibration of 100 different model realisations. The calibration is considered satisfactory with a mean Root Mean Squared Error (RMSE) of 2.1 m and a Scaled RMSE (SRMSE) of 4.2%. The current developed groundwater model is consistent with the lower end of a level 2 confidence level classification. In general, a model will not fit entirely into one class of confidence level because determining the most appropriate class depends upon multiple factors.

The 100 calibrated model realisations predicted that the extent of the 1 m drawdown contours resulting from the dewatering of the proposed pits would be as follows:

- At Rustlers Roost, groundwater drawdowns of up to 1 m are predicted up to 2.3 km to the east and west, 5.3 km to the north and 3.7 km to the south;
- At Quest 29, groundwater drawdowns appear to be much more radial in nature, with drawdowns of up to 1 metre predicted up to 2 km from the mining pits to the north, south and east, and 4.5km to the west;
- The modelling suggests that the probability of Marrakai Creek, Mary River and McKinlay River being impacted by the proposed pits is minimal; and

- Topography is inferred to have a strong control on the shape and extent, and longevity of drawdown impacts. At Rustlers Roost drawdown predominantly follows a north south topographic high with local water levels modelled to take up to 40 years to recover. A cross groundwater flow component at the Quest29 mining pits is interpreted to explain the relatively quick (<10 year) groundwater recoveries.

7.3 Water Management Modelling

A site wide water balance model has been developed to estimate pit dewatering requirements, water disposal requirements and to assess the adequacy of the current water management system. The model was run in a stochastic mode to account for the parameter uncertainties that are controlling the water production.

- **Seepage into the Pits and Dewatering Requirements**

Groundwater seeping into pits during dewatering (to maintain dry environment in the pits) is the main inflow of water into the water management system (77% of inflows). Average dewatering requirements from the pits (combination of groundwater seepage, rainfall and runoff minus evaporation) are estimated at 103 L/sec for the Rustlers Roost pit (maximum rate of 600 L/sec) and between 15 and 52 L/sec for the Quest 29 pits (maximum rate of 125 L/sec applied based on pump capacity).

- **Water Storage and Discharge to Creeks**

Water will be stored on the site during the wet season and discharged to creeks in the wet season (Mount Bunday Creek and McKinley River). At the Rustlers Roost site the primary storage is the Northern TSF Water Storage Dam (6,998 ML capacity) and at the Quest 29 site the water is stored in non-operational pits. The model empties water storages during the wet season and discharges this stored water and dewatering water to the creeks so that maximum storage is available during the dry season.

For 95% of model runs there is no uncontrolled release during the dry season (i.e. there is sufficient storage on site). For the 95th percentile and maximum scenarios (i.e. high hydraulic conductivity and high runoff) there is some dry season release. The model is set up to maintain 5% storage in the storages to allow for water reuse in the dry season and lowering this threshold may negate the requirement for dry season release in these unlikely scenarios. Cumulatively, about 36 GL of water is required to be released (with an uncertainty range from 17 GL to 78 GL) over the LOM.

- **Pit Lake Development**

During mining the pits will be dewatered to maintain a dry working environment. Following mining the pits will fill with groundwater, rainfall and runoff and a pit lake will develop. Pit lake levels are expected to reach equilibrium within a decade for the Quest 29 pits and within 30 years for the Rustlers Roost pit. The pit lake levels are expected to stabilize to a similar level as groundwater, suggesting that the pit lakes interaction with groundwater will vary seasonally, sometimes acting as a sink and sometimes as a source. Throughflow (where groundwater levels are higher on one side of the pit than the other) will occur during periods where inflows equal outflows and the ambient watertable is higher on one side of the pit than the other (which will depend on the pits position in the catchment). This is more likely to occur at the Quest 29 pits as they are on a regional groundwater flow path, whereas the Rustlers Roost pit is within a groundwater divide and may more likely act as a recharge source to groundwater. The pit lake water quality is expected to be similar to the groundwater quality (based on the mass balance and not taking into account rock reactions that may occur due to dewatering). Further geochemical and solute transport modelling would assist in understanding the potential impacts to groundwater.

8. Groundwater Management Plan

A Water Management Plan, inclusive of measures to address groundwater, has been developed and is included in Appendix Q of the SEIS.

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Appendix A Rustlers Roost 2020-2021 Water Quality Monitoring Results

A.1 Rustlers Roost Groundwater Monitoring Results (2020-2021)

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	SWL(initial)	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential
Analyte Short Name	SWL (initial)	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)
Units	mbTOC	µS/cm	-	°C	NTU	ppt	mg/L	mV
Toms Gully SSTV (80th percentile)	-	41	5.8 - 8.0	-	87	-	-	-
Tropical Australia Lowland Rivers	-	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	4000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
RRMB01								
10/09/2020	4.06	-	-	-	-	-	-	-
21/10/2020	4.29	-	-	-	-	-	-	-
9/11/2020	4.65	199.3	6.14	31.8	576	0.09	130	101
4/12/2020	2.5	-	-	-	-	-	-	-
7/01/2021	2.21	169.4	5.94	30.8	36.7	0.1	109.8	217
3/02/2021	2.27	-	-	-	-	-	-	-
11/03/2021	2.18	149.9	5.74	31.1	287	0.07	96.8	32.9
16/04/2021	2.24	-	-	-	-	-	-	-
29/04/2021	2.3	130	5.35	31.2	38.2	0.06	84.5	100
8/07/2021	2.58	129.9	5.3	32.4	54.7	0.06	84	94.5
RRMB02								
9/11/2020	4.5	215.3	6.21	32.2	9.41	0.1	139.75	75
4/12/2020	4.56	-	-	-	-	-	-	-
6/01/2021	3.59	204.5	6.22	31.4	0.84	0.1	133.1	149
3/02/2021	2.83	-	-	-	-	-	-	-
10/03/2021	1.4	199	6.01	32.1	0.93	0.09	130	43.9
16/04/2021	0.78	-	-	-	-	-	-	-
29/04/2021	0.91	204	6.09	31.5	1.21	0.09	133	58
8/07/2021	1.91	193	5.88	31.8	0.76	0.09	125	72.1
RRMB03								
9/11/2020	14.99	130.7	5.78	33.2	3.68	0.06	85.15	119.8
4/12/2020	15.18	-	-	-	-	-	-	-
6/01/2021	14.42	123.9	5.8	32.6	0.71	0.1	80.6	169
3/02/2021	13.37	-	-	-	-	-	-	-
10/03/2021	11.33	124.1	5.6	33.5	8.68	0.06	81.25	23.4
16/04/2021	10.31	-	-	-	-	-	-	-
6/05/2021	10.57	126.2	5.54	32.4	5.88	0.06	81.9	118.8
7/07/2021	11.68	118	5.57	31.9	0.42	0.05	76.7	124.2
RRMB04								
10/11/2020	7.84	286.6	6.76	32.5	2.79	0.13	186.55	51.2
4/12/2020	7.98	-	-	-	-	-	-	-
6/01/2021	6.93	260.8	6.78	32.6	3.22	0.1	169.9	61
3/02/2021	5.77	-	-	-	-	-	-	-
10/03/2021	4.3	261	6.5	32.8	4.07	0.12	171	30
16/04/2021	3.65	-	-	-	-	-	-	-
6/05/2021	3.92	293.4	6.48	32.3	15.7	0.14	190.6	32.7
7/07/2021	4.95	294	6.38	31.8	4.5	0.14	190	38.8
RRMB05								
10/11/2020	16.08	269.9	6.52	32.3	1.49	0.13	175.5	-12.5
4/12/2020	16.19	-	-	-	-	-	-	-
6/01/2021	15.43	305.4	6.58	31.4	1.51	0.1	196.4	164
3/02/2021	15.16	-	-	-	-	-	-	-
11/03/2021	12.42	293.8	6.54	32	3.98	0.14	191	-93
16/04/2021	11.98	-	-	-	-	-	-	-
29/04/2021	12.16	281	6.36	31.9	1.32	0.13	182	-93
8/07/2021	12.97	271	6.22	31.5	0.69	0.13	176	-118
RRMB06								
9/11/2020	24.43	84.9	5.97	34.8	2.6	0.04	55.25	33.6

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	SWL(initial)	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential
Analyte Short Name	SWL (initial)	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)
Units	mbTOC	µS/cm	-	°C	NTU	ppt	mg/L	mV
Toms Gully SSTV (80th percentile)	-	41	5.8 - 8.0	-	87	-	-	-
Tropical Australia Lowland Rivers	-	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	4000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
4/12/2020	24.52	-	-	-	-	-	-	-
7/01/2021	23.88	84.4	5.9	32.3	0.81	0	55	84
3/02/2021	23.7	-	-	-	-	-	-	-
10/03/2021	20.98	78.5	5.66	33.4	0.63	0.03	50.7	37.2
16/04/2021	20.44	-	-	-	-	-	-	-
6/05/2021	20.62	81	5.64	32.7	3.1	0.04	52.7	55.9
8/07/2021	20.4	78.3	5.65	32.7	0.91	0.03	50.7	14.3
RRMB07								
10/11/2020	26.51	40.5	4.27	34.1	1.52	0.02	26.65	223.6
4/12/2020	26.65	-	-	-	-	-	-	-
6/01/2021	26.11	37.1	4.4	33.4	0.84	24.2	-	271
3/02/2021	25.82	-	-	-	-	-	-	-
10/03/2021	23.02	37.8	3.77	33.6	1.16	0.02	24.7	178.9
16/04/2021	22.22	-	-	-	-	-	-	-
6/05/2021	22.37	37.8	4.09	33.4	2.14	0.02	24.7	165.4
8/07/2021	23.23	36.1	3.84	32.5	0.44	0.02	23.4	213.2
RRMB08								
10/11/2020	27.28	89.7	5.53	33.3	1.53	0.04	57.85	149
4/12/2020	27.49	-	-	-	-	-	-	-
6/01/2021	27.53	76.3	5.45	33.4	1.02	0	49.7	188
3/02/2021	26.84	-	-	-	-	-	-	-
10/03/2021	24.75	72.7	5.08	34.3	0.45	0.03	47.4	70
16/04/2021	22.34	-	-	-	-	-	-	-
6/05/2021	21.97	75	5.23	33.2	4.32	0.03	48.7	124.8
8/07/2021	22.71	67.8	5.11	32.4	2.27	44.2	139.8	21

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Field Measurements	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity
Analyte	Dissolved Oxygen	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3
Analyte Short Name	DO_%sat (field)	TSS	Turbidity (lab)	Total Hardness	Alk_OH	Alk_CO3	Alk_HCO3
Units	%	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	54	87	-	-	-	-
Tropical Australia Lowland Rivers	85-120	2 - 15	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
RRMB01							
10/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
9/11/2020	32.4	182	348	4	<1	<1	37
4/12/2020	-	-	-	-	-	-	-
7/01/2021	39.7	16	23.7	7	<1	<1	42
3/02/2021	-	-	-	-	-	-	-
11/03/2021	4.1	48	60	11	<1	<1	46
16/04/2021	-	-	-	-	-	-	-
29/04/2021	5.4	24	21.2	4	<1	<1	31
8/07/2021	4.8	66	46.8	4	<1	<1	38
RRMB02							
9/11/2020	2.8	<5	2.7	72	<1	<1	106
4/12/2020	-	-	-	-	-	-	-
6/01/2021	9.1	<5	<0.1	72	<1	<1	103
3/02/2021	-	-	-	-	-	-	-
10/03/2021	4.4	<5	<0.1	76	<1	<1	102
16/04/2021	-	-	-	-	-	-	-
29/04/2021	2.6	6	<0.1	72	<1	<1	94
8/07/2021	2.2	<5	<0.1	69	<1	<1	112
RRMB03							
9/11/2020	21	<5	0.6	41	<1	<1	61
4/12/2020	-	-	-	-	-	-	-
6/01/2021	11.7	<5	<0.1	41	<1	<1	60
3/02/2021	-	-	-	-	-	-	-
10/03/2021	4.9	<5	2.7	41	<1	<1	53
16/04/2021	-	-	-	-	-	-	-
6/05/2021	6.2	<5	1.3	41	<1	<1	59
7/07/2021	12.4	<5	0.1	44	<1	<1	55
RRMB04							
10/11/2020	25.9	<5	0.6	98	<1	<1	120
4/12/2020	-	-	-	-	-	-	-
6/01/2021	21.4	5	0.6	100	<1	<1	118
3/02/2021	-	-	-	-	-	-	-
10/03/2021	7.6	<5	0.7	32	<1	<1	115
16/04/2021	-	-	-	-	-	-	-
6/05/2021	3.3	8	2	108	<1	<1	130
7/07/2021	5.1	<5	6	119	<1	<1	142
RRMB05							
10/11/2020	1	<5	0.8	93	<1	<1	119
4/12/2020	-	-	-	-	-	-	-
6/01/2021	2.9	9	1.2	114	<1	<1	138
3/02/2021	-	-	-	-	-	-	-
11/03/2021	2	<5	2.7	117	<1	<1	138
16/04/2021	-	-	-	-	-	-	-
29/04/2021	2.3	8	5.6	91	<1	<1	122
8/07/2021	2.3	<5	10	187	<1	<1	195
RRMB06							
9/11/2020	4.4	<5	2.3	20	<1	<1	31

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Field Measurements	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity
Analyte	Dissolved Oxygen	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3
Analyte Short Name	DO_%sat (field)	TSS	Turbidity (lab)	Total Hardness	Alk_OH	Alk_CO3	Alk_HCO3
Units	%	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	54	87	-	-	-	-
Tropical Australia Lowland Rivers	85-120	2 - 15	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
4/12/2020	-	-	-	-	-	-	-
7/01/2021	10.4	7	2.9	20	<1	<1	34
3/02/2021	-	-	-	-	-	-	-
10/03/2021	2.9	<5	1.3	13	<1	<1	27
16/04/2021	-	-	-	-	-	-	-
6/05/2021	2.5	6	3.2	20	<1	<1	29
8/07/2021	3.1	<5	1.8	20	<1	<1	31
RRMB07							
10/11/2020	29.2	<5	<0.1	<1	<1	<1	6
4/12/2020	-	-	-	-	-	-	-
6/01/2021	39.9	<5	<0.1	<1	<1	<1	2
3/02/2021	-	-	-	-	-	-	-
10/03/2021	20.9	<5	<0.1	<1	<1	<1	4
16/04/2021	-	-	-	-	-	-	-
6/05/2021	27.4	<5	<0.1	<1	<1	<1	6
8/07/2021	28.7	<5	<0.1	<1	<1	<1	<1
RRMB08							
10/11/2020	28	<5	0.6	12	<1	<1	37
4/12/2020	-	-	-	-	-	-	-
6/01/2021	33.6	6	<0.1	9	<1	<1	30
3/02/2021	-	-	-	-	-	-	-
10/03/2021	19	<5	<0.1	9	<1	<1	30
16/04/2021	-	-	-	-	-	-	-
6/05/2021	18.9	<5	<0.1	9	<1	<1	27
8/07/2021	22.94	<5	0.2	9	<1	<1	25

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Alkalinity	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Total Alkalinity as CaCO3	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride
Analyte Short Name	Alk_Tot	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	210	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	1000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
RRMB01							
10/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
9/11/2020	37	29	<1	29	28	31	3
4/12/2020	-	-	-	-	-	-	-
7/01/2021	42	10	<1	10	10	27	3
3/02/2021	-	-	-	-	-	-	-
11/03/2021	46	10	<1	10	10	19	2
16/04/2021	-	-	-	-	-	-	-
29/04/2021	31	20	<1	20	19	20	6
8/07/2021	38	21	<1	21	20	22	4
RRMB02							
9/11/2020	106	24	<1	23	22	<1	3
4/12/2020	-	-	-	-	-	-	-
6/01/2021	103	15	<1	15	15	<1	4
3/02/2021	-	-	-	-	-	-	-
10/03/2021	102	9	<1	9	9	<1	3
16/04/2021	-	-	-	-	-	-	-
29/04/2021	94	20	<1	20	19	<1	5
8/07/2021	112	11	<1	11	11	<1	3
RRMB03							
9/11/2020	61	41	<1	41	40	<1	3
4/12/2020	-	-	-	-	-	-	-
6/01/2021	60	19	<1	19	18	<1	3
3/02/2021	-	-	-	-	-	-	-
10/03/2021	53	19	<1	19	18	<1	3
16/04/2021	-	-	-	-	-	-	-
6/05/2021	59	35	<1	35	34	<1	3
7/07/2021	55	19	<1	19	19	<1	3
RRMB04							
10/11/2020	120	15	<1	15	14	15	4
4/12/2020	-	-	-	-	-	-	-
6/01/2021	118	10	<1	10	10	10	4
3/02/2021	-	-	-	-	-	-	-
10/03/2021	115	8	<1	8	7	9	3
16/04/2021	-	-	-	-	-	-	-
6/05/2021	130	15	<1	15	14	10	3
7/07/2021	142	6	<1	6	6	4	3
RRMB05							
10/11/2020	119	18	<1	17	16	8	4
4/12/2020	-	-	-	-	-	-	-
6/01/2021	138	12	<1	12	11	8	4
3/02/2021	-	-	-	-	-	-	-
11/03/2021	138	12	<1	12	11	8	4
16/04/2021	-	-	-	-	-	-	-
29/04/2021	122	16	<1	16	16	4	4
8/07/2021	195	7	<1	7	6	9	5
RRMB06							
9/11/2020	31	12	<1	12	12	2	2

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Alkalinity	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Total Alkalinity as CaCO3	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride
Analyte Short Name	Alk_Tot	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	210	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	1000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
4/12/2020	-	-	-	-	-	-	-
7/01/2021	34	12	<1	12	11	2	3
3/02/2021	-	-	-	-	-	-	-
10/03/2021	27	8	<1	8	7	2	2
16/04/2021	-	-	-	-	-	-	-
6/05/2021	29	12	<1	12	11	2	2
8/07/2021	31	8	<1	8	8	2	2
RRMB07							
10/11/2020	6	52	<1	52	50	<1	4
4/12/2020	-	-	-	-	-	-	-
6/01/2021	2	24	<1	24	24	<1	4
3/02/2021	-	-	-	-	-	-	-
10/03/2021	4	20	<1	20	19	<1	4
16/04/2021	-	-	-	-	-	-	-
6/05/2021	6	41	<1	41	41	1	4
8/07/2021	<1	26	<1	26	26	<1	4
RRMB08							
10/11/2020	37	58	<1	58	57	1	2
4/12/2020	-	-	-	-	-	-	-
6/01/2021	30	22	<1	22	22	2	3
3/02/2021	-	-	-	-	-	-	-
10/03/2021	30	13	<1	13	13	1	2
16/04/2021	-	-	-	-	-	-	-
6/05/2021	27	30	<1	30	30	2	3
8/07/2021	25	17	<1	17	17	1	2

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Calcium	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt
Analyte Short Name	Ca	Mg	Na	K	Al_F	As_F	Cd_F	Cr_F	Co_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	0.295	0.042	0.0004	0.006	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	insufficient data	0.024	0.0002	0.001	-
ANZECC 2000 Livestock Watering (beef cattle)	1000	2000	-	-	5	0.5	0.01	1	1
ANZECC 2000 long term irrigation	-	-	-	-	5	0.1	0.01	0.1	0.05
RRMB01									
10/09/2020	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-
9/11/2020	<1	1	26	<1	<0.01	0.001	<0.0001	<0.001	0.015
4/12/2020	-	-	-	-	-	-	-	-	-
7/01/2021	1	1	28	<1	<0.01	0.002	<0.0001	<0.001	0.004
3/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	1	2	22	<1	0.19	0.009	<0.0001	<0.001	0.005
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	<1	1	22	<1	0.04	0.002	<0.0001	<0.001	0.007
8/07/2021	<1	1	22	<1	0.02	0.001	<0.0001	<0.001	0.002
RRMB02									
9/11/2020	9	12	9	4	<0.01	0.001	<0.0001	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	9	12	9	4	<0.01	0.002	<0.0001	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	9	13	9	4	<0.01	0.002	<0.0001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	9	12	8	4	<0.01	0.002	<0.0001	<0.001	<0.001
8/07/2021	8	12	8	4	<0.01	0.001	<0.0001	<0.001	<0.001
RRMB03									
9/11/2020	5	7	4	4	<0.01	<0.001	<0.0001	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	5	7	3	4	<0.01	0.001	<0.0001	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	5	7	4	4	<0.01	0.002	<0.0001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	5	7	4	4	<0.01	<0.001	<0.0001	<0.001	<0.001
7/07/2021	6	7	4	4	<0.01	0.001	<0.0001	<0.001	<0.001
RRMB04									
10/11/2020	31	5	10	4	0.1	0.002	<0.0001	0.002	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	30	6	8	4	0.08	0.003	<0.0001	0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	11	1	1	<1	0.09	<0.001	<0.0001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	30	8	7	3	0.08	0.002	<0.0001	<0.001	<0.001
7/07/2021	33	9	5	3	<0.01	0.002	<0.0001	<0.001	<0.001
RRMB05									
10/11/2020	24	8	6	8	0.05	0.002	<0.0001	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	26	12	6	9	0.03	0.002	<0.0001	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	27	12	8	8	0.01	0.004	<0.0001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	20	10	6	7	<0.01	0.001	<0.0001	<0.001	<0.001
8/07/2021	50	15	5	4	<0.01	0.07	<0.0001	<0.001	<0.001
RRMB06									
9/11/2020	3	3	2	5	<0.01	0.032	<0.0001	<0.001	0.001

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Calcium	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt
Analyte Short Name	Ca	Mg	Na	K	Al_F	As_F	Cd_F	Cr_F	Co_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	0.295	0.042	0.0004	0.006	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	insufficient data	0.024	0.0002	0.001	-
ANZECC 2000 Livestock Watering (beef cattle)	1000	2000	-	-	5	0.5	0.01	1	1
ANZECC 2000 long term irrigation	-	-	-	-	5	0.1	0.01	0.1	0.05
4/12/2020	-	-	-	-	-	-	-	-	-
7/01/2021	3	3	2	5	<0.01	0.035	<0.0001	<0.001	0.001
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	2	2	2	4	<0.01	0.034	<0.0001	<0.001	0.001
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	3	3	2	5	<0.01	0.035	<0.0001	<0.001	<0.001
8/07/2021	3	3	2	4	<0.01	0.034	<0.0001	<0.001	<0.001
RRMB07									
10/11/2020	<1	<1	1	<1	0.08	<0.001	<0.0001	<0.001	0.006
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	<1	<1	2	<1	0.09	<0.001	<0.0001	<0.001	0.007
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	<1	<1	2	<1	0.08	<0.001	<0.0001	<0.001	0.008
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	<1	<1	2	<1	0.11	<0.001	<0.0001	<0.001	0.008
8/07/2021	<1	<1	1	<1	0.07	<0.001	<0.0001	<0.001	0.007
RRMB08									
10/11/2020	3	1	6	6	<0.01	<0.001	<0.0001	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	2	1	6	7	<0.01	0.001	<0.0001	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	2	1	6	7	<0.01	0.001	<0.0001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	2	1	6	6	<0.01	<0.001	<0.0001	<0.001	<0.001
8/07/2021	2	1	5	6	<0.01	<0.001	<0.0001	<0.001	<0.001

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Copper	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cu_F	Pb_F	Mn_F	Ni_F	Se_F	Sn_F	U_F	Zn_F	Fe_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0018	0.0056	2.5	0.013	-	-	-	0.015	2.7
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.2	2	0.2	0.2	0.02	-	0.01	2	0.2
RRMB01									
10/09/2020	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-
9/11/2020	0.001	<0.001	0.017	0.002	<0.01	<0.001	<0.001	0.048	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
7/01/2021	<0.001	<0.001	0.015	0.006	<0.01	<0.001	<0.001	0.006	0.05
3/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	0.002	<0.001	0.045	0.006	<0.01	<0.001	<0.001	0.014	0.51
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	0.003	<0.001	0.029	0.003	<0.01	<0.001	<0.001	0.017	0.11
8/07/2021	<0.001	<0.001	0.022	0.005	<0.01	<0.001	<0.001	0.007	0.07
RRMB02									
9/11/2020	<0.001	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	0.006	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	0.01	<0.001	0.003	<0.001	<0.01	<0.001	<0.001	0.018	<0.05
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	<0.001	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	0.002	<0.001	0.001	<0.001	<0.01	<0.001	<0.001	0.008	<0.05
8/07/2021	<0.001	<0.001	0.001	<0.001	<0.01	<0.001	<0.001	0.005	<0.05
RRMB03									
9/11/2020	0.003	<0.001	0.005	0.001	<0.01	<0.001	<0.001	0.022	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	0.002	<0.001	<0.001	0.002	<0.01	<0.001	<0.001	0.016	<0.05
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	0.001	<0.001	0.001	0.002	<0.01	<0.001	<0.001	0.011	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	0.011	0.006	0.005	<0.001	<0.01	<0.001	<0.001	0.078	<0.05
7/07/2021	0.004	<0.001	<0.001	0.002	<0.01	<0.001	<0.001	0.049	<0.05
RRMB04									
10/11/2020	<0.001	<0.001	0.031	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	<0.001	<0.001	0.24	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	<0.001	<0.001	0.153	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	<0.001	<0.001	0.402	<0.001	<0.01	<0.001	<0.001	0.006	0.18
7/07/2021	<0.001	<0.001	0.627	<0.001	<0.01	<0.001	<0.001	0.009	0.27
RRMB05									
10/11/2020	<0.001	<0.001	0.11	<0.001	<0.01	<0.001	<0.001	<0.005	0.22
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	<0.001	<0.001	0.132	<0.001	<0.01	<0.001	<0.001	0.008	0.25
3/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	<0.001	0.147	<0.001	<0.01	<0.001	<0.001	<0.005	0.65
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	<0.001	<0.001	0.218	<0.001	<0.01	<0.001	<0.001	<0.005	0.54
8/07/2021	<0.001	<0.001	0.219	<0.001	<0.01	<0.001	<0.001	0.007	0.87
RRMB06									
9/11/2020	<0.001	<0.001	0.441	0.002	<0.01	<0.001	<0.001	0.013	1.71

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Copper	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cu_F	Pb_F	Mn_F	Ni_F	Se_F	Sn_F	U_F	Zn_F	Fe_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0018	0.0056	2.5	0.013	-	-	-	0.015	2.7
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.2	2	0.2	0.2	0.02	-	0.01	2	0.2
4/12/2020	-	-	-	-	-	-	-	-	-
7/01/2021	<0.001	<0.001	0.501	0.002	<0.01	<0.001	<0.001	0.014	1.84
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	<0.001	<0.001	0.462	0.002	<0.01	<0.001	<0.001	0.008	2.16
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	0.007	<0.001	0.476	0.001	<0.01	<0.001	<0.001	0.027	2.23
8/07/2021	<0.001	<0.001	0.491	0.001	<0.01	<0.001	<0.001	0.017	2.47
RRMB07									
10/11/2020	0.026	0.003	0.166	0.002	<0.01	<0.001	<0.001	0.019	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	0.026	<0.001	0.203	0.002	<0.01	<0.001	<0.001	0.045	<0.05
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	0.022	<0.001	0.209	0.003	<0.01	<0.001	<0.001	0.01	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	0.033	0.005	0.221	0.002	<0.01	<0.001	<0.001	0.07	<0.05
8/07/2021	0.026	<0.001	0.205	0.002	<0.01	<0.001	<0.001	0.067	<0.05
RRMB08									
10/11/2020	0.003	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	0.012	<0.05
4/12/2020	-	-	-	-	-	-	-	-	-
6/01/2021	0.007	<0.001	0.004	0.001	<0.01	<0.001	<0.001	0.027	<0.05
3/02/2021	-	-	-	-	-	-	-	-	-
10/03/2021	0.002	<0.001	0.004	0.002	<0.01	<0.001	<0.001	0.007	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-
6/05/2021	0.008	<0.001	0.004	<0.001	<0.01	<0.001	<0.001	0.036	<0.05
8/07/2021	0.003	<0.001	0.002	0.001	<0.01	<0.001	<0.001	0.026	<0.05

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Aluminium Al	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium
Analyte Short Name	Al_T	As_T	Cd_T	Cr_T	Co_T	Cu_T	Pb_T	Mn_T	Ni_T	Se_T	Sn_T	U_T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	insufficient data	0.024	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data
ANZECC 2000 Livestock Watering (beef cattle)	5	0.5	0.01	1	1	2	0.1	-	1	0.02	-	0.2
ANZECC 2000 long term irrigation	5	0.1	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01
RRMB01												
10/09/2020	-	-	-	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-	-	-	-
9/11/2020	1.29	0.002	<0.0001	0.002	0.018	0.006	0.003	0.03	0.004	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
7/01/2021	0.68	0.003	<0.0001	<0.001	0.006	0.002	<0.001	0.017	0.005	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	0.59	0.011	<0.0001	<0.001	0.006	0.007	<0.001	0.051	0.008	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
29/04/2021	0.28	0.003	<0.0001	<0.001	0.009	0.006	<0.001	0.034	0.003	<0.01	<0.001	<0.001
8/07/2021	0.34	0.004	<0.0001	<0.001	0.01	0.005	0.001	0.026	0.008	<0.01	<0.001	<0.001
RRMB02												
9/11/2020	0.07	0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	<0.01	0.001	<0.0001	<0.001	<0.001	0.009	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	<0.01	0.003	<0.0001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
29/04/2021	<0.01	0.002	0.0002	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.01	<0.001	<0.001
8/07/2021	<0.01	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.01	<0.001	<0.001
RRMB03												
9/11/2020	0.01	<0.001	<0.0001	<0.001	<0.001	0.003	<0.001	0.006	0.001	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	<0.01	<0.001	<0.0001	<0.001	<0.001	0.002	<0.001	<0.001	0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	0.03	0.003	<0.0001	<0.001	<0.001	0.001	<0.001	0.002	0.002	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
6/05/2021	0.04	0.001	<0.0001	<0.001	<0.001	0.015	<0.001	0.005	0.002	<0.01	<0.001	<0.001
7/07/2021	<0.01	0.002	<0.0001	<0.001	<0.001	0.007	<0.001	<0.001	0.002	<0.01	<0.001	<0.001
RRMB04												
10/11/2020	0.3	0.001	<0.0001	0.002	<0.001	<0.001	<0.001	0.07	<0.001	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	0.12	0.003	<0.0001	<0.001	<0.001	<0.001	<0.001	0.242	<0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	0.16	0.002	<0.0001	0.001	<0.001	<0.001	<0.001	0.31	<0.001	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
6/05/2021	0.17	0.003	<0.0001	<0.001	<0.001	0.002	<0.001	0.452	<0.001	<0.01	<0.001	<0.001
7/07/2021	0.03	0.002	<0.0001	<0.001	<0.001	0.001	<0.001	0.608	<0.001	<0.01	<0.001	<0.001
RRMB05												
10/11/2020	0.08	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	0.115	<0.001	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	0.05	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	0.129	<0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	0.06	0.005	<0.0001	<0.001	<0.001	<0.001	<0.001	0.172	<0.001	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
29/04/2021	0.01	0.002	<0.0001	<0.001	<0.001	<0.001	<0.001	0.249	<0.001	<0.01	<0.001	<0.001
8/07/2021	<0.01	0.083	<0.0001	<0.001	<0.001	<0.001	<0.001	0.237	<0.001	<0.01	<0.001	<0.001
RRMB06												
9/11/2020	<0.01	0.028	<0.0001	<0.001	<0.001	<0.001	<0.001	0.467	0.002	<0.01	<0.001	<0.001

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Aluminium Al	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium
Analyte Short Name	Al_T	As_T	Cd_T	Cr_T	Co_T	Cu_T	Pb_T	Mn_T	Ni_T	Se_T	Sn_T	U_T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	insufficient data	0.024	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data
ANZECC 2000 Livestock Watering (beef cattle)	5	0.5	0.01	1	1	2	0.1	-	1	0.02	-	0.2
ANZECC 2000 long term irrigation	5	0.1	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
7/01/2021	<0.01	0.033	<0.0001	<0.001	<0.001	<0.001	<0.001	0.487	0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	<0.01	0.037	<0.0001	<0.001	<0.001	<0.001	<0.001	0.466	0.002	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
6/05/2021	<0.01	0.037	<0.0001	<0.001	0.001	<0.001	<0.001	0.51	0.002	<0.01	<0.001	<0.001
8/07/2021	<0.01	0.039	<0.0001	<0.001	0.001	<0.001	<0.001	0.505	0.002	<0.01	<0.001	<0.001
RRMB07												
10/11/2020	0.1	<0.001	<0.0001	<0.001	0.006	0.028	0.003	0.198	0.002	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	0.1	<0.001	<0.0001	<0.001	0.007	0.027	<0.001	0.198	0.002	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	0.08	<0.001	<0.0001	<0.001	0.008	0.041	<0.001	0.212	0.003	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
6/05/2021	0.11	<0.001	<0.0001	<0.001	0.009	0.038	<0.001	0.242	0.003	<0.01	<0.001	<0.001
8/07/2021	0.08	<0.001	<0.0001	<0.001	0.008	0.029	0.002	0.208	0.003	<0.01	<0.001	<0.001
RRMB08												
10/11/2020	0.46	<0.001	<0.0001	<0.001	<0.001	0.006	<0.001	0.015	0.003	<0.01	<0.001	<0.001
4/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
6/01/2021	<0.01	<0.001	<0.0001	<0.001	<0.001	0.006	<0.001	<0.001	0.001	<0.01	<0.001	<0.001
3/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
10/03/2021	<0.01	0.001	<0.0001	<0.001	<0.001	0.002	<0.001	0.003	0.002	<0.01	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
6/05/2021	0.02	<0.001	<0.0001	<0.001	<0.001	0.011	<0.001	0.004	0.002	<0.01	<0.001	<0.001
8/07/2021	0.02	0.001	<0.0001	<0.001	<0.001	0.007	<0.001	0.004	0.002	<0.01	<0.001	<0.001

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Zinc	Iron	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Zn_T	Fe_T	Ferrous Iron	NH3	Nox	TKN_N	TN_N	P_Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	0.008	-	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	20	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	2	-	-	-	-	-	5	0.05
RRMB01								
10/09/2020	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-
9/11/2020	0.064	1.47	<0.05	1.29	1.6	2.1	3.7	0.21
4/12/2020	-	-	-	-	-	-	-	-
7/01/2021	0.008	0.88	<0.05	0.3	0.13	0.3	0.4	0.03
3/02/2021	-	-	-	-	-	-	-	-
11/03/2021	0.019	1.07	0.53	0.52	<0.01	0.6	0.6	0.12
16/04/2021	-	-	-	-	-	-	-	-
29/04/2021	0.019	0.54	0.1	0.3	0.06	0.4	0.5	0.03
8/07/2021	0.012	1.05	0.21	0.74	<0.01	0.8	0.8	0.05
RRMB02								
9/11/2020	0.007	0.07	<0.05	<0.01	0.08	<0.1	<0.1	0.2
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	0.017	<0.05	<0.05	0.05	0.02	<0.1	<0.1	0.23
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	<0.005	<0.05	<0.05	<0.01	<0.01	<0.1	<0.1	0.22
16/04/2021	-	-	-	-	-	-	-	-
29/04/2021	0.009	<0.05	<0.05	<0.01	<0.01	<0.1	<0.1	0.24
8/07/2021	0.008	<0.05	<0.05	<0.01	<0.01	<0.1	<0.1	0.24
RRMB03								
9/11/2020	0.023	<0.05	<0.05	<0.01	0.09	<0.1	<0.1	0.03
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	0.015	<0.05	<0.05	0.01	0.06	<0.1	<0.1	0.02
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	0.012	0.06	<0.05	0.02	0.06	<0.1	<0.1	0.05
16/04/2021	-	-	-	-	-	-	-	-
6/05/2021	0.052	0.07	<0.05	<0.01	0.08	<0.1	<0.1	0.03
7/07/2021	0.06	<0.05	<0.05	<0.01	0.06	<0.1	<0.1	0.03
RRMB04								
10/11/2020	<0.005	<0.05	<0.05	<0.01	0.13	<0.1	0.1	0.02
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	<0.005	<0.05	<0.05	<0.01	0.06	<0.1	<0.1	0.04
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	<0.005	<0.05	<0.05	<0.01	0.01	<0.1	<0.1	0.02
16/04/2021	-	-	-	-	-	-	-	-
6/05/2021	0.01	0.35	0.22	<0.01	0.04	<0.1	<0.1	0.04
7/07/2021	0.015	0.36	0.44	0.03	<0.01	<0.1	<0.1	<0.01
RRMB05								
10/11/2020	<0.005	0.26	0.26	<0.01	0.06	<0.1	<0.1	0.08
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	0.008	0.31	0.31	<0.01	<0.01	<0.1	<0.1	0.05
3/02/2021	-	-	-	-	-	-	-	-
11/03/2021	<0.005	0.92	0.11	0.01	<0.01	<0.1	<0.1	0.02
16/04/2021	-	-	-	-	-	-	-	-
29/04/2021	0.007	1.07	1.2	0.03	<0.01	<0.1	<0.1	0.14
8/07/2021	0.009	1.06	1.17	<0.01	<0.01	<0.1	<0.1	0.04
RRMB06								
9/11/2020	0.011	1.95	2.13	<0.01	0.04	<0.1	<0.1	0.56

Table A.1 - Rustlers Roost Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Zinc	Iron	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Zn_T	Fe_T	Ferrous Iron	NH3	Nox	TKN_N	TN_N	P_Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	0.008	-	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	20	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	2	-	-	-	-	-	5	0.05
4/12/2020	-	-	-	-	-	-	-	-
7/01/2021	0.013	1.89	2.35	<0.01	0.04	<0.1	<0.1	0.62
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	0.01	2.3	1.1	<0.01	<0.01	<0.1	<0.1	0.69
16/04/2021	-	-	-	-	-	-	-	-
6/05/2021	0.024	2.5	0.26	0.03	0.02	<0.1	<0.1	0.74
8/07/2021	0.024	2.59	2.89	<0.01	<0.01	<0.1	<0.1	0.8
RRMB07								
10/11/2020	0.019	0.05	<0.05	<0.01	0.21	<0.1	0.2	<0.01
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	0.044	<0.05	<0.05	<0.01	0.18	<0.1	0.2	<0.01
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	0.01	<0.05	<0.05	0.03	0.18	<0.1	0.2	0.01
16/04/2021	-	-	-	-	-	-	-	-
6/05/2021	0.07	<0.05	<0.05	<0.01	0.19	<0.1	0.2	<0.01
8/07/2021	0.06	<0.05	<0.05	<0.01	0.15	<0.1	0.2	<0.01
RRMB08								
10/11/2020	0.026	0.48	<0.05	<0.01	0.1	<0.1	0.1	0.01
4/12/2020	-	-	-	-	-	-	-	-
6/01/2021	0.028	<0.05	<0.05	<0.01	0.04	<0.1	<0.1	<0.01
3/02/2021	-	-	-	-	-	-	-	-
10/03/2021	0.008	<0.05	<0.05	<0.01	0.04	<0.1	<0.1	0.04
16/04/2021	-	-	-	-	-	-	-	-
6/05/2021	0.045	<0.05	<0.05	<0.01	0.07	<0.1	<0.1	0.03
8/07/2021	0.039	<0.05	<0.05	<0.01	0.04	<0.1	<0.1	0.01

A.2 Rustlers Roost Open Pit Monitoring Results (2020-2021)

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
18/11/2020								
BACKHOE 0m	28.4	7.46	33	0.6	0.01	18.2	13.6	62.4
BACKHOE 10m	27.2	7.74	30.9	0.5	0.01	17.55	12.3	56.2
BACKHOE 15m	28.1	6.45	27.7	0.5	0.01	18.2	80.4	41.3
BACKHOE 20m	30.7	7.74	27	0.6	0.01	20.15	76.4	21.7
BACKHOE 25m	44	6.45	26.2	2	0.02	28.6	-49.2	19.7
18/11/2020								
BEEF BUCKET 0m	27.9	7.76	32.6	0.4	0.01	18.2	56.4	58.1
BEEF BUCKET 10m	28.2	7.72	31.9	0.5	0.01	18.2	51	57.1
BEEF BUCKET 15m	27.6	6.77	28.9	0.5	0.01	18.2	32.6	59.9
BEEF BUCKET 20m	29.6	6.49	27.4	0.5	0.01	19.5	76.7	22.1
BEEF BUCKET 25m	44	6.45	26.2	0.9	0.02	28.6	-49.2	19.7
18/11/2020								
DOLLY POT 0m	30.9	8.47	32.6	0.5	0.01	20.15	33.4	56.9
DOLLY POT 10m	35.7	8.05	32	0.8	0.01	23.4	51.7	63.1
DOLLY POT 15m	27	6.97	29.1	0.4	0.01	17.55	45.5	63.8
DOLLY POT 20m	32.4	6.63	27.5	0.7	0.01	20.8	76.9	18.8
DOLLY POT 25m	43.2	6.52	27.1	2.3	0.02	27.95	-8.3	22
18/11/2020								
SWEAT RIDGE 0m	27.9	7.34	32.9	0.4	0.01	18.2	-1.01	73.8
SWEAT RIDGE 12m	27.9	6.72	30	0.7	0.01	18.2	51.5	57.7
17/06/2021								
BACKHOE 0m	24.5	6.51	28.4	0.08	0.01	16	244.2	96.9
BACKHOE 10m	24.7	6.51	28.2	0.15	0.01	16	245.2	97
BACKHOE 15m	24.8	6.48	28	1.11	0.01	16	249.4	91.6
BACKHOE 20m	25.3	6.43	27.8	4.11	0.01	16	254	87.5
BACKHOE 25m	24.8	6.39	27.7	4.08	0.01	16	259.2	88.6
BACKHOE 27m	52.4	5.99	26.8	1.16	0.2	34	115.2	39.7
17/06/2021								
BEEF BUCKET 0m	24.9	6.55	28	0.35	0.01	16	241.8	94.2
BEEF BUCKET 5m	24.6	6.54	27.8	0.15	0.01	16	254.9	93.7
BEEF BUCKET 10m	24.9	6.46	27.9	0.83	0.01	16	251.1	87.7
BEEF BUCKET 15m	24.9	6.37	27.7	0.68	0.01	16	257.1	85.7
BEEF BUCKET 20m	24.7	6.38	27.8	0.77	0.01	16	257.2	87.1
BEEF BUCKET 27m	25.7	6.31	27.7	1.06	0.01	17	261.5	78.8
17/06/2021								
DOLLY POT 0m	24.8	6.78	27.9	0.67	0.01	16	221.3	96.5
DOLLY POT 10m	24.7	6.74	27.7	0.49	0.01	16	228.6	94.5
DOLLY POT 15m	24.9	6.72	27.5	1.17	0.01	16	232.3	90.6
DOLLY POT 20m	25	6.63	27.6	0.79	0.01	16	238	88.5
DOLLY POT 25m	25.1	6.5	27.5	1.53	0.01	16	246.1	85.3
DOLLY POT 27m	27.3	6.35	27.4	2.34	0.01	18	258.1	67.3
17/06/2021								
SWEAT RIDGE 0m	30.4	7.55	28	0.41	0.01	20	184.7	94.3
SWEAT RIDGE 5m	28.3	7.17	27.9	1.25	0.01	18	206	93.9
SWEAT RIDGE 10m	26.2	6.9	27.8	0.95	0.01	18	219.4	91.7
SWEAT RIDGE 15m	29.5	6.75	27.6	2.75	0.01	19	228.1	88.7

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
18/11/2020							
BACKHOE 0m	<5	-	<1	<1	<1	6	6
BACKHOE 10m	<5	-	<1	<1	<1	6	6
BACKHOE 15m	<5	-	<1	<1	<1	7	7
BACKHOE 20m	<5	-	<1	<1	<1	8	8
BACKHOE 25m	<5	-	<1	<1	<1	12	12
18/11/2020							
BEEF BUCKET 0m	<5	-	<1	<1	<1	7	7
BEEF BUCKET 10m	<5	-	<1	<1	<1	6	6
BEEF BUCKET 15m	<5	-	<1	<1	<1	6	6
BEEF BUCKET 20m	<5	-	<1	<1	<1	7	7
BEEF BUCKET 25m	<5	-	<1	<1	<1	10	10
18/11/2020							
DOLLY POT 0m	<5	-	<1	<1	<1	8	8
DOLLY POT 10m	<5	-	<1	<1	<1	6	6
DOLLY POT 15m	<5	-	<1	<1	<1	6	6
DOLLY POT 20m	<5	-	<1	<1	<1	8	8
DOLLY POT 25m	<5	-	<1	<1	<1	14	14
18/11/2020							
SWEAT RIDGE 0m	<5	-	<1	<1	<1	6	6
SWEAT RIDGE 12m	<5	-	<1	<1	<1	7	7
17/06/2021							
BACKHOE 0m	<5	0.5	<1	<1	<1	9	9
BACKHOE 10m	<5	0.6	<1	<1	<1	9	9
BACKHOE 15m	<5	0.4	<1	<1	<1	9	9
BACKHOE 20m	<5	0.4	<1	<1	<1	11	11
BACKHOE 25m	<5	0.4	<1	<1	<1	8	8
BACKHOE 27m	6	2.8	<1	<1	<1	24	24
17/06/2021							
BEEF BUCKET 0m	<5	0.5	<1	<1	<1	8	8
BEEF BUCKET 5m	<5	0.6	<1	<1	<1	9	9
BEEF BUCKET 10m	<5	0.4	<1	<1	<1	8	8
BEEF BUCKET 15m	<5	0.4	<1	<1	<1	9	9
BEEF BUCKET 20m	<5	0.4	<1	<1	<1	9	9
BEEF BUCKET 27m	<5	0.6	<1	<1	<1	12	12
17/06/2021							
DOLLY POT 0m	<5	0.5	<1	<1	<1	13	13
DOLLY POT 10m	<5	0.5	<1	<1	<1	9	9
DOLLY POT 15m	5	0.6	<1	<1	<1	8	8
DOLLY POT 20m	<5	0.5	<1	<1	<1	8	8
DOLLY POT 25m	<5	0.5	<1	<1	<1	8	8
DOLLY POT 27m	6	0.8	<1	<1	<1	11	11
17/06/2021							
SWEAT RIDGE 0m	6	0.5	<1	<1	<1	9	9
SWEAT RIDGE 5m	6	0.6	<1	<1	<1	8	8
SWEAT RIDGE 10m	<5	0.5	<1	<1	<1	8	8
SWEAT RIDGE 15m	<5	1.2	<1	<1	<1	9	9

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium	Magnesium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca	Mg
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000	2000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
18/11/2020								
BACKHOE 0m	5	-	-	-	<1	2	<1	<1
BACKHOE 10m	4	-	-	-	<1	2	<1	<1
BACKHOE 15m	4	-	-	-	<1	2	<1	<1
BACKHOE 20m	8	-	-	-	<1	2	<1	<1
BACKHOE 25m	8	-	-	-	<1	2	<1	<1
18/11/2020								
BEEF BUCKET 0m	5	-	-	-	<1	2	<1	<1
BEEF BUCKET 10m	5	-	-	-	<1	3	<1	<1
BEEF BUCKET 15m	3	-	-	-	<1	2	<1	<1
BEEF BUCKET 20m	5	-	-	-	<1	3	<1	<1
BEEF BUCKET 25m	7	-	-	-	<1	2	<1	<1
18/11/2020								
DOLLY POT 0m	3	-	-	-	<1	3	<1	<1
DOLLY POT 10m	3	-	-	-	<1	4	<1	<1
DOLLY POT 15m	5	-	-	-	<1	2	<1	<1
DOLLY POT 20m	4	-	-	-	<1	3	<1	<1
DOLLY POT 25m	9	-	-	-	<1	2	<1	<1
18/11/2020								
SWEAT RIDGE 0m	3	-	-	-	<1	2	<1	<1
SWEAT RIDGE 12m	3	-	-	-	<1	2	<1	<1
17/06/2021								
BACKHOE 0m	3	<1	<1	<1	<1	2	<1	<1
BACKHOE 10m	3	<1	<1	<1	<1	2	<1	<1
BACKHOE 15m	5	<1	<1	<1	<1	2	<1	<1
BACKHOE 20m	3	<1	<1	<1	<1	2	<1	<1
BACKHOE 25m	3	<1	<1	<1	<1	2	<1	<1
BACKHOE 27m	10	<1	<1	<1	<1	2	<1	<1
17/06/2021								
BEEF BUCKET 0m	4	<1	<1	<1	<1	2	<1	<1
BEEF BUCKET 5m	3	<1	<1	<1	<1	2	<1	<1
BEEF BUCKET 10m	5	<1	<1	<1	<1	2	<1	<1
BEEF BUCKET 15m	4	<1	<1	<1	<1	2	<1	<1
BEEF BUCKET 20m	4	<1	<1	<1	<1	2	<1	<1
BEEF BUCKET 27m	4	<1	<1	<1	<1	2	<1	<1
17/06/2021								
DOLLY POT 0m	8	<1	<1	<1	<1	2	<1	<1
DOLLY POT 10m	4	<1	<1	<1	<1	2	<1	<1
DOLLY POT 15m	4	<1	<1	<1	<1	2	<1	<1
DOLLY POT 20m	5	<1	<1	<1	<1	2	<1	<1
DOLLY POT 25m	3	<1	<1	<1	<1	2	<1	<1
DOLLY POT 27m	4	<1	<1	<1	<1	2	<1	<1
17/06/2021								
SWEAT RIDGE 0m	4	<1	<1	<1	<1	2	<1	<1
SWEAT RIDGE 5m	3	<1	<1	<1	<1	2	<1	<1
SWEAT RIDGE 10m	8	<1	<1	<1	<1	2	<1	<1
SWEAT RIDGE 15m	4	<1	<1	<1	<1	2	<1	<1

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead
Analyte Short Name	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F	Pb F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	0.295	0.042	0.0004	0.006	-	0.0018	0.0056
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014	0.0034
ANZECC 2000 Livestock Watering (beef cattle)	-	-	5	0.5	0.01	1	1	2	0.1
ANZECC 2000 long term irrigation	-	-	5	0.1	0.01	0.1	0.05	0.2	2
18/11/2020									
BACKHOE 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 10m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 20m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 25m	2	1	<0.01	0.008	<0.0001	<0.001	<0.001	<0.001	<0.001
18/11/2020									
BEEF BUCKET 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 10m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 20m	2	1	0.02	<0.001	<0.0001	<0.001	<0.001	0.001	<0.001
BEEF BUCKET 25m	2	1	<0.01	0.005	<0.0001	<0.001	<0.001	<0.001	<0.001
18/11/2020									
DOLLY POT 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 10m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 20m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	0.001	<0.001
DOLLY POT 25m	2	1	<0.01	0.007	<0.0001	<0.001	<0.001	<0.001	<0.001
18/11/2020									
SWEAT RIDGE 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
SWEAT RIDGE 12m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
17/06/2021									
BACKHOE 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 10m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 20m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 25m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BACKHOE 27m	2	1	<0.01	0.009	<0.0001	<0.001	0.001	<0.001	<0.001
17/06/2021									
BEEF BUCKET 0m	2	<1	<0.01	<0.001	0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 5m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 10m	2	<1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 20m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
BEEF BUCKET 27m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
17/06/2021									
DOLLY POT 0m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 10m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 15m	2	<1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 20m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 25m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001
DOLLY POT 27m	2	1	<0.01	<0.001	0.0001	<0.001	<0.001	<0.001	<0.001
17/06/2021									
SWEAT RIDGE 0m	2	<1	<0.01	<0.001	0.0001	<0.001	<0.001	<0.001	<0.001
SWEAT RIDGE 5m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	0.002	<0.001
SWEAT RIDGE 10m	2	1	<0.01	<0.001	0.0001	<0.001	<0.001	<0.001	<0.001
SWEAT RIDGE 15m	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	0.001	<0.001

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium Al	Arsenic	Cadmium
Analyte Short Name	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T	Cd T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	2.5	0.013	-	-	-	0.015	2.7	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024	0.0002
ANZECC 2000 Livestock Watering (beef cattle)	-	1	0.02	-	0.2	20	-	5	0.5	0.01
ANZECC 2000 long term irrigation	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1	0.01
18/11/2020										
BACKHOE 0m	0.003	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 10m	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 15m	0.048	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 20m	0.193	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	0.001	<0.0001
BACKHOE 25m	0.584	<0.001	<0.01	<0.001	<0.001	<0.005	0.98	<0.01	0.016	<0.0001
18/11/2020										
BEEF BUCKET 0m	0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 10m	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 15m	0.005	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 20m	0.112	<0.001	<0.01	<0.001	<0.001	0.006	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 25m	0.481	<0.001	<0.01	<0.001	<0.001	<0.005	0.72	<0.01	0.006	<0.0001
18/11/2020										
DOLLY POT 0m	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 10m	<0.001	<0.001	<0.01	<0.001	<0.001	0.006	<0.05	0.02	<0.001	<0.0001
DOLLY POT 15m	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 20m	0.203	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	0.001	<0.0001
DOLLY POT 25m	0.622	<0.001	<0.01	<0.001	<0.001	<0.005	1.2	<0.01	0.01	<0.0001
18/11/2020										
SWEAT RIDGE 0m	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
SWEAT RIDGE 12m	0.052	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
17/06/2021										
BACKHOE 0m	0.043	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 10m	0.022	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 15m	0.022	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 20m	0.033	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 25m	0.034	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BACKHOE 27m	0.78	<0.001	<0.01	<0.001	<0.001	<0.005	2.56	<0.01	0.012	<0.0001
17/06/2021										
BEEF BUCKET 0m	0.018	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 5m	0.017	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 10m	0.015	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 15m	0.03	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 20m	0.024	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
BEEF BUCKET 27m	0.071	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
17/06/2021										
DOLLY POT 0m	0.016	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 10m	0.012	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 15m	0.009	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 20m	0.014	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 25m	0.016	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
DOLLY POT 27m	0.259	0.002	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
17/06/2021										
SWEAT RIDGE 0m	0.017	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
SWEAT RIDGE 5m	0.014	<0.001	<0.01	<0.001	<0.001	0.006	<0.05	<0.01	<0.001	<0.0001
SWEAT RIDGE 10m	0.012	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001
SWEAT RIDGE 15m	0.014	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001	<0.0001

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Nutrients
Analyte	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron	Ferrous Iron	Ammonia
Analyte Short Name	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T	Ferrous Iron	NH3
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-	1.4
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-	0.01
ANZG 2018 freshwater - 95% species protection	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	-	0.9
ANZECC 2000 Livestock Watering (beef cattle)	1	1	2	0.1	-	1	0.02	-	0.2	20	-	-	-
ANZECC 2000 long term irrigation	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-	-	-
18/11/2020													
BACKHOE 0m	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	0.03
BACKHOE 10m	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BACKHOE 15m	<0.001	<0.001	0.001	<0.001	0.061	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BACKHOE 20m	<0.001	<0.001	0.001	<0.001	0.24	<0.001	<0.01	<0.001	<0.001	<0.001	0.11	<0.005	<0.01
BACKHOE 25m	<0.001	0.001	<0.001	<0.001	0.677	<0.001	<0.01	<0.001	<0.001	<0.001	2	<0.005	0.27
18/11/2020													
BEEF BUCKET 0m	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BEEF BUCKET 10m	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BEEF BUCKET 15m	<0.001	<0.001	<0.001	<0.001	0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BEEF BUCKET 20m	<0.001	<0.001	0.001	<0.001	0.123	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
BEEF BUCKET 25m	<0.001	0.001	0.002	<0.001	0.535	<0.001	<0.01	<0.001	<0.001	<0.001	1.09	<0.005	0.08
18/11/2020													
DOLLY POT 0m	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.01	<0.01	<0.001	<0.001	<0.05	<0.005	0.03
DOLLY POT 10m	<0.001	<0.001	0.002	<0.001	0.006	<0.001	<0.01	<0.001	<0.001	0.01	<0.05	-	<0.01
DOLLY POT 15m	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
DOLLY POT 20m	<0.001	<0.001	0.002	<0.001	0.219	<0.001	<0.01	<0.001	<0.001	<0.001	0.06	<0.005	<0.01
DOLLY POT 25m	<0.001	0.001	<0.001	<0.001	0.671	<0.001	<0.01	<0.001	<0.001	<0.001	1.9	<0.005	0.26
18/11/2020													
SWEAT RIDGE 0m	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
SWEAT RIDGE 12m	<0.001	<0.001	<0.001	<0.001	0.061	<0.001	<0.01	<0.001	<0.001	<0.001	<0.05	<0.005	<0.01
17/06/2021													
BACKHOE 0m	<0.001	<0.001	<0.001	<0.001	0.02	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	<0.01
BACKHOE 10m	<0.001	<0.001	<0.001	<0.001	0.052	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	<0.01
BACKHOE 15m	<0.001	<0.001	<0.001	<0.001	0.059	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.05
BACKHOE 20m	<0.001	<0.001	<0.001	<0.001	0.064	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.06
BACKHOE 25m	<0.001	<0.001	<0.001	<0.001	0.068	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.09
BACKHOE 27m	<0.001	0.002	<0.001	<0.001	0.849	<0.001	<0.01	<0.001	<0.001	<0.005	3.97	<0.05	0.57
17/06/2021													
BEEF BUCKET 0m	<0.001	<0.001	<0.001	<0.001	0.04	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.01
BEEF BUCKET 5m	<0.001	<0.001	<0.001	<0.001	0.047	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	<0.01
BEEF BUCKET 10m	<0.001	<0.001	0.003	<0.001	0.042	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.02
BEEF BUCKET 15m	<0.001	<0.001	<0.001	<0.001	0.054	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.04
BEEF BUCKET 20m	<0.001	<0.001	<0.001	<0.001	0.059	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.05
BEEF BUCKET 27m	<0.001	<0.001	<0.001	<0.001	0.108	<0.001	<0.01	<0.001	<0.001	<0.005	0.12	<0.05	0.16
17/06/2021													
DOLLY POT 0m	<0.001	<0.001	<0.001	<0.001	0.035	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.02
DOLLY POT 10m	<0.001	<0.001	<0.001	<0.001	0.032	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.01
DOLLY POT 15m	<0.001	<0.001	0.001	<0.001	0.037	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.08
DOLLY POT 20m	<0.001	<0.001	<0.001	<0.001	0.043	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.06
DOLLY POT 25m	<0.001	<0.001	<0.001	<0.001	0.037	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.04
DOLLY POT 27m	<0.001	<0.001	<0.001	<0.001	0.263	<0.001	<0.01	<0.001	<0.001	<0.005	0.16	<0.05	0.08
17/06/2021													
SWEAT RIDGE 0m	<0.001	<0.001	<0.001	<0.001	0.049	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	<0.01
SWEAT RIDGE 5m	<0.001	<0.001	0.002	<0.001	0.048	<0.001	<0.01	<0.001	<0.001	0.007	<0.05	<0.05	0.03
SWEAT RIDGE 10m	<0.001	<0.001	<0.001	<0.001	0.048	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05	0.03
SWEAT RIDGE 15m	<0.001	<0.001	0.002	<0.001	0.06	<0.001	<0.01	<0.001	<0.001	<0.005	0.05	<0.05	0.07

Table A.2 - Rustlers Roost Open Pit Water Quality

Analyte Group	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-
Tropical Australia Lowland Rivers	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-
ANZECC 2000 long term irrigation	-	-	5	0.05
18/11/2020				
BACKHOE 0m	<0.01	0.1	0.1	<0.01
BACKHOE 10m	<0.01	0.1	0.1	<0.01
BACKHOE 15m	<0.01	<0.1	<0.1	<0.01
BACKHOE 20m	<0.01	0.1	0.1	<0.01
BACKHOE 25m	<0.01	0.3	0.3	0.01
18/11/2020				
BEEF BUCKET 0m	<0.01	<0.1	<0.1	<0.01
BEEF BUCKET 10m	<0.01	<0.1	<0.1	0.03
BEEF BUCKET 15m	<0.01	0.1	0.1	<0.01
BEEF BUCKET 20m	<0.01	0.2	0.2	0.08
BEEF BUCKET 25m	<0.01	0.2	0.2	<0.01
18/11/2020				
DOLLY POT 0m	<0.01	0.2	0.2	0.03
DOLLY POT 10m	<0.01	0.2	0.2	<0.01
DOLLY POT 15m	<0.01	<0.1	<0.1	0.02
DOLLY POT 20m	<0.01	<0.1	<0.1	0.02
DOLLY POT 25m	<0.01	0.3	0.3	0.02
18/11/2020				
SWEAT RIDGE 0m	<0.01	<0.1	<0.1	<0.01
SWEAT RIDGE 12m	<0.01	<0.1	<0.1	<0.01
17/06/2021				
BACKHOE 0m	<0.01	0.1	0.1	<0.01
BACKHOE 10m	<0.01	0.2	0.2	0.01
BACKHOE 15m	<0.01	0.2	0.2	0.02
BACKHOE 20m	<0.01	0.2	0.2	<0.01
BACKHOE 25m	<0.01	0.4	0.4	<0.01
BACKHOE 27m	<0.01	0.7	0.7	0.02
17/06/2021				
BEEF BUCKET 0m	<0.01	0.2	0.2	0.01
BEEF BUCKET 5m	<0.01	0.2	0.2	0.01
BEEF BUCKET 10m	<0.01	0.2	0.2	0.01
BEEF BUCKET 15m	<0.01	0.2	0.2	0.01
BEEF BUCKET 20m	<0.01	0.2	0.2	<0.01
BEEF BUCKET 27m	<0.01	0.2	0.2	0.03
17/06/2021				
DOLLY POT 0m	0.02	0.1	0.1	0.01
DOLLY POT 10m	0.02	0.1	0.1	<0.01
DOLLY POT 15m	<0.01	0.2	0.2	0.01
DOLLY POT 20m	<0.01	0.2	0.2	<0.01
DOLLY POT 25m	<0.01	0.2	0.2	0.01
DOLLY POT 27m	0.04	0.2	0.2	0.01
17/06/2021				
SWEAT RIDGE 0m	<0.01	0.2	0.2	0.03
SWEAT RIDGE 5m	<0.01	0.2	0.2	0.02
SWEAT RIDGE 10m	<0.01	0.1	0.1	0.01
SWEAT RIDGE 15m	<0.01	0.4	0.4	0.01

A.3 Rustlers Roost Surface Water Monitoring Results (2020-2021)

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	SWL (initial)	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential
Analyte Short Name	SWL (initial)	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)
Units	mbTOC	µS/cm	-	°C	NTU	ppt	mg/L	mV
Toms Gully SSTV (80th percentile)	-	41	5.8 - 8.0	-	87	-	-	-
Tropical Australia Lowland Rivers	-	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	4000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
RRSW2								
28/11/2016	-	38	6.4	-	-	-	-	-
26/01/2017	-	46	6.5	-	24	-	-	-
26/03/2017	-	83	7.4	-	11	-	-	-
22/02/2019	-	120	7	-	12	-	-	-
19/01/2020	-	66	6.5	-	40	-	-	-
16/02/2020	-	98	6.8	-	23	-	-	-
4/12/2020	-	19.1	5.5	29.9	899	0.01	12	269
6/01/2021	-	137.2	6.12	29.2	88.5	0.1	89.2	157
3/02/2021	-	59	6.22	29	35.7	0.03	38.35	108.4
8/03/2021	-	110.7	6.62	28.6	12.1	0.05	72.15	55
29/04/2021	-	160	6.37	27.5	18	0.07	104	70
14/05/2021	-	138.7	6.91	30.8	10.7	0.06	90	205.2
RRMCDS								
15/04/2021	-	21.7	6.31	31.5	9.2	0.01	14	191.7
RRMCUS								
15/04/2021	-	21.9	6.19	27.3	24.5	0.01	14	199.3
RRSW5								
22/08/2012	-	-	-	-	-	-	-	-
9/12/2012	-	-	-	-	-	-	-	-
20/12/2016	-	23	6.3	-	720	-	-	-
26/03/2017	-	13	6.4	-	17	-	-	-
30/06/2018	-	130	6.9	-	7	-	-	-
22/02/2019	-	160	7.8	-	14	-	-	-
20/08/2019	-	140	7.7	-	24	-	-	-
30/10/2019	-	300	7.8	-	9.1	-	-	-
16/02/2020	-	210	8.2	-	3.5	-	-	-
11/11/2020	-	313.3	7.98	35.4	17.8	0.15	203.4	72.6
3/02/2021	-	190.8	7.29	31.4	13.8	0.09	124.15	90.9
29/04/2021	-	121	7.42	29.5	6.54	0.06	79	49.8
RRSW6								
9/12/2012	-	-	-	-	-	-	-	-
20/12/2016	-	25	5.9	-	30	-	-	-
26/03/2017	-	10	5.6	-	10	-	-	-
30/06/2018	-	10	6	-	4	-	-	-
3/02/2021	-	13.8	5.46	29.7	46.8	-	9.1	126
29/04/2021	dry	-	-	-	-	-	-	-
RRSW7								
20/12/2016	-	49	4.3	-	28	-	-	-
26/01/2017	-	11	6.2	-	4.8	-	-	-
26/03/2017	-	13	6	-	21	-	-	-
30/06/2018	-	26	6.3	-	2.4	-	-	-
12/12/2018	-	17	6.2	-	3	-	-	-
22/02/2019	-	14	6.2	-	2.2	-	-	-
20/08/2019	-	30	6.3	-	3.6	-	-	-
19/01/2020	-	19	6.1	-	5.5	-	-	-
10/11/2020	-	37.8	6.43	31.6	27.2	0.02	24.7	63.9
3/02/2021	-	31.6	5.94	29.9	19.3	0.01	20.8	93.2

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	SWL (initial)	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential
Analyte Short Name	SWL (initial)	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)
Units	mbTOC	µS/cm	-	°C	NTU	ppt	mg/L	mV
Toms Gully SSTV (80th percentile)	-	41	5.8 - 8.0	-	87	-	-	-
Tropical Australia Lowland Rivers	-	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	4000	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
29/04/2021	-	34.3	5.73	31.3	2.7	0.01	22.1	63.6
RRSW10								
20/12/2016	-	55	7.1	-	860	-	-	-
26/01/2017	-	24	6.6	-	44	-	-	-
26/03/2017	-	8	6.1	-	73	-	-	-
3/02/2021	-	30.2	5.77	28	13.7	0.01	19.5	103.3
29/04/2021	-	33.2	5.99	29.7	12.7	0.01	21.4	54
RRSW11								
28/11/2016	-	82	7.3	-	290	-	-	-
20/12/2016	-	81	6.8	-	610	-	-	-
26/01/2017	-	32	6.8	-	78	-	-	-
26/03/2017	-	21	6.3	-	300	-	-	-
30/06/2018	-	26	6.3	-	11	-	-	-
22/02/2019	-	36	6.2	-	2.8	-	-	-
6/01/2021	-	42.6	5.75	31.9	45.3	0	27.7	100
3/02/2021	-	38.7	5.83	29.7	7.26	0.02	25.35	96.6
8/03/2021	-	47.5	5.32	30.3	3.37	0.02	30.55	60
29/04/2021	-	45.2	5.8	30.8	10.8	0.02	29.5	46.4
14/05/2021	-	43.7	5.88	31.2	11	0.02	28	100
RRSW12								
20/12/2016	-	13	5.4	-	47	-	-	-
26/01/2017	-	14	6.1	-	24	-	-	-
26/03/2017	-	10	5.6	-	42	-	-	-
3/02/2021	-	14.6	5.15	30.1	6.97	0.05	9.75	142.8
8/03/2021	-	17.3	4.46	33.8	4.98	0.01	11.05	99
29/04/2021	dry	-	-	-	-	-	-	-
14/05/2021	dry	-	-	-	-	-	-	-
RRSW22								
22/08/2012	-	-	-	-	-	-	-	-
9/12/2012	-	-	-	-	-	-	-	-
20/12/2016	-	25	7	-	3.5	-	-	-
26/03/2017	-	21	6.9	-	9.6	-	-	-
30/06/2018	-	22	6.4	-	2.4	-	-	-
22/02/2019	-	23	7.1	-	0.7	-	-	-
20/08/2019	-	24	6.6	-	3.5	-	-	-
30/10/2019	-	27	7.1	-	1.5	-	-	-
9/11/2020	-	27.3	7.59	32.7	-	0.01	17.55	72.5
3/02/2021	-	23.1	6.55	31.4	1.19	0.01	14.95	103
29/04/2021	-	24.1	7.34	31.4	2.3	0.01	15.6	-45
RRSW23								
4/12/2020	-	38.9	6.19	33.2	373	0.02	25	256
7/01/2021	-	45.8	5.98	30	748	0	29.8	252
3/02/2021	-	57.7	6.64	29.6	36.3	0.03	37.7	104.1
8/03/2021	-	96	6.3	31.7	22.3	0.04	62.4	75.9
29/04/2021	-	143	6.13	28.3	34.4	0.07	93	87.3
14/05/2021	-	124.3	7.32	30.7	14.2	0.06	81	186

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Field Measurements	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity
Analyte	Dissolved Oxygen	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3
Analyte Short Name	DO_%sat (field)	TSS	Turbidity (lab)	Total Hardness	Alk_OH	Alk_CO3	Alk_HCO3
Units	%	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	54	87	-	-	-	-
Tropical Australia Lowland Rivers	85-120	2 - 15	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
RRSW2							
28/11/2016	-	1000	-	10	<5	<5	15
26/01/2017	-	16	-	8	<5	<5	15
26/03/2017	-	14	-	16	<5	<5	36
22/02/2019	-	8	-	18	0.7	0.8	6.1
19/01/2020	-	53	-	17	<5	<5	22
16/02/2020	-	17	-	15	<5	<5	37
4/12/2020	75.1	433	1180	<1	<1	<1	2
6/01/2021	68.1	20	60.9	17	<1	<1	51
3/02/2021	81.7	10	19.2	7	<1	<1	23
8/03/2021	59	8	9.4	17	<1	<1	46
29/04/2021	50.6	11	9.7	17	<1	<1	54
14/05/2021	114.9	<5	8.3	20	<1	<1	53
RRMCDS							
15/04/2021	101.5	6	7.5	<1	<1	<1	6
RRMCUS							
15/04/2021	87.6	14	19.7	<1	<1	<1	4
RRSW5							
22/08/2012	-	9	-	60	<5	<5	83
9/12/2012	-	18	-	73	<5	<5	100
20/12/2016	-	-	-	4	<5	<5	<5
26/03/2017	-	16	-	<3	<5	<5	7
30/06/2018	-	97	-	42	<5	<5	66
22/02/2019	-	15	-	58	0.9	2.3	22
20/08/2019	-	23	-	31	<5	<5	67
30/10/2019	-	33	-	74	<5	<5	110
16/02/2020	-	6	-	71	<5	<5	87
11/11/2020	55.6	19	10.1	81	<1	<1	126
3/02/2021	67	12	3.4	65	<1	<1	71
29/04/2021	75	13	2.7	40	<1	<1	46
RRSW6							
9/12/2012	-	15	-	<3	<5	<5	6
20/12/2016	-	-	-	4	<5	<5	<5
26/03/2017	-	<5	-	<3	<5	<5	<5
30/06/2018	-	17	-	<3	<5	<5	<5
3/02/2021	63.5	8	26.7	<1	<1	<1	6
29/04/2021	-	-	-	-	-	-	-
RRSW7							
20/12/2016	-	-	-	5	<5	<5	<5
26/01/2017	-	<5	-	<3	<5	<5	<5
26/03/2017	-	6	-	<3	<5	<5	7
30/06/2018	-	<5	-	5	<5	<5	10
12/12/2018	-	<5	-	5	<5	<5	7
22/02/2019	-	11	-	<3	0.6	<0.5	<0.5
20/08/2019	-	19	-	7	<5	<5	10
19/01/2020	-	10	-	<3	<5	<5	<5
10/11/2020	57.3	8	17.9	<1	<1	<1	12
3/02/2021	55.5	<5	11.8	<1	<1	<1	10

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Field Measurements	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity
Analyte	Dissolved Oxygen	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3
Analyte Short Name	DO_%sat (field)	TSS	Turbidity (lab)	Total Hardness	Alk_OH	Alk_CO3	Alk_HCO3
Units	%	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	54	87	-	-	-	-
Tropical Australia Lowland Rivers	85-120	2 - 15	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
29/04/2021	62.8	6	3	<1	<1	<1	13
RRSW10							
20/12/2016	-	-	-	21	<5	<5	27
26/01/2017	-	32	-	6	<5	<5	8
26/03/2017	-	250	-	<3	<5	<5	<5
3/02/2021	47.6	6	6.7	<1	<1	<1	8
29/04/2021	66	17	5.5	5	<1	<1	11
RRSW11							
28/11/2016	-	75	-	32	<5	<5	38
20/12/2016	-	-	-	32	<5	<5	37
26/01/2017	-	36	-	11	<5	<5	14
26/03/2017	-	490	-	4	<5	<5	8
30/06/2018	-	18	-	<3	<5	<5	7
22/02/2019	-	6	-	10	0.6	1.6	2.8
6/01/2021	46.5	11	30.9	10	<1	<1	22
3/02/2021	33.9	6	4.6	7	<1	<1	17
8/03/2021	22.4	<5	3.9	10	<1	<1	25
29/04/2021	50.9	6	3.2	7	<1	<1	13
14/05/2021	19.7	14	8.8	7	<1	<1	14
RRSW12							
20/12/2016	-	-	-	<3	<5	<5	<5
26/01/2017	-	7	-	<3	<5	<5	<5
26/03/2017	-	<5	-	<3	<5	<5	<5
3/02/2021	85.5	<5	3.6	<1	<1	<1	3
8/03/2021	65	<5	3.4	<1	<1	<1	4
29/04/2021	-	-	-	-	-	-	-
14/05/2021	-	-	-	-	-	-	-
RRSW22							
22/08/2012	-	<5	-	5	<5	<5	13
9/12/2012	-	<5	-	6	<5	<5	15
20/12/2016	-	-	-	5	<5	<5	<5
26/03/2017	-	<5	-	4	<5	<5	8
30/06/2018	-	120	-	<3	<5	<5	7
22/02/2019	-	<5	-	<3	0.7	1.3	<0.5
20/08/2019	-	13	-	<3	<5	<5	10
30/10/2019	-	11	-	5	<5	<5	9
9/11/2020	89.1	5	1.4	<1	<1	<1	5
3/02/2021	95.8	<5	0.4	<1	<1	<1	5
29/04/2021	73	8	0.6	<1	<1	<1	4
RRSW23							
4/12/2020	107.3	198	324	4	<1	<1	9
7/01/2021	81.7	402	405	5	<1	<1	13
3/02/2021	96.6	9	23.5	5	<1	<1	21
8/03/2021	118.5	5	11	12	<1	<1	38
29/04/2021	71.6	14	20.3	12	<1	<1	47
14/05/2021	116.5	<5	9.4	12	<1	<1	42

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Alkalinity	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Total Alkalinity as CaCO3	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Alk_Tot	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
RRSW2								
28/11/2016	15	11	-	-	-	3	1	2.4
26/01/2017	15	9	-	-	-	2	3	2.4
26/03/2017	36	<5	-	-	-	2	3	6.3
22/02/2019	17	5	-	-	-	7	2	6.1
19/01/2020	22	-	-	-	-	2	4	3.8
16/02/2020	37	6	-	-	-	6	5	4.8
4/12/2020	2	7	<1	7	7	<1	<1	<1
6/01/2021	51	14	<1	14	14	10	3	7
3/02/2021	23	10	<1	10	9	3	3	3
8/03/2021	46	9	<1	9	8	10	2	7
29/04/2021	54	5	<1	5	5	14	4	7
14/05/2021	53	10	<1	10	9	11	2	8
RRMCDS								
15/04/2021	6	8	<1	8	8	<1	2	<1
RRMCUS								
15/04/2021	4	4	<1	4	4	<1	2	<1
RRSW5								
22/08/2012	83	<5	-	-	-	6	3	23
9/12/2012	100	<5	-	-	-	3	5	28
20/12/2016	<5	7	-	-	-	<1	<1	1.5
26/03/2017	<5	<5	-	-	-	3	4	0.6
30/06/2018	66	<5	-	-	-	2	2	16
22/02/2019	9.6	<5	-	-	-	<1	5	22
20/08/2019	67	<5	-	-	-	2	5	11
30/10/2019	110	<5	-	-	-	6	15	27
16/02/2020	87	<5	-	-	-	11	7	27
11/11/2020	126	8	<1	8	8	3	13	29
3/02/2021	71	5	<1	5	5	16	6	26
29/04/2021	46	4	<1	4	4	6	4	16
RRSW6								
9/12/2012	6	<5	-	-	-	<1	2	0.5
20/12/2016	<5	8	-	-	-	<1	3	0.6
26/03/2017	<5	10	-	-	-	<1	1	<0.5
30/06/2018	<5	<5	-	-	-	<1	<1	<0.5
3/02/2021	6	3	<1	3	3	<1	2	<1
29/04/2021	-	-	-	-	-	-	-	-
RRSW7								
20/12/2016	<5	11	-	-	-	<1	4	0.6
26/01/2017	<5	6	-	-	-	<1	2	<0.5
26/03/2017	<5	8	-	-	-	<1	1	<0.5
30/06/2018	10	<5	-	-	-	<1	2	0.6
12/12/2018	7	6	-	-	-	<1	<1	0.6
22/02/2019	1.4	5	-	-	-	<1	<1	<0.5
20/08/2019	10	<5	-	-	-	<1	2	1
19/01/2020	<5	-	-	-	-	<1	3	<0.5
10/11/2020	12	8	<1	8	8	<1	2	<1
3/02/2021	10	5	<1	5	5	<1	2	<1

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Alkalinity	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Total Alkalinity as CaCO3	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Alk_Tot	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
29/04/2021	13	5	<1	5	5	<1	2	<1
RRSW10								
20/12/2016	27	6	-	-	-	<1	<1	6.8
26/01/2017	8	5	-	-	-	<1	2	1.4
26/03/2017	<5	<5	-	-	-	<1	<1	<0.5
3/02/2021	8	6	<1	6	5	<1	2	<1
29/04/2021	11	6	<1	6	6	<1	3	2
RRSW11								
28/11/2016	38	<5	-	-	-	7	<1	11
20/12/2016	37	10	-	-	-	1	1	11
26/01/2017	14	6	-	-	-	<1	1	3
26/03/2017	5	<5	-	-	-	<1	2	1.4
30/06/2018	7	<5	-	-	-	<1	3	0.5
22/02/2019	1.8	11	-	-	-	<1	1	2.8
6/01/2021	22	7	<1	7	7	1	<1	4
3/02/2021	17	7	<1	7	7	<1	1	3
8/03/2021	25	10	<1	10	10	<1	1	4
29/04/2021	13	8	<1	8	8	2	4	3
14/05/2021	14	10	<1	10	10	<1	1	3
RRSW12								
20/12/2016	<5	6	-	-	-	<1	1	<0.5
26/01/2017	<5	7	-	-	-	<1	2	<0.5
26/03/2017	<5	9	-	-	-	<1	2	<0.5
3/02/2021	3	3	<1	3	2	<1	2	<1
8/03/2021	4	6	<1	6	5	<1	2	<1
29/04/2021	-	-	-	-	-	-	-	-
14/05/2021	-	-	-	-	-	-	-	-
RRSW22								
22/08/2012	13	<5	-	-	-	<1	3	0.7
9/12/2012	15	<5	-	-	-	<1	2	1.1
20/12/2016	<5	<5	-	-	-	<1	3	0.6
26/03/2017	<5	<5	-	-	-	<1	3	0.6
30/06/2018	7	<5	-	-	-	<1	2	<0.5
22/02/2019	1.9	<5	-	-	-	<1	2	<0.5
20/08/2019	10	<5	-	-	-	<1	2	<0.5
30/10/2019	9	<5	-	-	-	2	2	0.6
9/11/2020	5	5	<1	5	5	1	2	<1
3/02/2021	5	3	<1	3	2	2	2	<1
29/04/2021	4	4	<1	4	4	<1	4	<1
RRSW23								
4/12/2020	9	6	<1	6	6	<1	3	<1
7/01/2021	13	5	<1	5	5	1	3	2
3/02/2021	21	5	<1	5	4	3	3	2
8/03/2021	38	5	<1	5	5	8	3	5
29/04/2021	47	5	<1	5	5	13	4	5
14/05/2021	42	5	<1	5	5	11	3	5

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al_F	As_F	Cd_F	Cr_F	Co_F	Cu_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
RRSW2									
28/11/2016	0.9	1.9	1.8	0.16	0.007	<0.0001	<0.001	<0.001	0.001
26/01/2017	0.6	5.6	0.6	0.11	0.012	<0.0001	<0.001	0.001	0.002
26/03/2017	<0.5	9.6	1.4	<0.01	0.004	<0.0001	<0.001	<0.001	<0.001
22/02/2019	0.7	17	0.8	<0.01	0.015	<0.0001	<0.001	0.005	0.002
19/01/2020	1.9	4.3	4.1	0.44	0.012	<0.0001	<0.001	<0.001	0.002
16/02/2020	0.9	14	1	0.02	0.007	<0.0001	<0.001	0.003	0.002
4/12/2020	<1	<1	1	0.11	<0.001	<0.0001	<0.001	0.001	<0.001
6/01/2021	<1	16	<1	<0.01	0.01	<0.0001	<0.001	0.003	0.001
3/02/2021	<1	7	<1	0.19	0.009	<0.0001	<0.001	0.001	0.001
8/03/2021	<1	15	<1	0.12	0.067	<0.0001	0.004	0.005	<0.001
29/04/2021	<1	21	<1	0.07	0.046	<0.0001	0.002	0.007	<0.001
14/05/2021	<1	20	<1	0.15	0.073	<0.0001	0.004	0.005	<0.001
RRMCDS									
15/04/2021	<1	2	<1	0.18	<0.001	<0.0001	<0.001	<0.001	<0.001
RRMCUS									
15/04/2021	<1	2	<1	0.17	<0.001	<0.0001	<0.001	<0.001	0.002
RRSW5									
22/08/2012	12	0.7	1.1	0.01	0.011	<0.0001	<0.001	<0.001	0.001
9/12/2012	1	14	1.5	0.071	0.02	<0.0001	<0.001	<0.001	0.001
20/12/2016	<0.5	1.5	1	0.09	0.004	<0.0001	<0.001	<0.001	<0.001
26/03/2017	<0.5	0.6	1.3	0.03	0.002	<0.0001	<0.001	<0.001	<0.001
30/06/2018	0.7	7.7	0.9	<0.01	0.007	<0.0001	<0.001	<0.001	<0.001
22/02/2019	0.9	9.6	2.3	0.01	0.011	<0.0001	<0.001	<0.001	0.004
20/08/2019	1	18	3.1	0.01	0.012	<0.0001	<0.001	<0.001	0.003
30/10/2019	1.7	24	3	<0.01	0.024	<0.0001	<0.001	<0.001	0.001
16/02/2020	1.1	13	1.5	0.01	0.01	<0.0001	<0.001	<0.001	0.001
11/11/2020	2	23	3	<0.01	0.023	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	10	2	0.02	0.002	<0.0001	<0.001	<0.001	<0.001
29/04/2021	<1	6	<1	0.01	0.005	0.0001	<0.001	<0.001	<0.001
RRSW6									
9/12/2012	<0.5	1.8	1.4	0.033	0.002	<0.0001	<0.001	<0.001	0.001
20/12/2016	0.6	1.9	2.1	0.11	0.002	<0.0001	<0.001	<0.001	0.002
26/03/2017	<0.5	0.7	<0.5	0.05	<0.001	<0.0001	<0.001	<0.001	<0.001
30/06/2018	<0.5	0.9	<0.5	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	2	<1	0.22	0.001	<0.0001	<0.001	<0.001	0.002
29/04/2021	-	-	-	-	-	-	-	-	-
RRSW7									
20/12/2016	0.8	1.9	2.5	0.12	<0.001	<0.0001	<0.001	<0.001	0.001
26/01/2017	<0.5	1.3	<0.5	0.03	<0.001	<0.0001	<0.001	<0.001	<0.001
26/03/2017	<0.5	0.7	0.6	0.09	<0.001	<0.0001	<0.001	<0.001	<0.001
30/06/2018	1	1.2	1.8	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001
12/12/2018	0.7	1.2	<0.5	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001
22/02/2019	0.6	1.4	<0.5	<0.01	<0.001	<0.0001	<0.001	0.001	<0.001
20/08/2019	1.2	1.4	1.4	<0.01	<0.001	<0.0001	<0.001	0.003	<0.001
19/01/2020	0.6	1.5	0.9	0.09	<0.001	<0.0001	<0.001	0.002	<0.001
10/11/2020	<1	2	<1	<0.01	<0.001	<0.0001	<0.001	0.001	<0.001
3/02/2021	<1	2	<1	<0.01	<0.001	<0.0001	<0.001	0.001	<0.001

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al_F	As_F	Cd_F	Cr_F	Co_F	Cu_F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
29/04/2021	<1	1	<1	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001
RRSW10									
20/12/2016	1.1	1.9	2.1	0.02	0.008	<0.0001	<0.001	<0.001	<0.001
26/01/2017	0.5	1.6	1.3	0.05	0.002	<0.0001	<0.001	<0.001	0.002
26/03/2017	<0.5	<0.5	<0.5	0.04	<0.001	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	1	<1	<0.01	0.001	<0.0001	<0.001	<0.001	<0.001
29/04/2021	<1	2	<1	<0.01	0.002	<0.0001	<0.001	<0.001	<0.001
RRSW11									
28/11/2016	0.8	1.7	2.2	0.02	0.014	<0.0001	<0.001	<0.001	0.002
20/12/2016	1	2.5	1.7	0.01	0.009	<0.0001	<0.001	<0.001	0.001
26/01/2017	0.7	1.4	1.4	0.08	0.003	<0.0001	<0.001	<0.001	0.001
26/03/2017	<0.5	1.3	0.9	0.03	0.001	<0.0001	<0.001	<0.001	<0.001
30/06/2018	<0.5	2.4	1.6	<0.01	0.001	<0.0001	<0.001	<0.001	<0.001
22/02/2019	0.6	1.8	1.6	<0.01	0.003	<0.0001	<0.001	0.004	0.002
6/01/2021	<1	2	1	<0.01	0.002	<0.0001	<0.001	0.002	0.002
3/02/2021	<1	2	1	<0.01	0.003	<0.0001	<0.001	0.003	0.001
8/03/2021	<1	2	1	<0.01	0.004	<0.0001	<0.001	0.004	<0.001
29/04/2021	<1	2	<1	<0.01	0.003	<0.0001	<0.001	0.003	<0.001
14/05/2021	<1	2	1	0.04	0.004	<0.0001	<0.001	0.003	<0.001
RRSW12									
20/12/2016	<0.5	1	1	0.07	<0.001	<0.0001	<0.001	<0.001	0.001
26/01/2017	<0.5	1.8	<0.5	0.14	<0.001	<0.0001	<0.001	<0.001	0.001
26/03/2017	<0.5	1.1	<0.5	0.14	0.001	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	2	<1	0.05	<0.001	<0.0001	<0.001	<0.001	<0.001
8/03/2021	<1	2	<1	0.05	<0.001	<0.0001	<0.001	<0.001	<0.001
29/04/2021	-	-	-	-	-	-	-	-	-
14/05/2021	-	-	-	-	-	-	-	-	-
RRSW22									
22/08/2012	2.6	0.7	1.5	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
9/12/2012	0.8	2.3	1.6	0.02	0.001	<0.0001	<0.001	<0.001	<0.001
20/12/2016	0.8	2.1	1.3	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
26/03/2017	0.6	1.7	1.1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
30/06/2018	0.5	1.7	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
22/02/2019	0.7	1.9	1.3	<0.01	<0.001	<0.0001	<0.001	<0.001	0.001
20/08/2019	0.7	1.9	1.2	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
30/10/2019	0.8	2.2	1.4	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
9/11/2020	<1	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
29/04/2021	<1	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001
RRSW23									
4/12/2020	1	2	3	0.25	0.001	<0.0001	<0.001	<0.001	<0.001
7/01/2021	<1	4	<1	0.07	0.002	<0.0001	<0.001	<0.001	<0.001
3/02/2021	<1	7	<1	0.15	0.006	<0.0001	<0.001	<0.001	<0.001
8/03/2021	<1	12	<1	0.24	0.051	<0.0001	0.003	0.004	<0.001
29/04/2021	<1	22	1	0.32	0.022	<0.0001	0.001	0.005	<0.001
14/05/2021	<1	18	<1	0.39	0.042	<0.0001	0.002	0.004	0.005

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium Al	Arsenic
Analyte Short Name	Pb_F	Mn_F	Ni_F	Se_F	Sn_F	U_F	Zn_F	Fe_F	Al_T	As_T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
RRSW2										
28/11/2016	<0.001	0.012	<0.001	-	-	<0.0005	0.002	0.25	0.72	0.014
26/01/2017	<0.001	0.032	<0.001	-	-	<0.0005	0.01	0.19	0.31	0.017
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.05	0.01	0.007
22/02/2019	<0.001	0.036	<0.001	-	-	<0.0005	<0.001	0.17	0.12	0.049
19/01/2020	<0.001	0.023	0.002	-	-	<0.0005	0.03	1.5	0.44	0.051
16/02/2020	<0.001	0.084	0.001	-	-	<0.0005	0.014	0.33	0.27	0.025
4/12/2020	<0.001	0.207	<0.001	<0.01	<0.001	<0.001	<0.005	0.06	0.31	<0.001
6/01/2021	<0.001	0.047	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	1.21	0.027
3/02/2021	<0.001	0.035	<0.001	<0.01	<0.001	<0.001	<0.005	0.32	0.58	0.014
8/03/2021	<0.001	0.033	<0.001	<0.01	<0.001	<0.001	<0.005	0.31	0.22	0.087
29/04/2021	<0.001	0.073	<0.001	<0.01	<0.001	<0.001	<0.005	0.55	0.17	0.066
14/05/2021	<0.001	0.054	<0.001	<0.01	<0.001	<0.001	<0.005	0.82	0.16	0.078
RRMCDS										
15/04/2021	<0.001	0.022	<0.001	<0.01	<0.001	<0.001	<0.005	0.42	0.16	<0.001
RRMCUS										
15/04/2021	<0.001	0.045	<0.001	<0.01	<0.001	<0.001	<0.005	1.07	0.53	<0.001
RRSW5										
22/08/2012	<0.001	0.006	0.001	<0.001	-	<0.0005	0.011	0.049	0.038	0.012
9/12/2012	<0.001	0.17	<0.001	<0.001	-	<0.0005	0.023	0.072	0.066	0.025
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.14	1.8	0.008
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.08	0.07	0.003
30/06/2018	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.26	0.1	0.015
22/02/2019	0.002	0.16	0.002	-	-	<0.0005	0.19	0.32	0.03	0.018
20/08/2019	<0.001	0.18	<0.001	-	-	<0.0005	0.054	0.47	0.07	0.02
30/10/2019	<0.001	0.14	0.002	-	-	<0.0005	0.008	0.08	0.03	0.03
16/02/2020	<0.001	<0.005	0.001	-	-	<0.0005	0.001	0.01	0.03	0.011
11/11/2020	<0.001	0.093	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.04	0.028
3/02/2021	<0.001	0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.08	0.003
29/04/2021	<0.001	0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.02	0.006
RRSW6										
9/12/2012	<0.001	0.018	<0.001	<0.001	-	<0.0005	0.015	0.19	0.058	0.002
20/12/2016	<0.001	0.023	<0.001	-	-	<0.0005	0.003	0.21	0.23	0.003
26/03/2017	<0.001	0.015	<0.001	-	-	<0.0005	<0.001	0.19	0.06	<0.001
30/06/2018	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.16	0.05	0.002
3/02/2021	<0.001	0.023	<0.001	<0.01	<0.001	<0.001	0.026	0.14	0.5	0.001
29/04/2021	-	-	-	-	-	-	-	-	-	-
RRSW7										
20/12/2016	<0.001	0.18	<0.001	-	-	<0.0005	0.002	0.14	0.22	<0.001
26/01/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.09	0.05	<0.001
26/03/2017	<0.001	0.094	<0.001	-	-	<0.0005	<0.001	0.22	0.19	<0.001
30/06/2018	<0.001	0.47	<0.001	-	-	<0.0005	<0.001	0.06	0.02	<0.001
12/12/2018	<0.001	0.54	<0.001	-	-	<0.0005	<0.001	0.06	0.03	<0.001
22/02/2019	<0.001	0.24	<0.001	-	-	<0.0005	<0.001	0.08	0.02	<0.001
20/08/2019	<0.001	0.64	<0.001	-	-	<0.0005	0.001	0.13	0.03	<0.001
19/01/2020	<0.001	0.33	<0.001	-	-	<0.0005	0.006	0.41	0.12	<0.001
10/11/2020	<0.001	0.794	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.1	0.001
3/02/2021	<0.001	0.595	<0.001	<0.01	<0.001	<0.001	<0.005	0.06	0.04	<0.001

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium Al	Arsenic
Analyte Short Name	Pb_F	Mn_F	Ni_F	Se_F	Sn_F	U_F	Zn_F	Fe_F	Al_T	As_T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
29/04/2021	<0.001	0.698	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.01	<0.001
RRSW10										
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.05	1.8	0.014
26/01/2017	<0.001	<0.005	0.002	-	-	<0.0005	0.006	0.21	0.2	0.004
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.06	0.09	0.001
3/02/2021	<0.001	0.059	<0.001	<0.01	<0.001	<0.001	<0.005	0.22	0.07	0.002
29/04/2021	<0.001	0.095	<0.001	<0.01	<0.001	<0.001	<0.005	0.52	0.01	0.002
RRSW11										
28/11/2016	<0.001	0.024	<0.001	-	-	<0.0005	<0.001	0.06	0.51	0.016
20/12/2016	<0.001	0.038	<0.001	-	-	<0.0005	<0.001	0.04	0.89	0.01
26/01/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.003	0.36	0.28	0.006
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.18	0.88	0.012
30/06/2018	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.06	0.06	0.002
22/02/2019	<0.001	0.65	<0.001	-	-	<0.0005	0.001	0.23	0.01	0.005
6/01/2021	<0.001	0.283	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.34	0.003
3/02/2021	<0.001	0.457	<0.001	<0.01	<0.001	<0.001	<0.005	0.12	0.06	0.003
8/03/2021	<0.001	0.518	<0.001	<0.01	<0.001	<0.001	<0.005	0.76	0.05	0.004
29/04/2021	<0.001	0.359	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.01	0.004
14/05/2021	<0.001	0.453	<0.001	<0.01	<0.001	<0.001	<0.005	1.01	0.09	0.004
RRSW12										
20/12/2016	<0.001	0.018	<0.001	-	-	<0.0005	0.002	0.05	0.36	<0.001
26/01/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.13	0.32	<0.001
26/03/2017	<0.001	0.018	<0.001	-	-	<0.0005	<0.001	0.15	0.27	0.002
3/02/2021	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	0.06	0.14	<0.001
8/03/2021	<0.001	0.007	<0.001	<0.01	<0.001	<0.001	<0.005	0.12	0.2	<0.001
29/04/2021	-	-	-	-	-	-	-	-	-	-
14/05/2021	-	-	-	-	-	-	-	-	-	-
RRSW22										
22/08/2012	<0.001	0.007	<0.001	<0.001	-	<0.0005	0.018	0.012	0.022	0.001
9/12/2012	<0.001	<0.005	<0.001	<0.001	-	<0.0005	0.015	<0.01	0.038	0.002
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	<0.01	0.02	0.002
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	0.02	0.001
30/06/2018	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	<0.01	0.001
22/02/2019	<0.001	0.014	<0.001	-	-	<0.0005	0.005	0.02	<0.01	0.001
20/08/2019	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	0.04	0.003
30/10/2019	<0.001	<0.005	<0.001	-	-	<0.0005	0.027	<0.01	0.03	<0.001
9/11/2020	<0.001	0.004	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001
3/02/2021	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001
29/04/2021	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.01	<0.001
RRSW23										
4/12/2020	<0.001	0.02	<0.001	<0.01	<0.001	<0.001	<0.005	0.51	0.57	0.003
7/01/2021	<0.001	0.003	<0.001	<0.01	<0.001	<0.001	<0.005	0.25	5.54	0.007
3/02/2021	<0.001	0.019	<0.001	<0.01	<0.001	<0.001	<0.005	0.27	0.61	0.009
8/03/2021	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	0.32	0.26	0.063
29/04/2021	<0.001	0.044	<0.001	<0.01	0.006	<0.001	<0.005	0.52	0.27	0.028
14/05/2021	<0.001	0.021	<0.001	<0.01	<0.001	<0.001	<0.005	0.66	0.27	0.043

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron	Ferrous Iron
Analyte Short Name	Cd_T	Cr_T	Co_T	Cu_T	Pb_T	Mn_T	Ni_T	Se_T	Sn_T	U_T	Zn_T	Fe_T	Ferrous Iron
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-	-
RRSW2													
28/11/2016	<0.0001	0.002	0.002	0.004	<0.001	0.18	0.001	-	-	<0.0005	0.007	1.6	-
26/01/2017	<0.0001	0.002	0.002	0.003	<0.001	0.056	0.001	-	-	<0.0005	0.015	0.73	-
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.095	<0.001	-	-	<0.0005	0.002	0.28	-
22/02/2019	<0.0001	0.002	0.006	0.001	<0.001	0.12	<0.001	-	-	<0.0005	0.001	1.5	-
19/01/2020	<0.0001	0.001	0.001	0.004	0.002	0.11	0.003	-	-	<0.0005	0.045	2.6	-
16/02/2020	<0.0001	0.002	0.004	0.003	<0.001	0.11	0.002	-	-	<0.0005	0.019	2.6	-
4/12/2020	<0.0001	<0.001	0.002	0.001	<0.001	0.279	<0.001	<0.01	<0.001	<0.001	<0.005	0.06	0.14
6/01/2021	<0.0001	0.003	0.004	0.001	<0.001	0.057	<0.001	<0.01	<0.001	<0.001	<0.005	1.76	<0.05
3/02/2021	<0.0001	0.002	0.002	0.001	<0.001	0.048	<0.001	<0.01	<0.001	<0.001	<0.005	1.28	0.17
8/03/2021	<0.0001	0.005	0.006	0.001	<0.001	0.032	<0.001	<0.01	<0.001	<0.001	<0.005	0.85	0.09
29/04/2021	<0.0001	0.003	0.008	0.001	<0.001	0.085	<0.001	<0.01	<0.001	<0.001	<0.005	1.18	0.61
14/05/2021	<0.0001	0.004	0.006	<0.001	<0.001	0.06	<0.001	<0.01	<0.001	<0.001	<0.005	1.07	0.27
RRMCDS													
15/04/2021	<0.0001	<0.001	<0.001	0.001	<0.001	0.024	<0.001	<0.01	<0.001	<0.001	<0.005	0.58	<0.05
RRMCUS													
15/04/2021	<0.0001	<0.001	<0.001	0.004	<0.001	0.054	<0.001	<0.01	<0.001	<0.001	<0.005	1.49	0.05
RRSW5													
22/08/2012	<0.0001	<0.001	<0.001	0.002	<0.001	0.051	0.001	<0.001	-	<0.0005	0.017	0.16	-
9/12/2012	<0.0001	<0.001	0.001	0.001	<0.001	0.2	0.002	<0.001	-	<0.0005	0.046	0.33	-
20/12/2016	<0.0001	0.003	0.002	0.005	0.001	0.077	0.002	-	-	<0.0005	0.009	2.2	-
26/03/2017	<0.0001	<0.001	<0.001	0.006	0.002	0.028	<0.001	-	-	<0.0005	0.005	0.48	-
30/06/2018	<0.0001	<0.001	0.002	0.002	<0.001	0.19	0.001	-	-	<0.0005	0.002	1.5	-
22/02/2019	<0.0001	<0.001	0.001	0.006	<0.001	0.33	0.004	-	-	<0.0005	0.28	0.88	-
20/08/2019	<0.0001	<0.001	0.001	0.006	<0.001	0.27	0.002	-	-	<0.0005	0.16	2.2	-
30/10/2019	<0.0001	<0.001	0.001	0.002	<0.001	0.2	0.002	-	-	<0.0005	0.036	0.49	-
16/02/2020	<0.0001	<0.001	0.001	0.002	<0.001	0.044	0.002	-	-	<0.0005	0.003	0.16	-
11/11/2020	<0.0001	<0.001	0.001	<0.001	<0.001	0.143	0.002	<0.01	<0.001	<0.001	<0.005	0.3	0.08
3/02/2021	<0.0001	0.002	0.002	0.002	<0.001	0.045	0.002	<0.01	<0.001	<0.001	<0.005	0.23	<0.05
29/04/2021	<0.0001	<0.001	0.001	<0.001	<0.001	0.051	<0.001	<0.01	<0.001	<0.001	0.022	0.07	<0.05
RRSW6													
9/12/2012	<0.0001	<0.001	<0.001	0.001	<0.001	0.031	<0.001	<0.001	-	<0.0005	0.014	0.53	-
20/12/2016	<0.0001	0.001	<0.001	0.002	<0.001	0.043	0.002	-	-	<0.0005	0.004	0.57	-
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.018	<0.001	-	-	<0.0005	<0.001	0.38	-
30/06/2018	<0.0001	<0.001	<0.001	<0.001	<0.001	0.041	<0.001	-	-	<0.0005	0.003	2.2	-
3/02/2021	<0.0001	<0.001	<0.001	0.001	<0.001	0.028	<0.001	<0.01	<0.001	<0.001	<0.005	0.34	0.08
29/04/2021	-	-	-	-	-	-	-	-	-	-	-	-	-
RRSW7													
20/12/2016	<0.0001	0.005	<0.001	0.002	<0.001	0.23	0.002	-	-	<0.0005	0.002	0.32	-
26/01/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.017	<0.001	-	-	<0.0005	<0.001	0.27	-
26/03/2017	<0.0001	<0.001	0.001	<0.001	<0.001	0.14	<0.001	-	-	<0.0005	<0.001	0.69	-
30/06/2018	<0.0001	<0.001	0.003	<0.001	<0.001	0.54	<0.001	-	-	<0.0005	0.003	0.98	-
12/12/2018	<0.0001	<0.001	0.002	<0.001	<0.001	0.57	<0.001	-	-	<0.0005	0.001	0.95	-
22/02/2019	<0.0001	<0.001	0.002	<0.001	<0.001	0.28	<0.001	-	-	<0.0005	0.003	0.64	-
20/08/2019	<0.0001	<0.001	0.003	<0.001	<0.001	0.69	<0.001	-	-	<0.0005	0.003	1.7	-
19/01/2020	<0.0001	<0.001	0.002	<0.001	<0.001	0.41	<0.001	-	-	<0.0005	0.002	1.2	-
10/11/2020	<0.0001	<0.001	0.002	<0.001	<0.001	0.967	<0.001	<0.01	<0.001	<0.001	<0.005	3.99	0.07
3/02/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.79	<0.001	<0.01	<0.001	<0.001	<0.005	1.44	<0.05

Table A.3 - Rustlers Roost Surface Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron	Ferrous Iron
Analyte Short Name	Cd_T	Cr_T	Co_T	Cu_T	Pb_T	Mn_T	Ni_T	Se_T	Sn_T	U_T	Zn_T	Fe_T	Ferrous Iron
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-	-
29/04/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.856	<0.001	<0.01	<0.001	<0.001	<0.005	0.54	0.08
RRSW10													
20/12/2016	<0.0001	0.004	0.002	0.008	0.001	0.23	0.003	-	-	<0.0005	0.02	4.9	-
26/01/2017	<0.0001	<0.001	<0.001	0.002	<0.001	0.11	0.001	-	-	<0.0005	0.018	0.83	-
26/03/2017	<0.0001	<0.001	<0.001	0.002	<0.001	0.11	<0.001	-	-	<0.0005	0.006	0.3	-
3/02/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.097	<0.001	<0.01	<0.001	<0.001	<0.005	1.4	0.05
29/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.094	<0.001	<0.01	<0.001	<0.001	<0.005	1.33	<0.05
RRSW11													
28/11/2016	<0.0001	0.002	0.001	0.004	<0.001	0.055	<0.001	-	-	<0.0005	0.004	1.8	-
20/12/2016	<0.0001	0.002	0.002	0.004	<0.001	0.092	0.001	-	-	<0.0005	0.006	3.2	-
26/01/2017	<0.0001	<0.001	<0.001	0.002	<0.001	0.071	<0.001	-	-	<0.0005	0.011	1.2	-
26/03/2017	<0.0001	0.002	0.004	0.007	0.002	1.2	0.003	-	-	0.0005	0.027	6.6	-
30/06/2018	<0.0001	<0.001	<0.001	0.002	<0.001	0.055	0.001	-	-	<0.0005	0.005	0.67	-
22/02/2019	<0.0001	<0.001	0.006	0.001	<0.001	0.81	<0.001	-	-	<0.0005	0.001	1	-
6/01/2021	<0.0001	<0.001	0.002	0.003	<0.001	0.308	<0.001	<0.01	<0.001	<0.001	<0.005	0.96	<0.05
3/02/2021	<0.0001	<0.001	0.004	0.002	<0.001	0.555	0.001	<0.01	<0.001	<0.001	<0.005	0.82	0.1
8/03/2021	<0.0001	<0.001	0.005	<0.001	<0.001	0.549	<0.001	<0.01	<0.001	<0.001	<0.005	0.95	0.79
29/04/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.359	<0.001	<0.01	<0.001	<0.001	<0.005	0.88	<0.05
14/05/2021	<0.0001	<0.001	0.004	<0.001	<0.001	0.476	<0.001	<0.01	<0.001	<0.001	<0.005	1.37	0.88
RRSW12													
20/12/2016	<0.0001	<0.001	<0.001	0.002	<0.001	0.025	<0.001	-	-	<0.0005	0.002	0.3	-
26/01/2017	<0.0001	<0.001	<0.001	0.001	<0.001	0.007	<0.001	-	-	<0.0005	0.003	0.29	-
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.028	<0.001	-	-	<0.0005	0.002	0.32	-
3/02/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.011	<0.001	<0.01	<0.001	<0.001	<0.005	0.17	<0.05
8/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.01	<0.001	<0.001	<0.005	0.32	0.06
29/04/2021	-	-	-	-	-	-	-	-	-	-	-	-	-
14/05/2021	-	-	-	-	-	-	-	-	-	-	-	-	-
RRSW22													
22/08/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	0.021	<0.001	<0.001	-	<0.0005	0.015	0.046	-
9/12/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	0.013	<0.001	<0.001	-	<0.0005	0.035	0.063	-
20/12/2016	<0.0001	<0.001	<0.001	<0.001	<0.001	0.019	<0.001	-	-	<0.0005	0.006	0.04	-
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.022	<0.001	-	-	<0.0005	0.002	0.03	-
30/06/2018	<0.0001	<0.001	<0.001	<0.001	<0.001	0.15	<0.001	-	-	<0.0005	0.004	0.16	-
22/02/2019	<0.0001	<0.001	<0.001	<0.001	<0.001	0.047	<0.001	-	-	<0.0005	0.002	0.05	-
20/08/2019	<0.0001	<0.001	0.001	0.001	<0.001	0.17	<0.001	-	-	<0.0005	0.002	0.67	-
30/10/2019	<0.0001	<0.001	<0.001	0.001	<0.001	0.02	<0.001	-	-	<0.0005	0.034	0.11	-
9/11/2020	<0.0001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	0.13	<0.05
3/02/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05
29/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.021	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	<0.05
RRSW23													
4/12/2020	<0.0001	<0.001	0.001	0.002	0.002	0.16	<0.001	<0.01	<0.001	<0.001	<0.005	1.01	1.26
7/01/2021	<0.0001	0.006	0.004	0.005	0.003	0.122	0.003	<0.01	<0.001	<0.001	<0.005	5.48	0.44
3/02/2021	<0.0001	0.001	0.002	0.007	<0.001	0.031	<0.001	<0.01	<0.001	<0.001	<0.005	1.14	0.34
8/03/2021	<0.0001	0.004	0.004	<0.001	<0.001	0.016	<0.001	<0.01	<0.001	<0.001	<0.005	0.76	0.08
29/04/2021	<0.0001	0.001	0.005	<0.001	<0.001	0.047	<0.001	<0.01	<0.001	<0.001	<0.005	0.79	0.34
14/05/2021	<0.0001	0.002	0.005	0.007	<0.001	0.023	<0.001	<0.01	<0.001	<0.001	<0.005	0.84	0.21

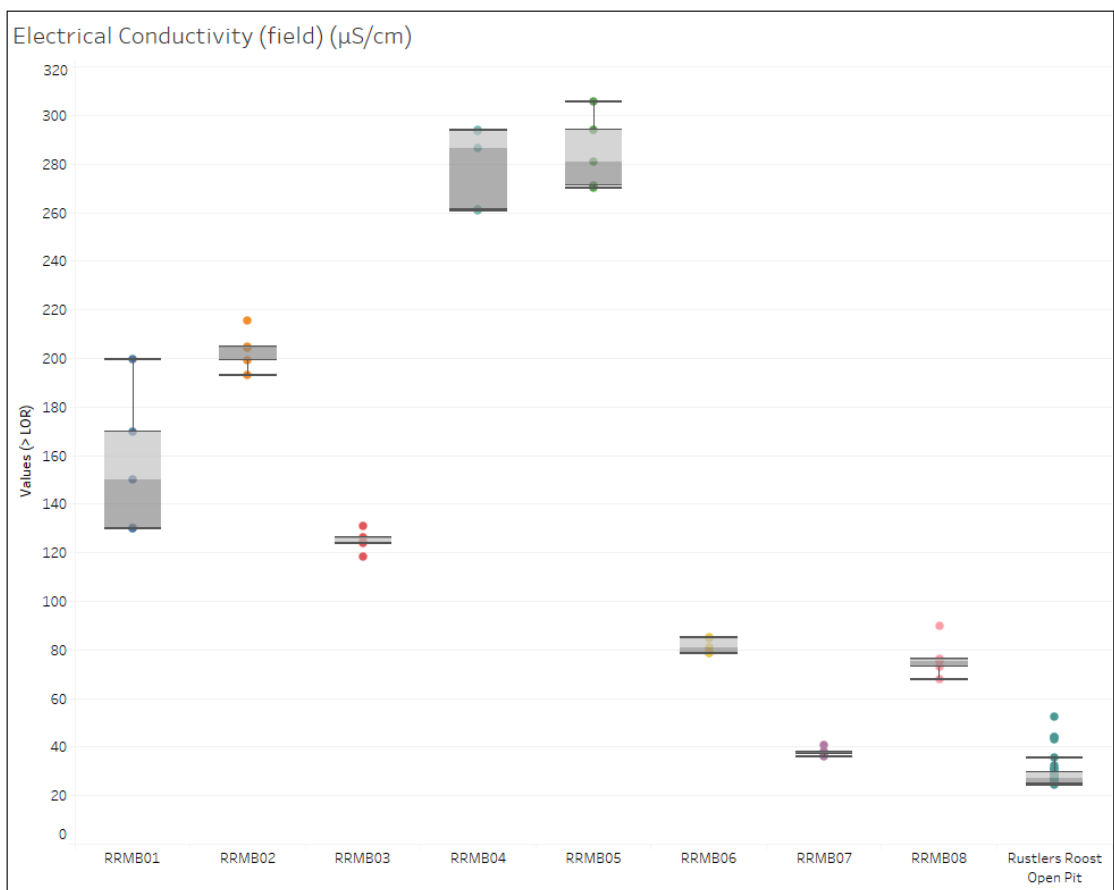
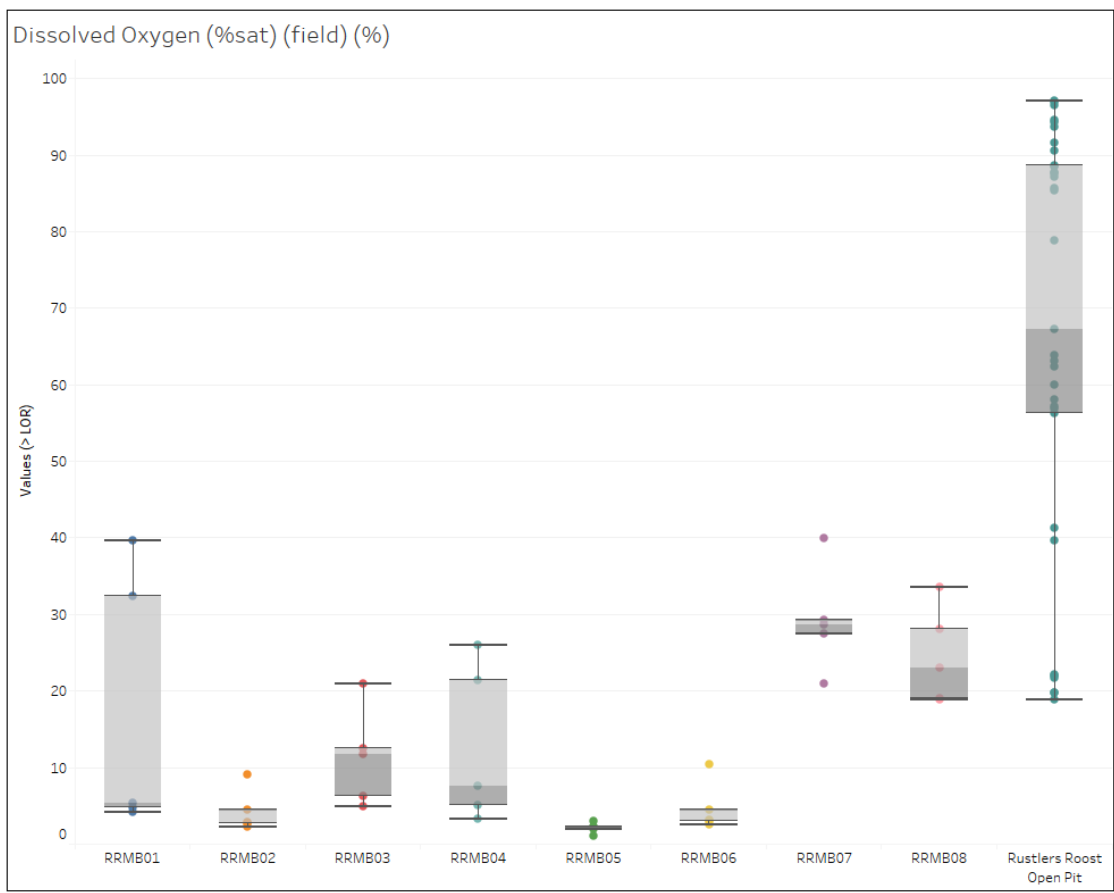
Table A.3 - Rustlers Roost Surface Water Quality

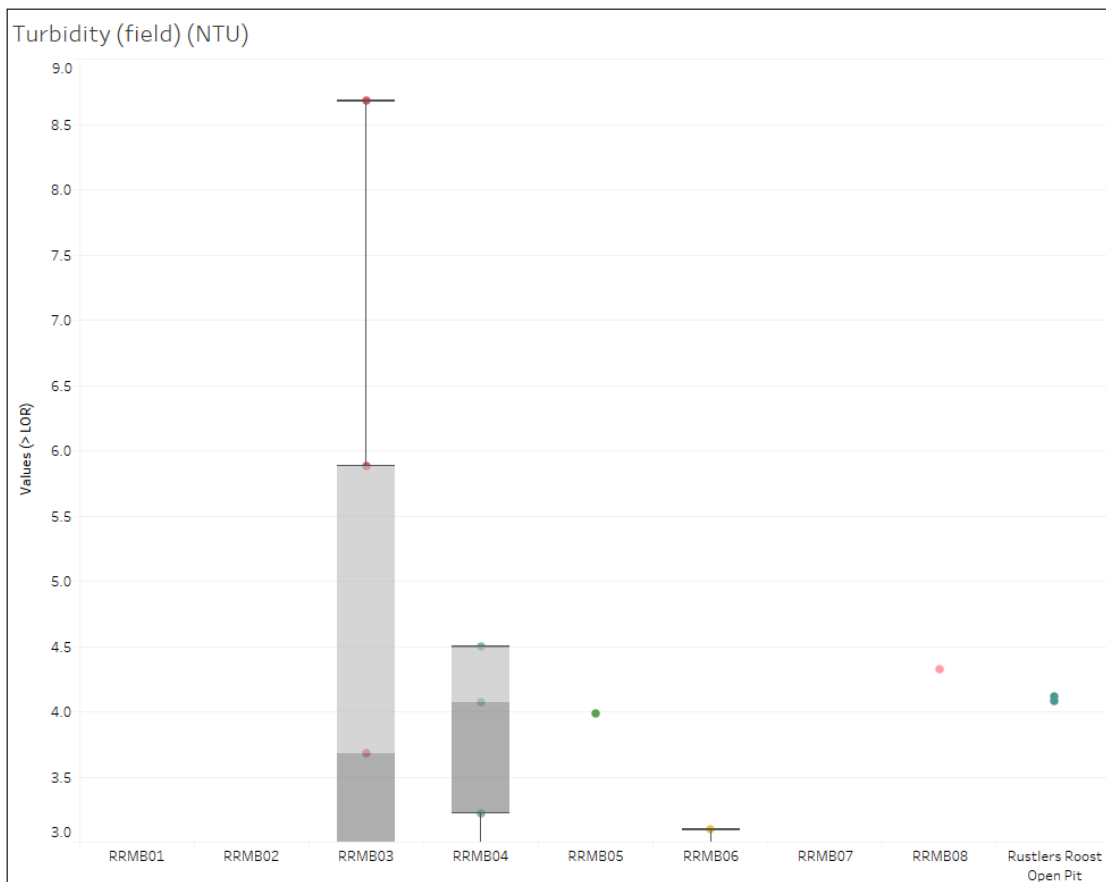
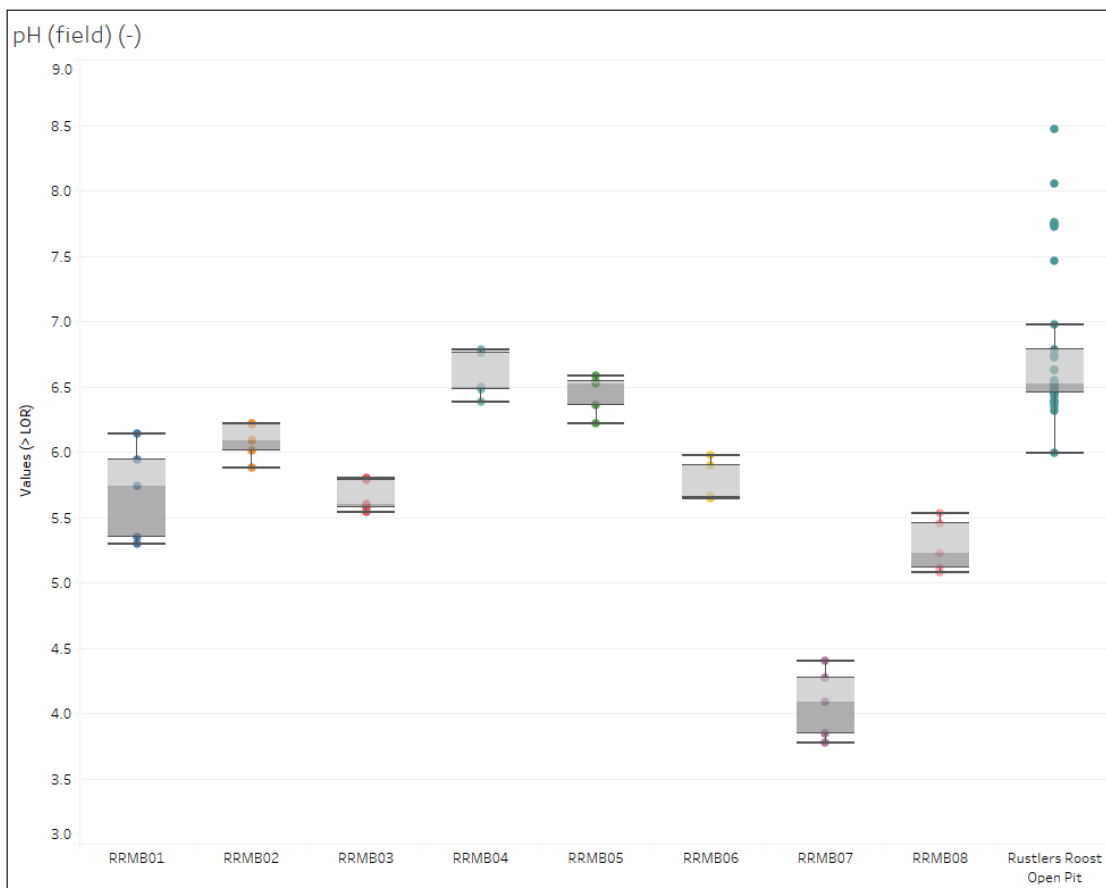
Analyte Group	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	NH3	Nox	TKN_N	TN_N	P_Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	1.4	-	-	-	-
Tropical Australia Lowland Rivers	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	5	0.05
RRSW2					
28/11/2016	-	-	-	-	-
26/01/2017	-	-	-	-	-
26/03/2017	-	-	-	-	-
22/02/2019	-	-	-	-	-
19/01/2020	-	-	-	-	-
16/02/2020	-	-	-	-	-
4/12/2020	0.09	0.77	1.5	2.3	0.32
6/01/2021	0.05	0.19	0.3	0.5	0.02
3/02/2021	0.02	0.04	0.2	0.2	<0.01
8/03/2021	0.06	0.22	0.2	0.4	0.04
29/04/2021	0.06	0.09	0.3	0.4	0.05
14/05/2021	0.1	0.11	0.2	0.3	0.03
RRMCDS					
15/04/2021	0.11	0.01	0.3	0.3	<0.01
RRMCUS					
15/04/2021	0.17	0.02	0.4	0.4	0.02
RRSW5					
22/08/2012	-	-	-	-	-
9/12/2012	-	-	-	-	-
20/12/2016	-	-	-	-	-
26/03/2017	-	-	-	-	-
30/06/2018	-	-	-	-	-
22/02/2019	-	-	-	-	-
20/08/2019	-	-	-	-	-
30/10/2019	-	-	-	-	-
16/02/2020	-	-	-	-	-
11/11/2020	<0.01	0.04	1.7	1.7	0.04
3/02/2021	0.97	0.21	1.3	1.5	0.04
29/04/2021	<0.01	<0.01	0.6	0.6	0.01
RRSW6					
9/12/2012	-	-	-	-	-
20/12/2016	-	-	-	-	-
26/03/2017	-	-	-	-	-
30/06/2018	-	-	-	-	-
3/02/2021	0.02	0.06	0.3	0.4	<0.01
29/04/2021	-	-	-	-	-
RRSW7					
20/12/2016	-	-	-	-	-
26/01/2017	-	-	-	-	-
26/03/2017	-	-	-	-	-
30/06/2018	-	-	-	-	-
12/12/2018	-	-	-	-	-
22/02/2019	-	-	-	-	-
20/08/2019	-	-	-	-	-
19/01/2020	-	-	-	-	-
10/11/2020	1.02	0.08	1.1	1.2	<0.01
3/02/2021	0.91	0.05	1	1	<0.01

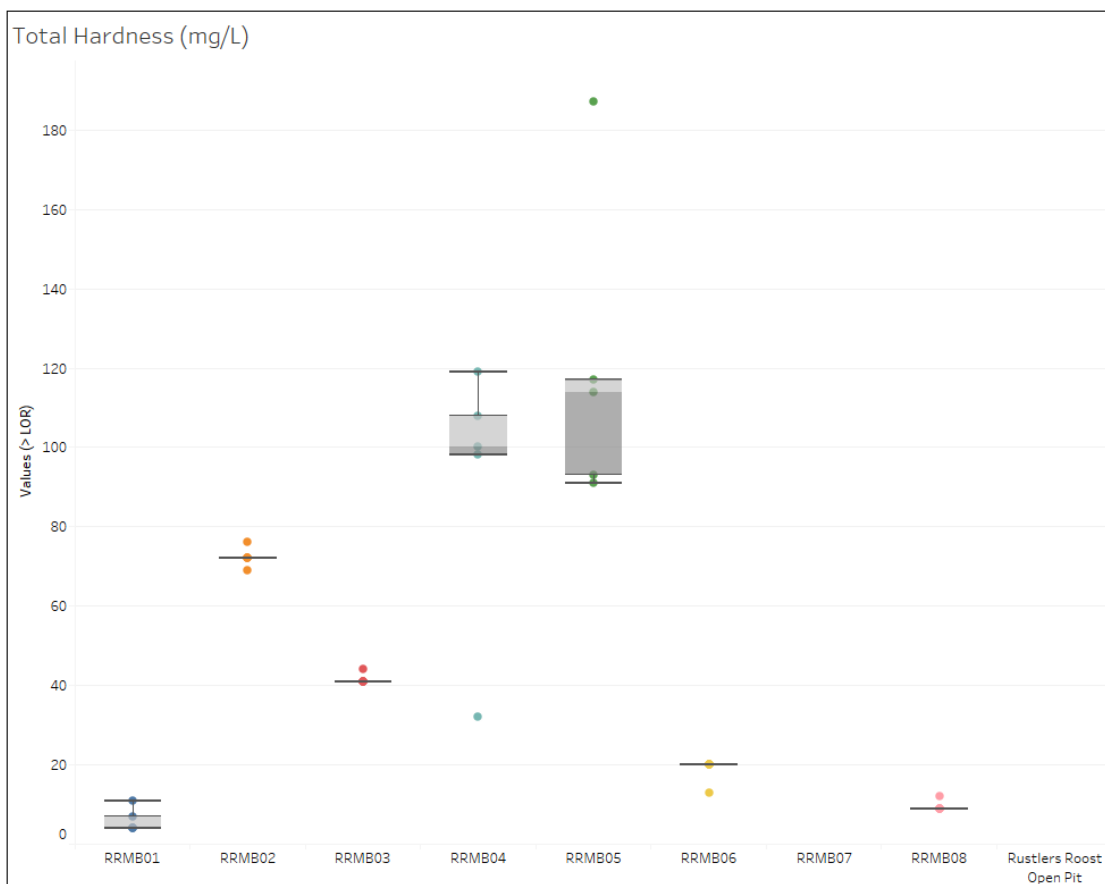
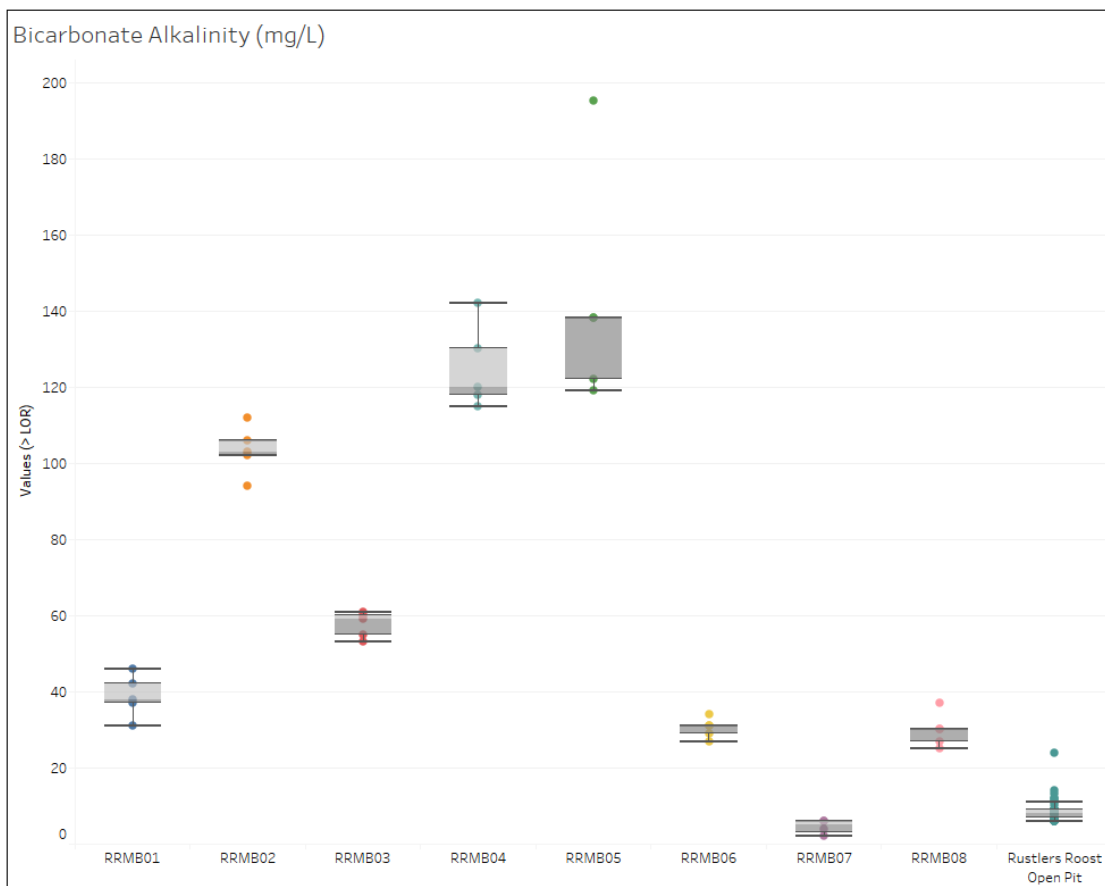
Table A.3 - Rustlers Roost Surface Water Quality

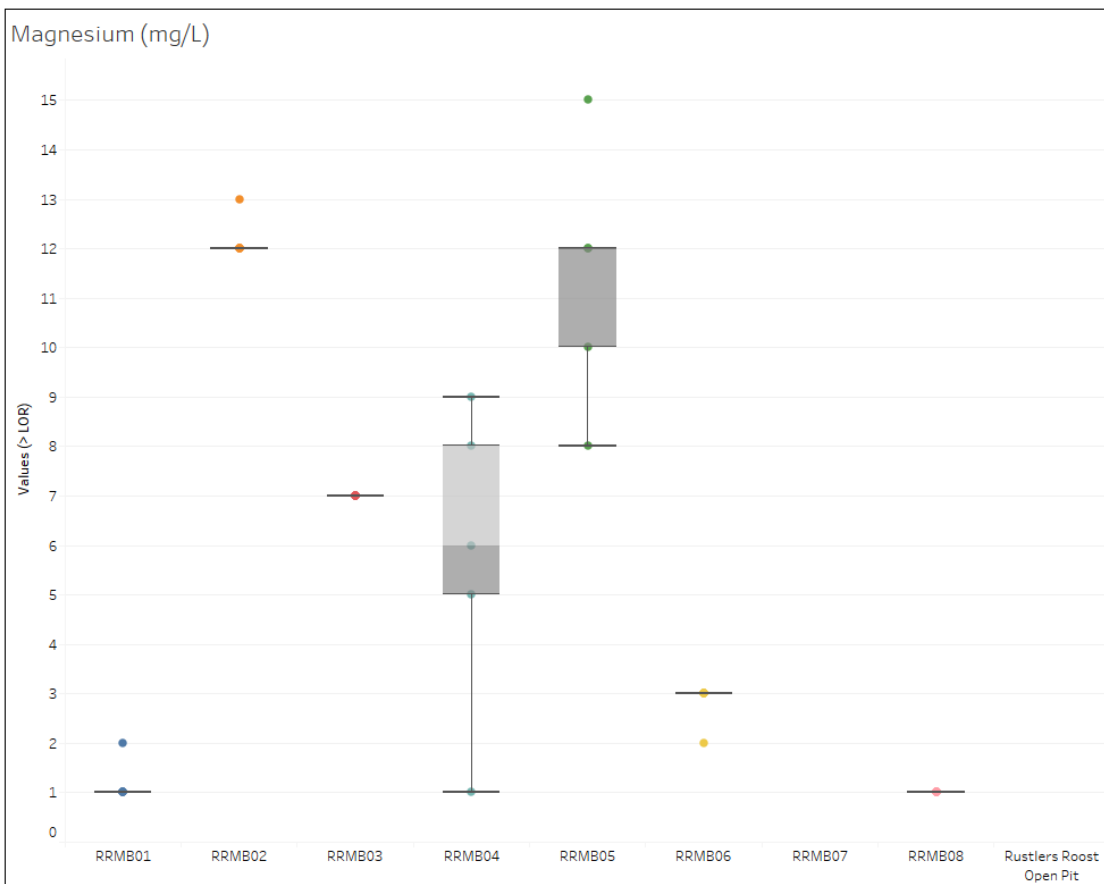
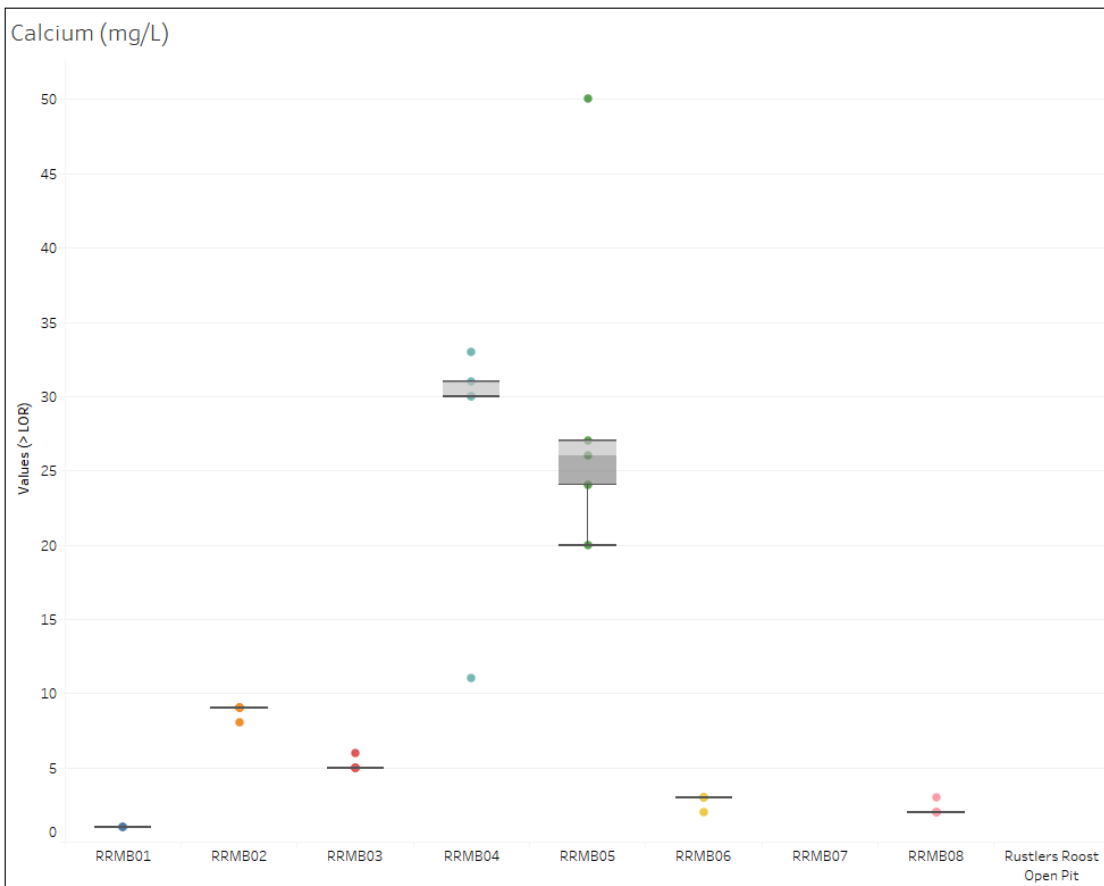
Analyte Group	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	NH3	Nox	TKN_N	TN_N	P_Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	1.4	-	-	-	-
Tropical Australia Lowland Rivers	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	5	0.05
29/04/2021	1.06	<0.01	1.2	1.2	<0.01
RRSW10					
20/12/2016	-	-	-	-	-
26/01/2017	-	-	-	-	-
26/03/2017	-	-	-	-	-
3/02/2021	0.04	0.23	0.2	0.4	0.01
29/04/2021	0.02	0.02	0.4	0.4	0.02
RRSW11					
28/11/2016	-	-	-	-	-
20/12/2016	-	-	-	-	-
26/01/2017	-	-	-	-	-
26/03/2017	-	-	-	-	-
30/06/2018	-	-	-	-	-
22/02/2019	-	-	-	-	-
6/01/2021	0.11	0.02	0.2	0.2	<0.01
3/02/2021	0.08	0.04	0.2	0.2	<0.01
8/03/2021	0.11	0.02	0.2	0.2	<0.01
29/04/2021	0.08	<0.01	0.2	0.2	0.01
14/05/2021	0.26	<0.01	0.3	0.3	<0.01
RRSW12					
20/12/2016	-	-	-	-	-
26/01/2017	-	-	-	-	-
26/03/2017	-	-	-	-	-
3/02/2021	<0.01	0.02	<0.1	<0.1	<0.01
8/03/2021	0.09	0.03	0.3	0.3	<0.01
29/04/2021	-	-	-	-	-
14/05/2021	-	-	-	-	-
RRSW22					
22/08/2012	-	-	-	-	-
9/12/2012	-	-	-	-	-
20/12/2016	-	-	-	-	-
26/03/2017	-	-	-	-	-
30/06/2018	-	-	-	-	-
22/02/2019	-	-	-	-	-
20/08/2019	-	-	-	-	-
30/10/2019	-	-	-	-	-
9/11/2020	0.02	0.1	<0.1	0.1	<0.01
3/02/2021	<0.01	0.03	<0.1	<0.1	<0.01
29/04/2021	<0.01	<0.01	0.7	0.7	<0.01
RRSW23					
4/12/2020	0.02	0.13	2.4	2.5	0.29
7/01/2021	0.1	0.09	1	1.1	0.16
3/02/2021	<0.01	0.07	0.2	0.3	<0.01
8/03/2021	0.17	0.14	0.4	0.5	0.02
29/04/2021	0.02	0.01	0.3	0.3	0.02
14/05/2021	0.1	0.03	0.2	0.2	0.01

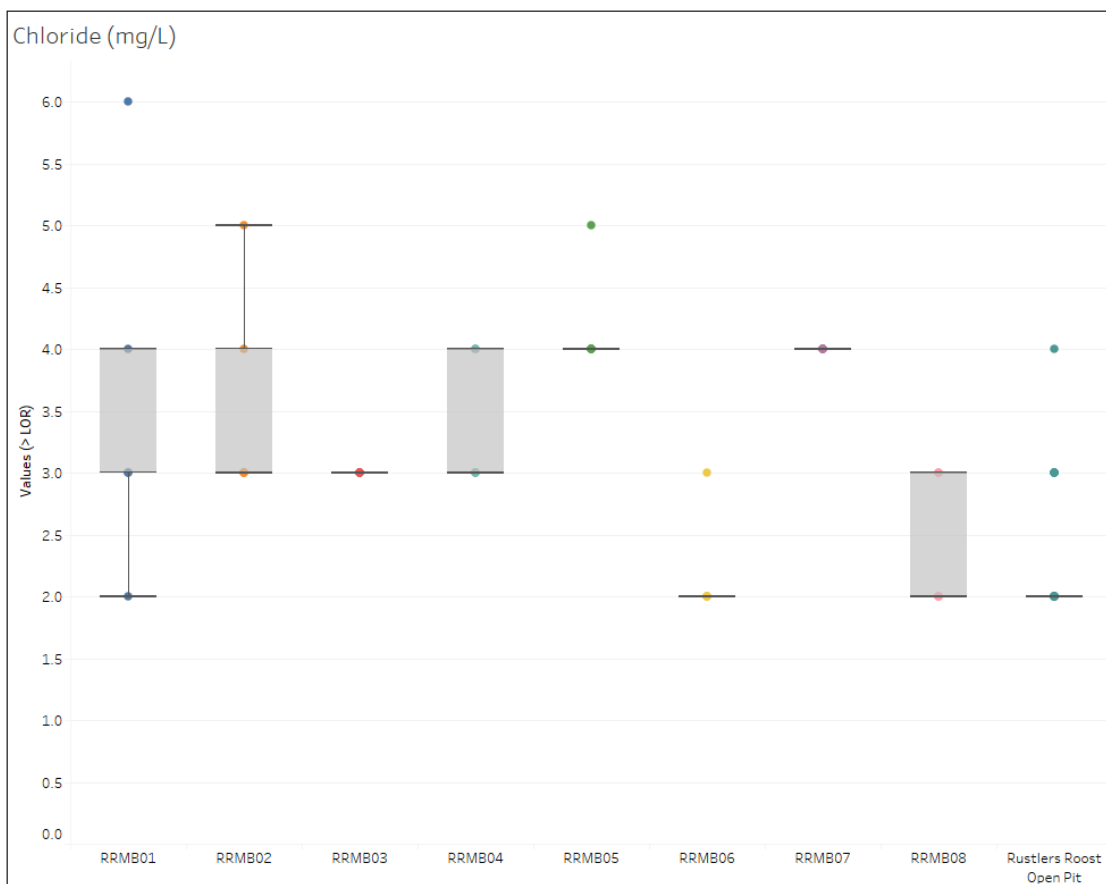
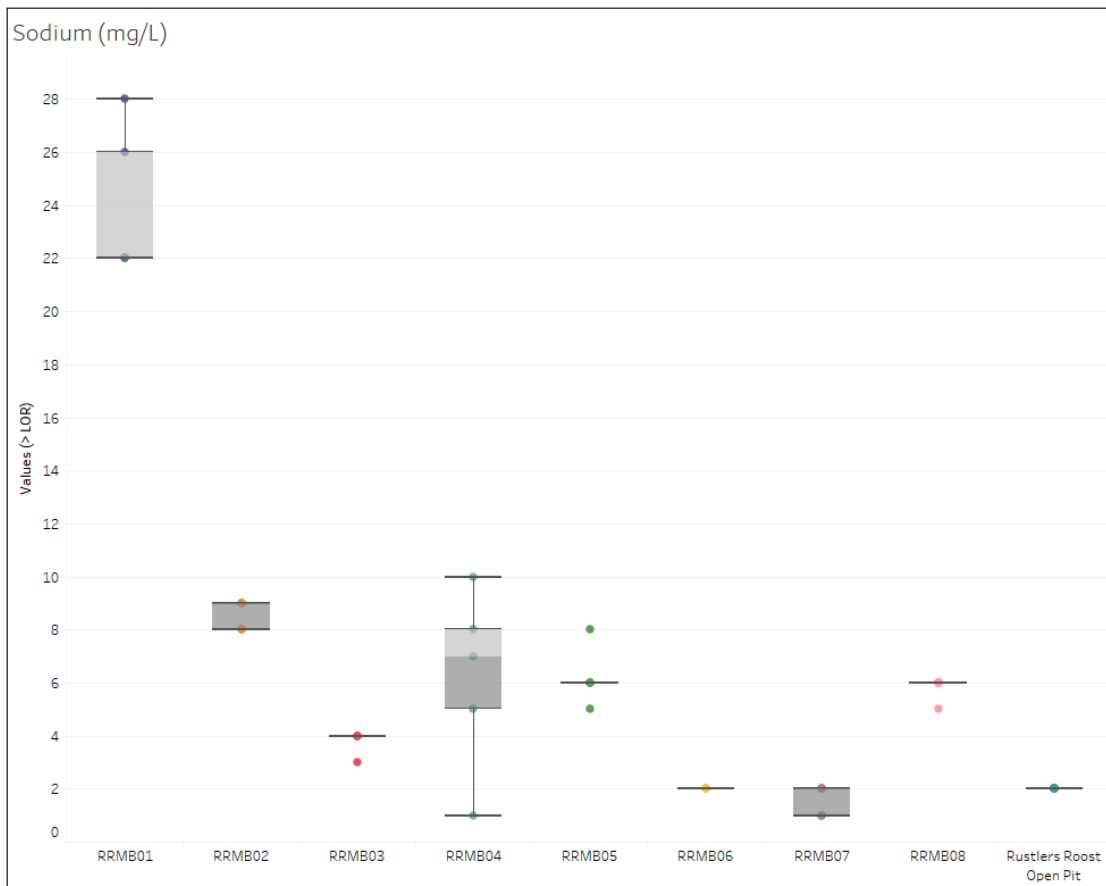
A.4 Rustlers Roost Groundwater Box & Whisker Plots (2020-2021)

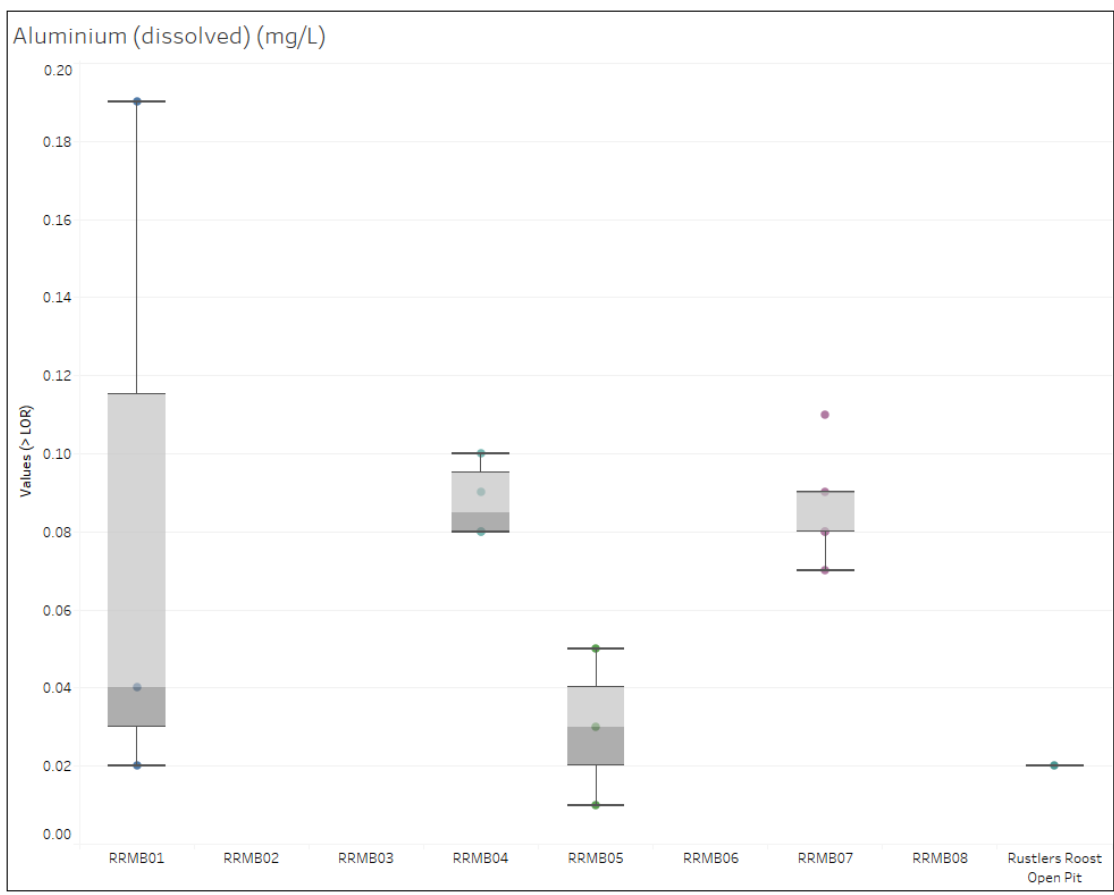
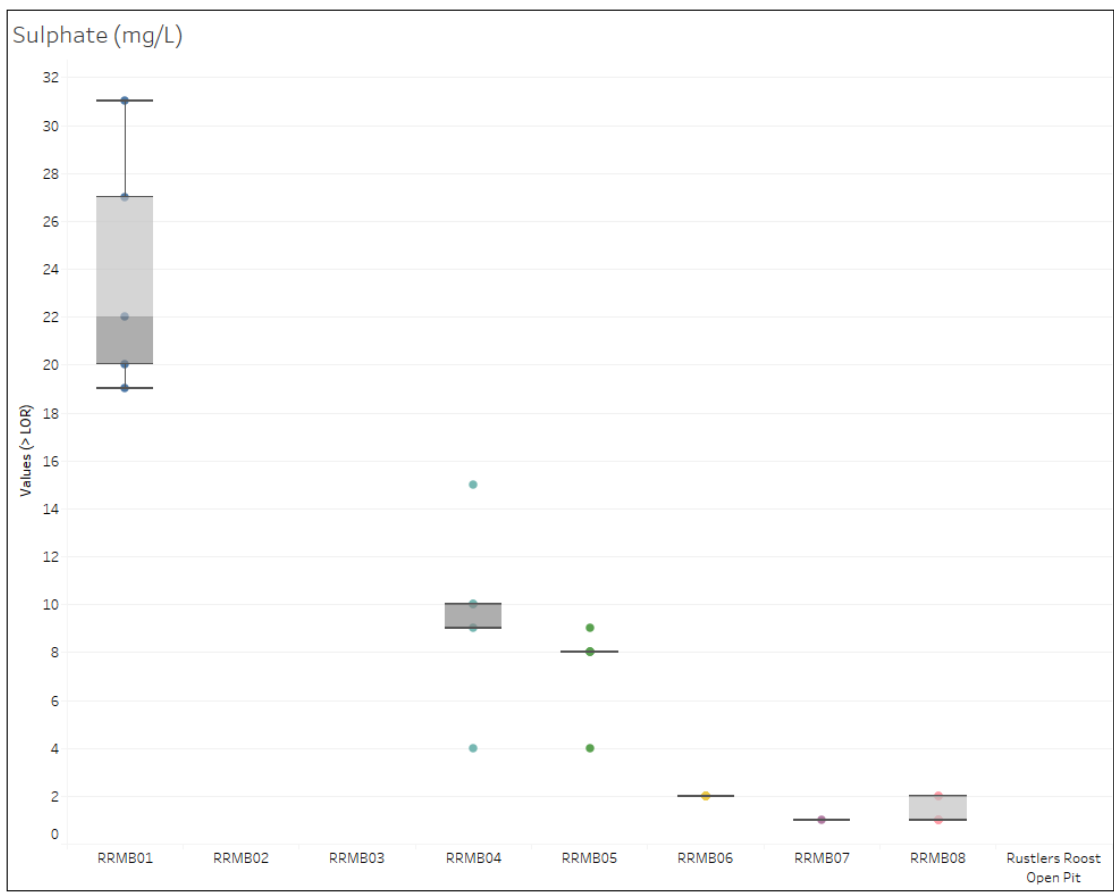


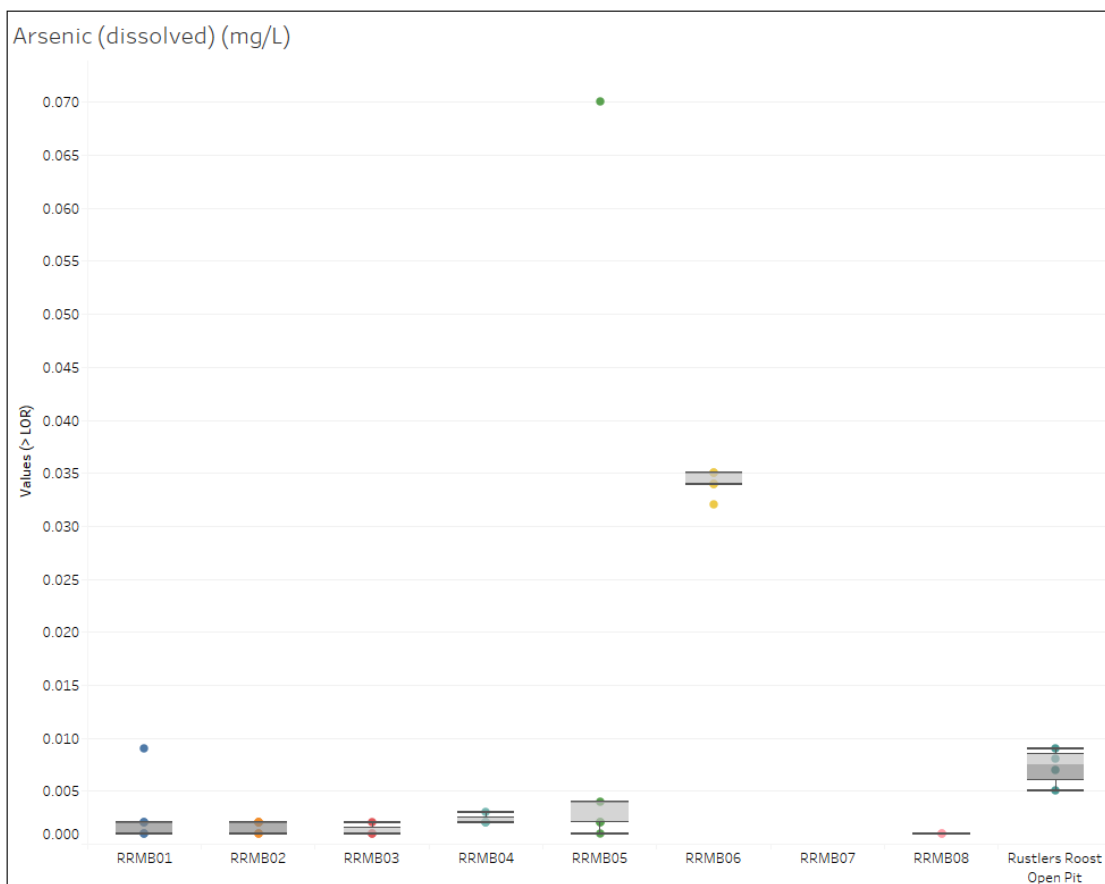
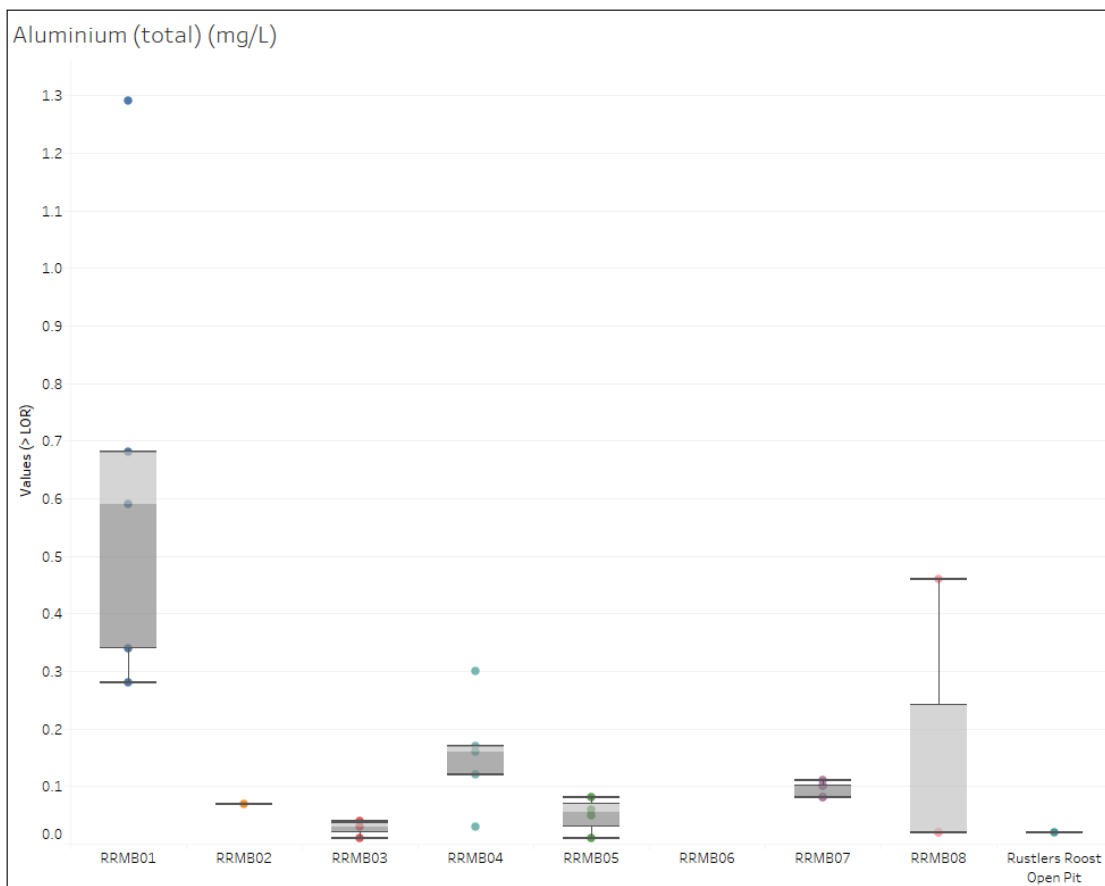


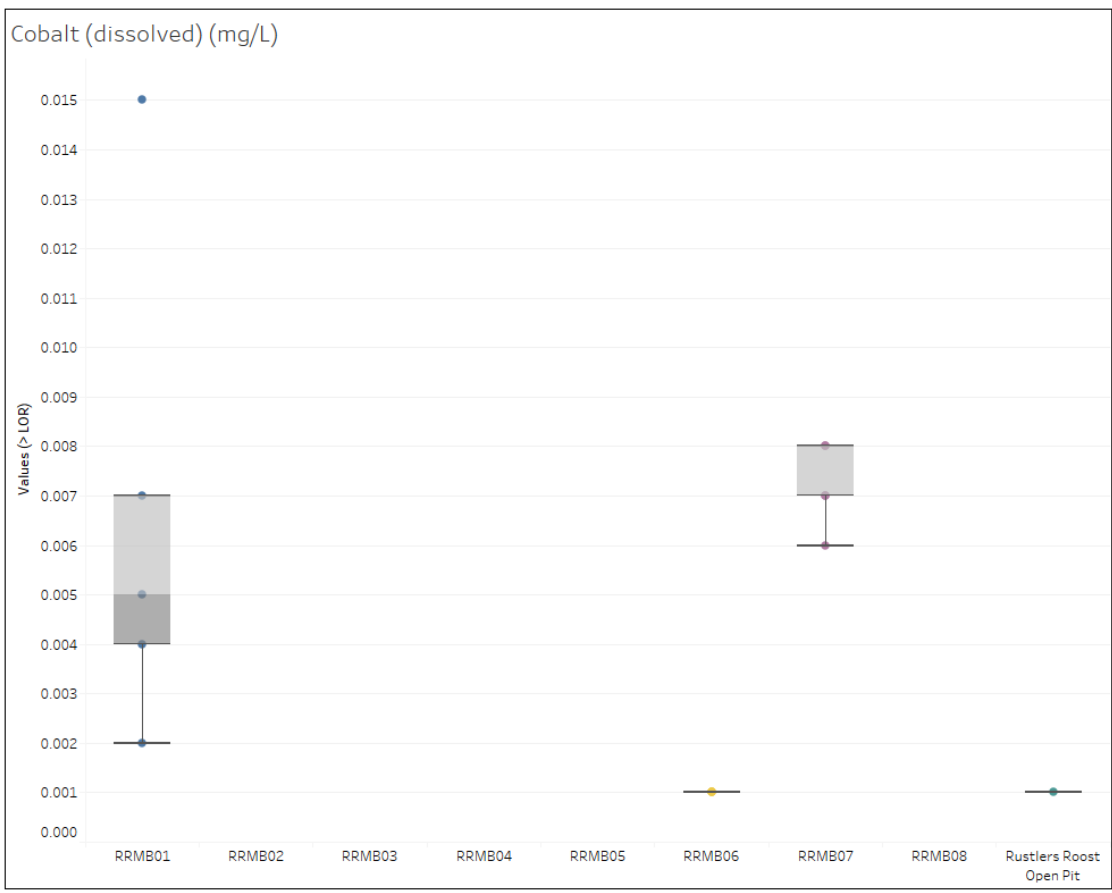
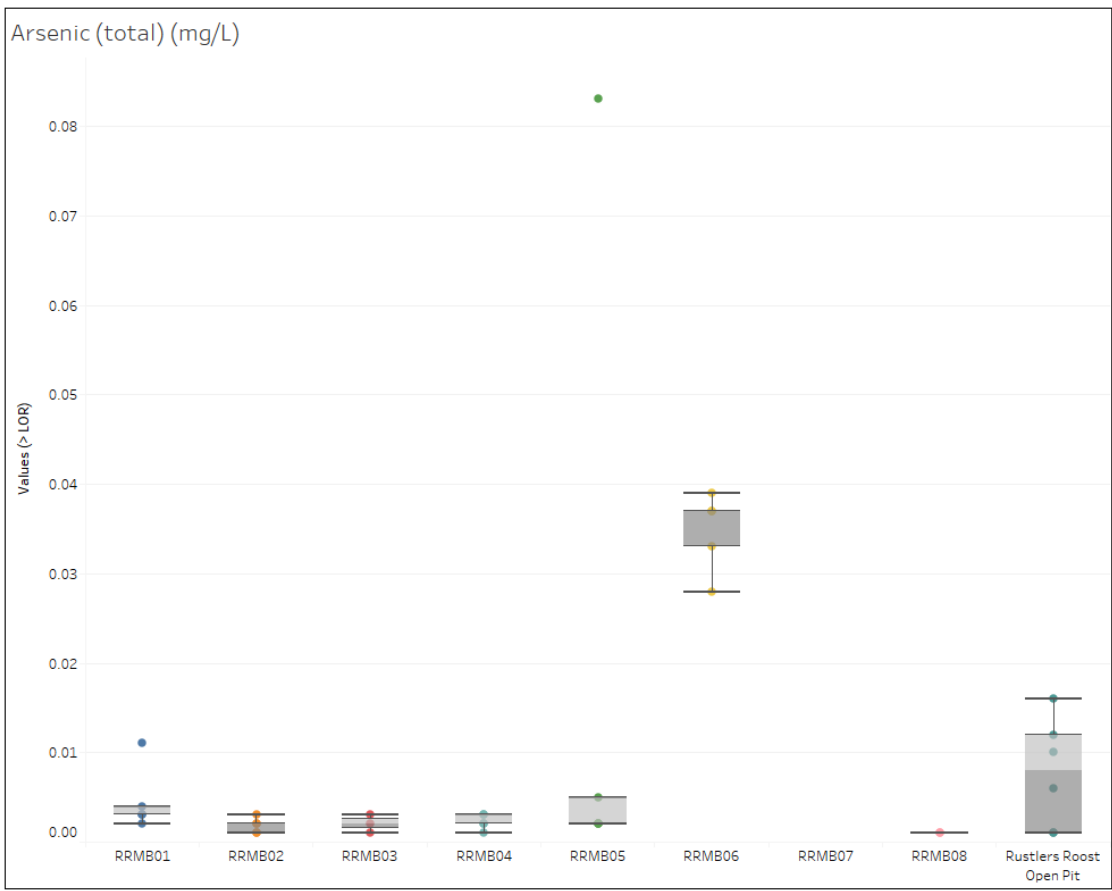


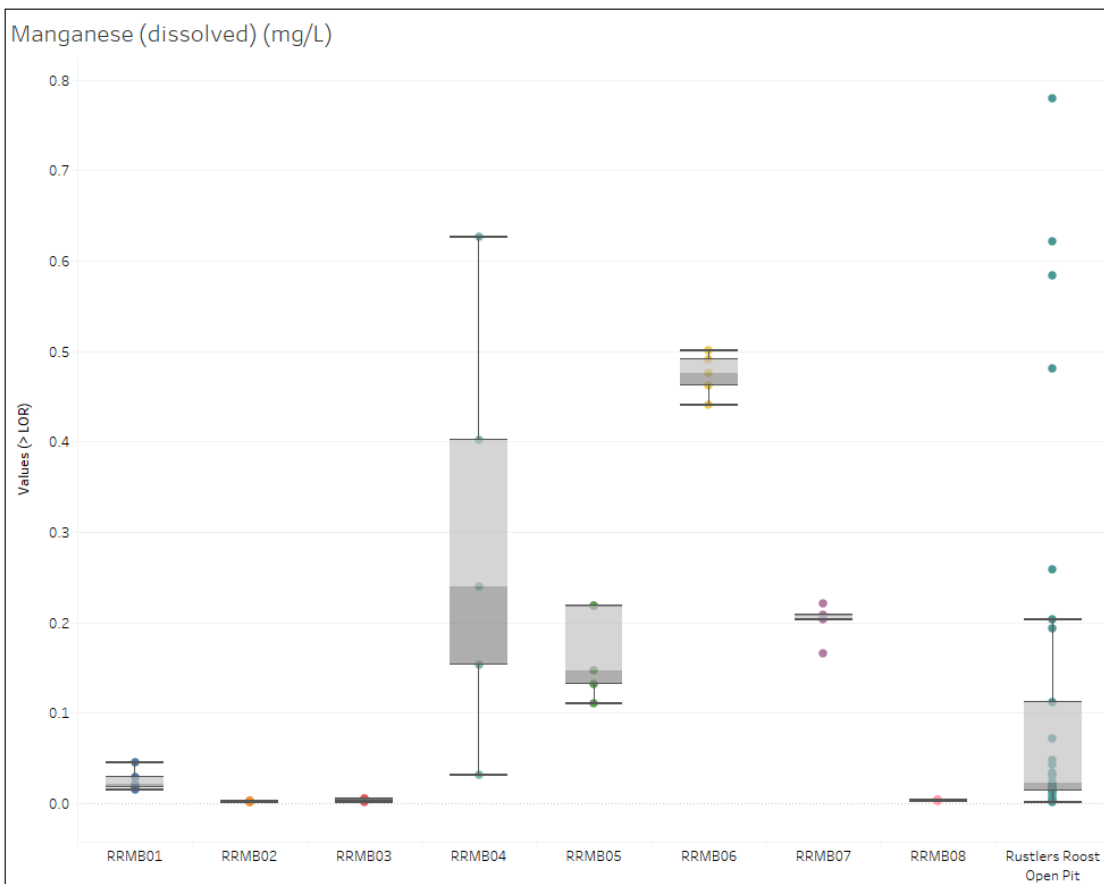
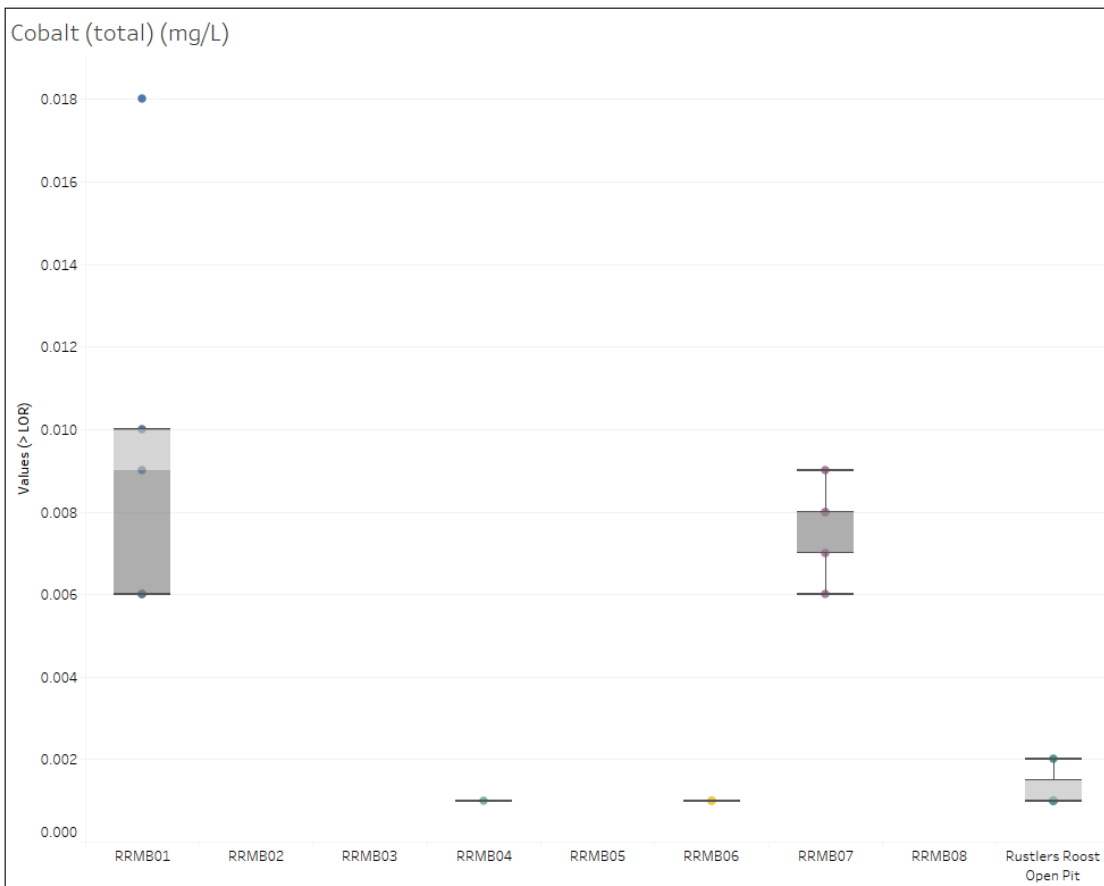


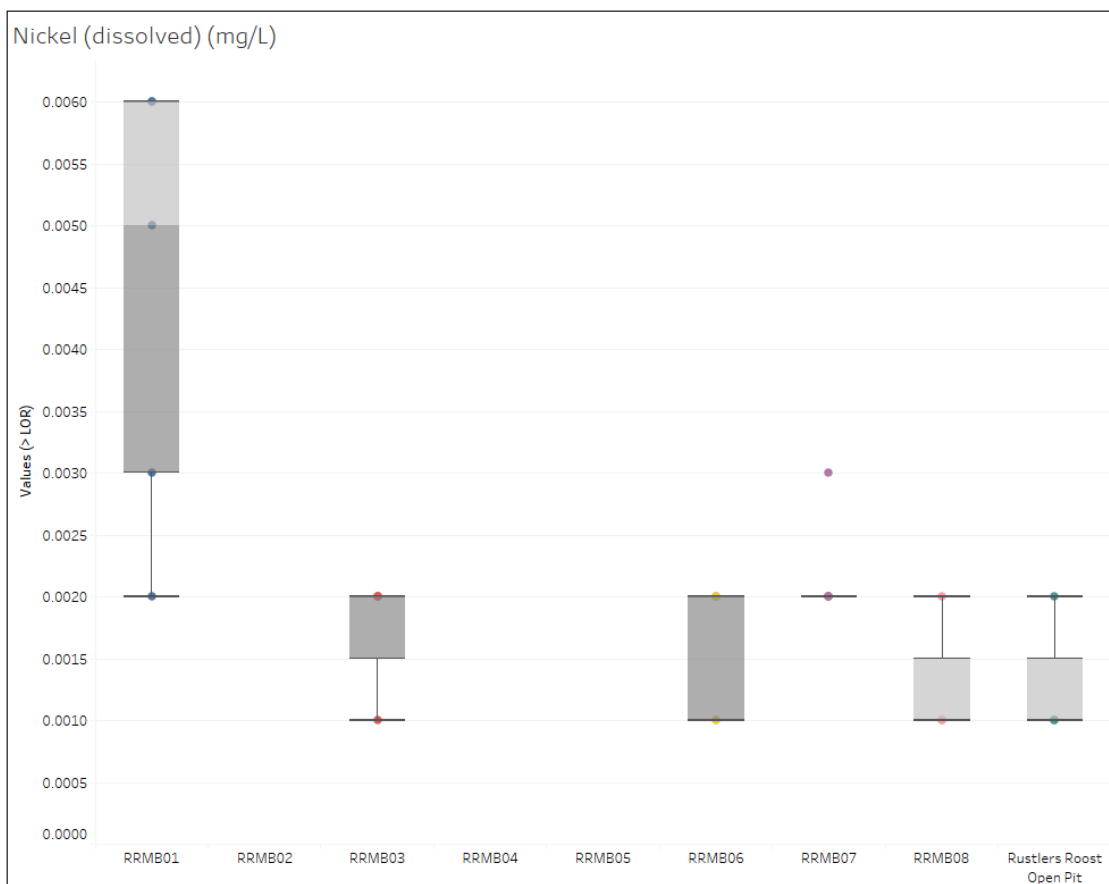
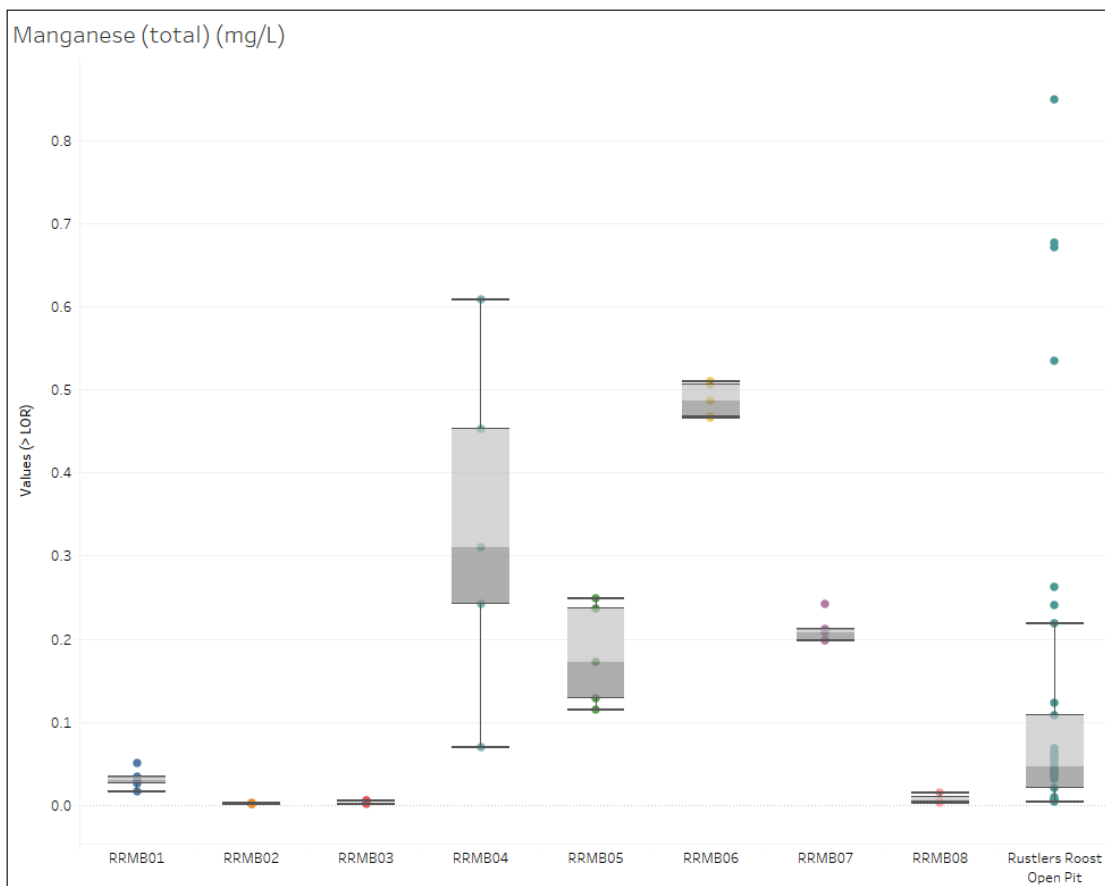


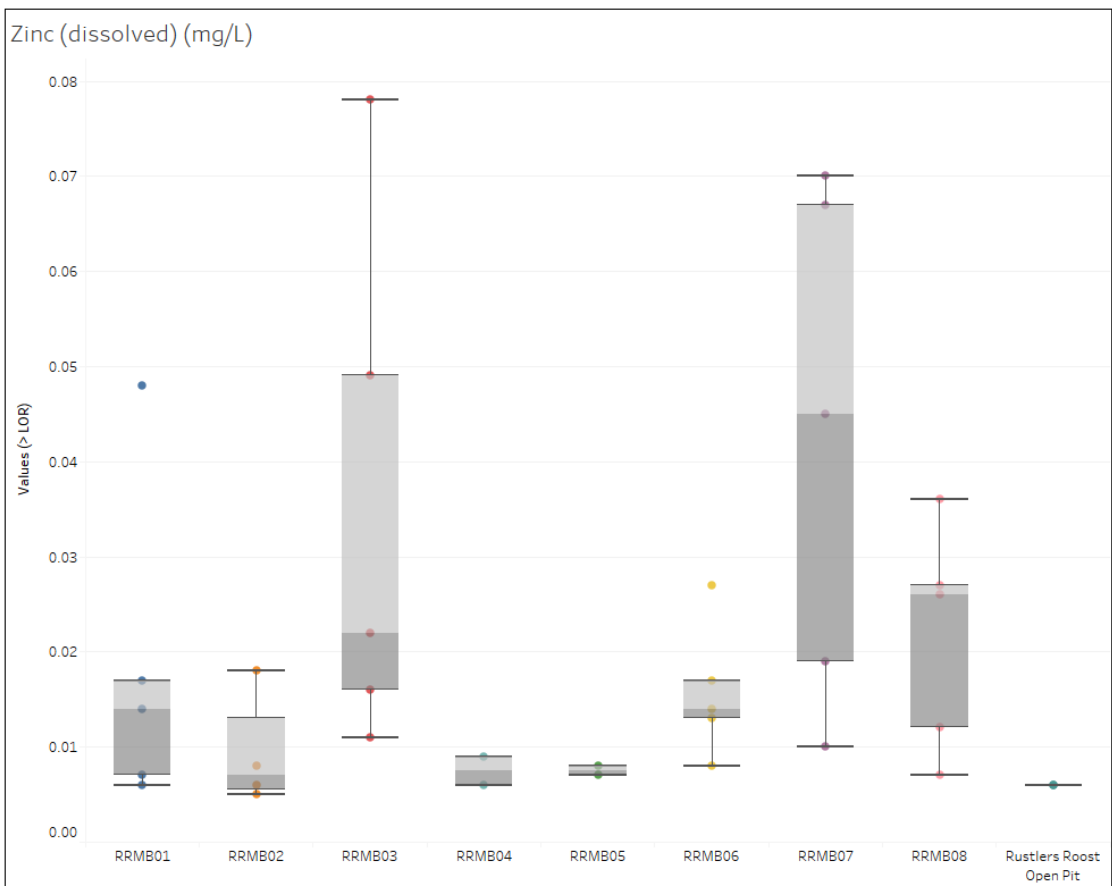
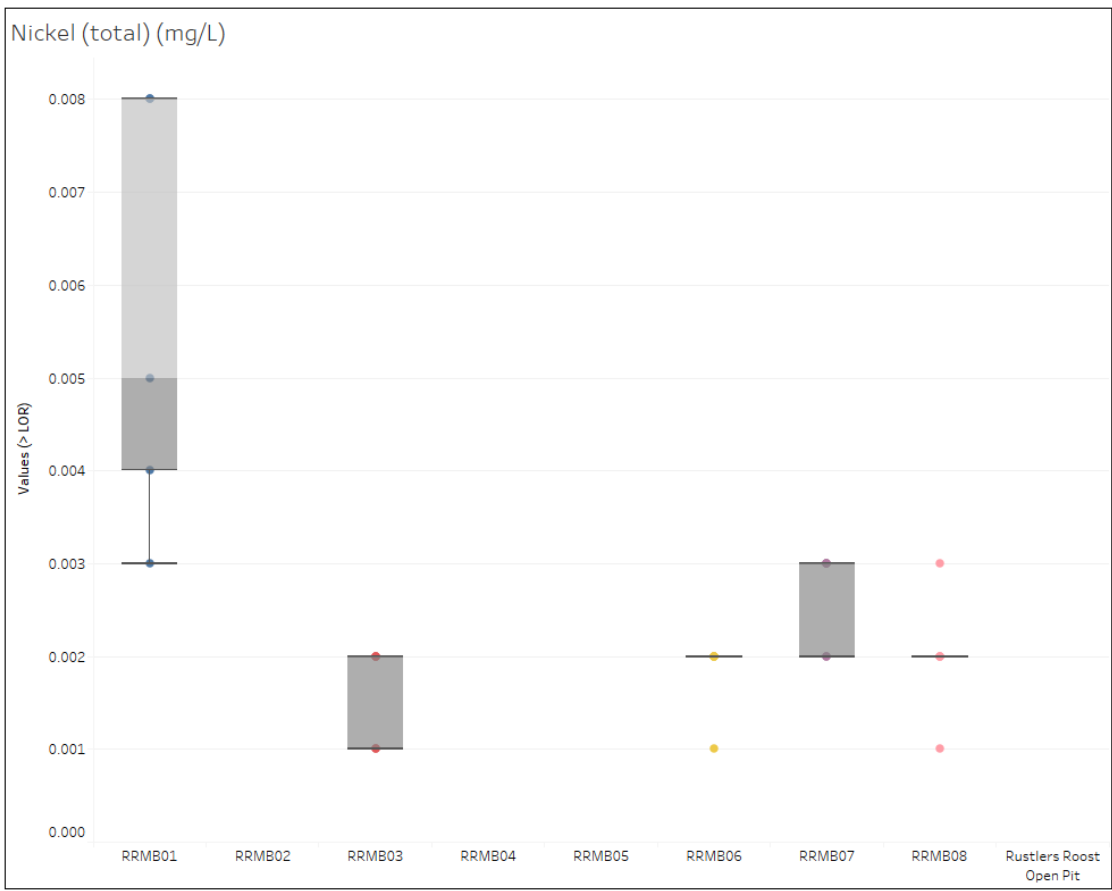


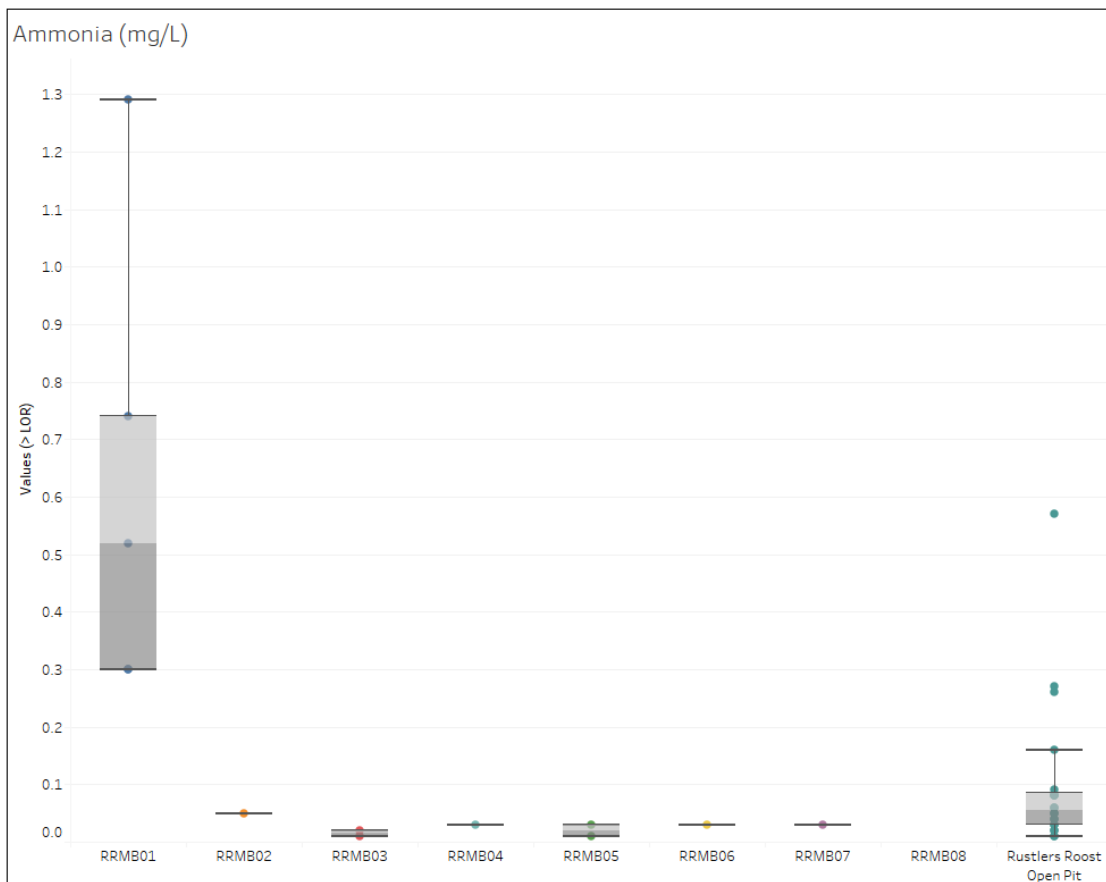
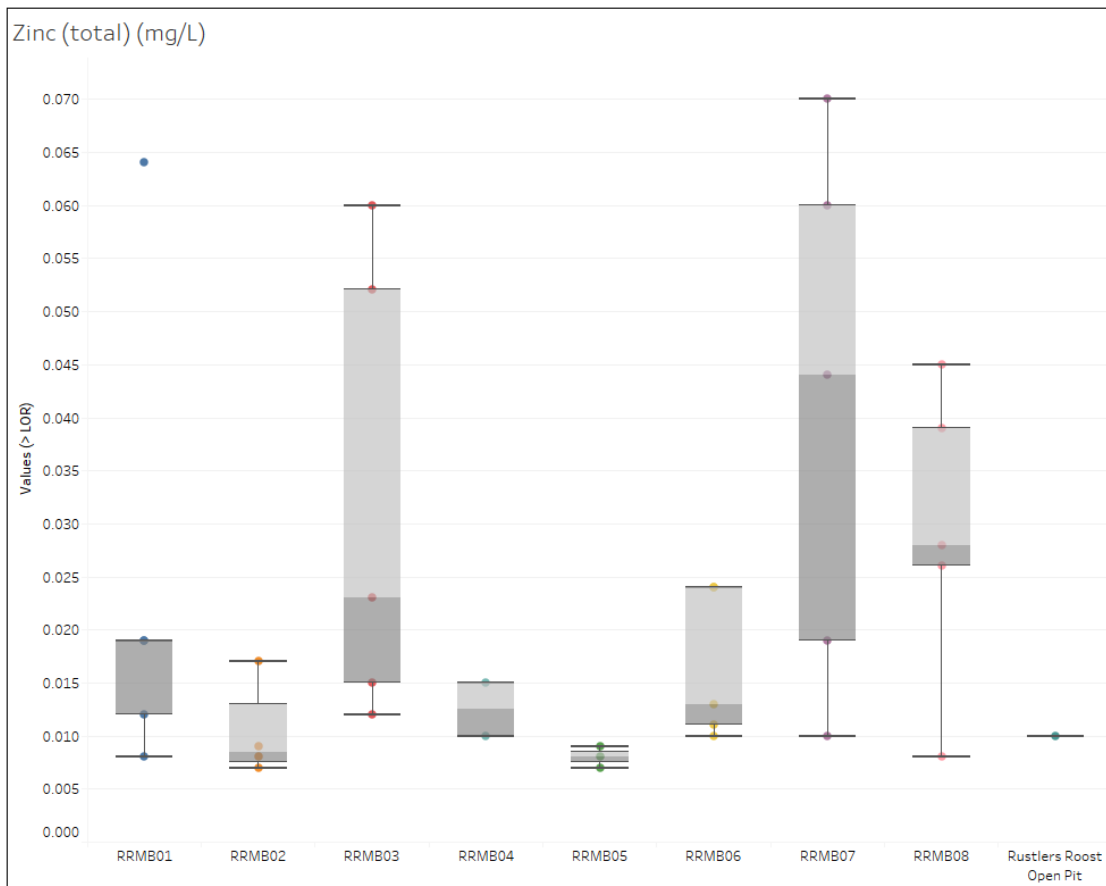


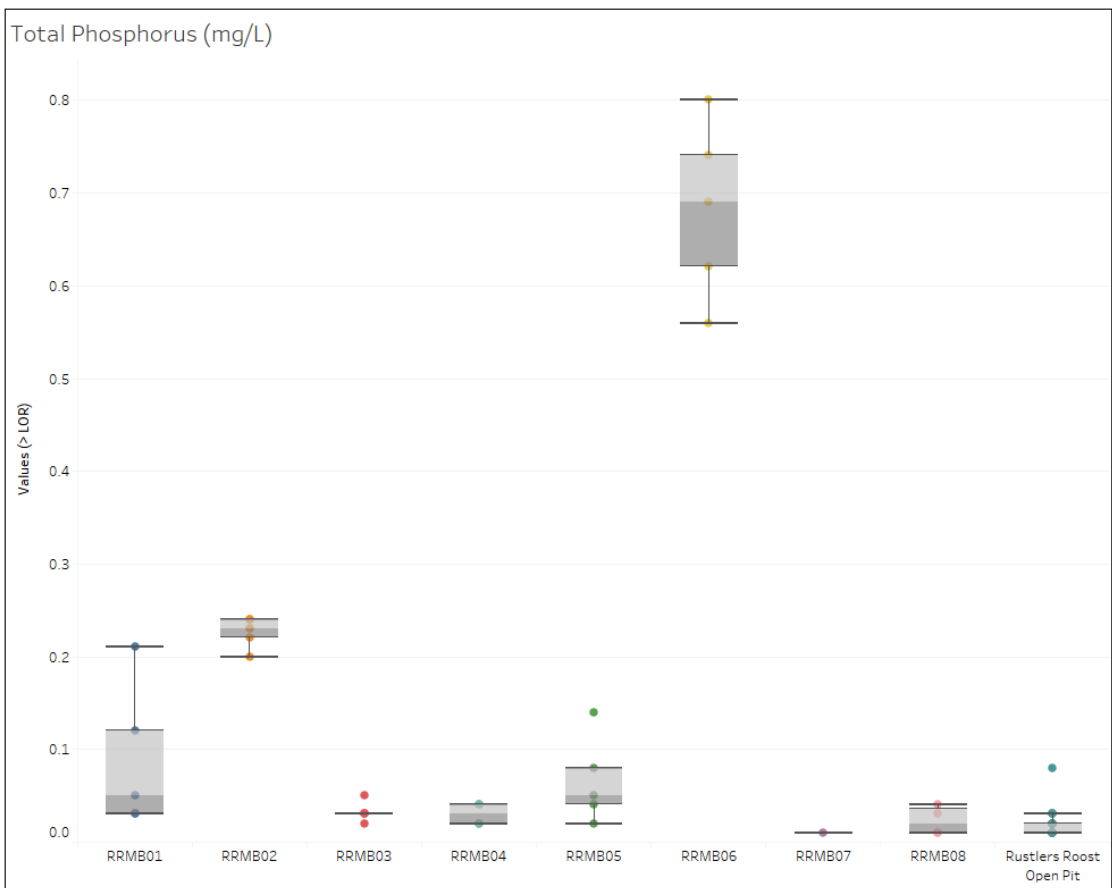
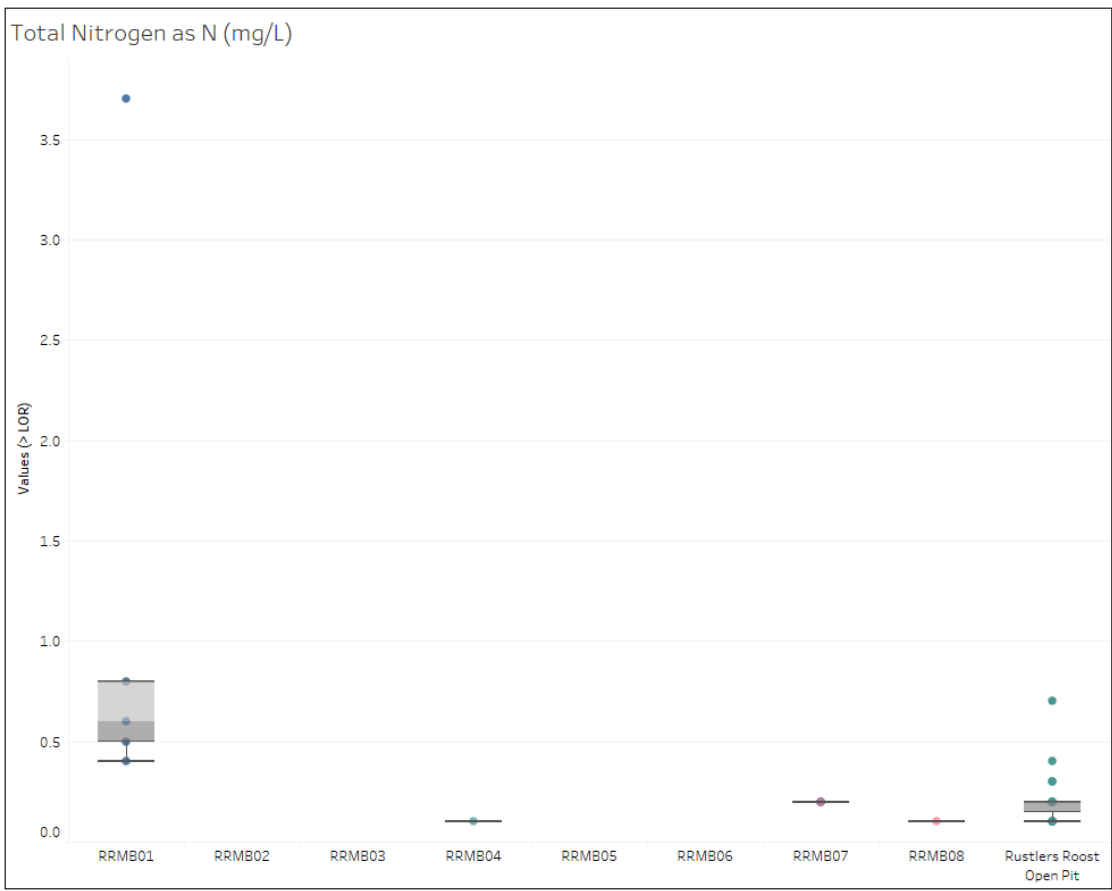












Appendix B Quest 29 2020-2021 Water Quality Monitoring Results

B.1 Quest 29 Groundwater Monitoring Results (2020-2021)

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
Q29MB01								
08/11/2010	1213	6.85	-	-	-	-	-	-
03/12/2010	1174	6.49	-	-	-	-	-	-
25/01/2011	1079	6.09	-	-	-	-	-	-
09/05/2011	210.4	6.2	-	-	-	-	-	-
22/11/2011	964	6.81	-	-	-	-	-	-
30/01/2012	1095	6.97	-	-	-	-	-	-
27/04/2012	932	6.92	-	-	-	-	-	-
22/08/2012	1128	6.46	-	290	-	-	-	-
01/09/2015	1013	7.33	-	290	-	-	-	-
11/12/2015	954	7.1	-	270	-	-	-	-
18/01/2016	-	6.61	-	50	-	-	-	-
11/05/2016	937	7.2	-	-	-	-	-	-
02/09/2016	-	-	-	3	-	-	-	-
30/06/2018	730	6.8	-	5	-	-	-	-
15/09/2020	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-
17/11/2020	1043	6.49	32.5	3.17	0.51	676	-49	1.7
04/12/2020	-	-	-	-	-	-	-	-
11/01/2021	1012	5.96	32.2	4.67	0.5	658	-185	6.4
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	985	6.44	33	4.29	0.48	637	-30.7	1.7
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	988	6.47	32.3	3.43	0.47	643	-54	4
09/07/2021	918	6.38	31.8	3.72	0.45	598	-57	3
Q29MB02								
22/11/2011	274	6.74	-	-	-	-	-	-
30/01/2012	328.4	6.9	-	-	-	-	-	-
22/08/2012	285.8	6.49	-	400	-	-	-	-
01/09/2015	272	7.5	-	270	-	-	-	-
11/12/2015	284	7.6	-	300	-	-	-	-
18/01/2016	-	6.49	-	-	-	-	-	-
11/05/2016	336	7.5	-	-	-	-	-	-
02/09/2016	-	-	-	8	-	-	-	-
11/01/2017	-	6.9	-	7	-	-	-	-
26/03/2017	-	6.6	-	5	-	-	-	-
30/06/2018	210	6.9	-	11	-	-	-	-
15/09/2020	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-
17/11/2020	334	6.48	33.1	6.41	0.16	218	-84.6	2.2
04/12/2020	-	-	-	-	-	-	-	-
11/01/2021	336.1	5.54	32.9	0.32	0.2	218.5	-196	4.9
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	250.9	6.09	33.7	3.45	0.12	163.8	39	1.6
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	337	6.25	33.1	2.07	0.16	219	-54	3.1
08/07/2021	241.5	6.01	32.8	0.7	0.11	156	33.5	2.2
Q29MB03								
16/11/2020	83.5	5.86	33.6	5.4	0.04	54.6	116	38.5
04/12/2020	-	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
11/01/2021	75.8	4.7	31.1	1.83	0	49.5	192	33.1
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	49	4.69	32.6	2.31	0.02	31.8	151.9	59.9
16/04/2021	-	-	-	-	-	-	-	-
29/04/2021	42.4	4.84	33.1	3.64	0.02	27.5	120	45
09/07/2021	38.5	4.47	32.2	0.98	0.02	25.1	122.2	45.9
Q29MB04								
16/11/2020	446	6.77	32.1	3.4	0.21	292	0.8	1.1
04/12/2020	-	-	-	-	-	-	-	-
07/01/2021	397.6	6.68	31.5	0.6	0.2	257.9	-104	9.9
03/02/2021	-	-	-	-	-	-	-	-
09/03/2021	391.7	6.56	31.5	0.39	0.18	254.8	-21.7	4.8
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	406	6.6	31.4	12.3	0.19	264	-36	4.2
09/07/2021	381	6.46	32	1.69	0.18	247	-4	2.5
Q29MB05								
17/11/2020	463	6.89	31.4	2.11	0.22	299	-44.5	1.7
04/12/2020	-	-	-	-	-	-	-	-
07/01/2021	432.1	6.86	31.5	0.6	0.2	281	-101	6
03/02/2021	-	-	-	-	-	-	-	-
08/03/2021	419.5	6.39	31.1	1.47	0.2	27.3	2.1	11.9
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	4.29	6.77	31.1	3.94	0.2	278	-21	4.5
09/07/2021	406.3	6.6	31.8	0.55	0.19	264	-23.4	2
Q29MB06								
16/11/2020	212	6.2	32.2	3.32	0.1	139	13.8	1.4
04/12/2020	-	-	-	-	-	-	-	-
11/01/2021	182.4	4.73	31.4	0.89	0.1	118.6	-52	12.4
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	166	5.93	32.6	0.68	0.08	118.9	23.8	2
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	181	5.93	31.7	1.82	0.08	117	19.8	3.9
09/07/2021	176	5.9	31.5	0.78	0.08	115	40.2	2.2
Q29MB07								
16/11/2020	437	6.53	32.4	2.67	0.21	284	-102	1
04/12/2020	-	-	-	-	-	-	-	-
07/01/2021	407.2	6.58	31.8	0.95	0.2	264.7	-154	4.7
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	382	6.44	32.2	1.35	0.18	247	-54.7	1.4
16/04/2021	-	-	-	-	-	-	-	-
28/04/2021	402	6.5	31.7	0.98	0.19	363	-29	4.1
09/07/2021	371	6.46	31.4	1	0.17	241	-32	2.3
Q29MB08								
16/11/2020	447	6.46	33	2.46	0.21	292	-52	1.2
04/12/2020	-	-	-	-	-	-	-	-
07/01/2021	428.4	6.47	32.4	1.12	0.2	278.4	-237	6
03/02/2021	-	-	-	-	-	-	-	-
09/03/2021	415.8	6.36	32.9	1.09	0.2	270	-87.5	1.7
16/04/2021	-	-	-	-	-	-	-	-
29/04/2021	439	6.4		1.98	0.22	286	-104	3.1

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
09/07/2021	596	6.61	32	1.8	0.28	390	-112	7.4
16/11/2020	259.7	6.13	31.7	11.1	0.12	169	36.8	1.9
04/12/2020	-	-	-	-	-	-	-	-
07/01/2021	232.7	6	31.4	2.29	0.1	151.2	20	10.9
03/02/2021	-	-	-	-	-	-	-	-
11/03/2021	211.3	5.82	31.8	0.35	0.1	137.8	35.9	1.4
16/04/2021	-	-	-	-	-	-	-	-
06/05/2021	238.8	5.87	30.7	1.08	0.11	155.3	66.2	13.7
08/07/2021	229	5.65	31.4	1.07	0.11	148	50	2.6

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Q29MB01							
08/11/2010	-	-	-	-	-	-	-
03/12/2010	73	-	-	-	<5	183	-
25/01/2011	84	-	-	-	<5	-	-
09/05/2011	470	-	-	-	<5	171	-
22/11/2011	5	-	-	-	<5	146	-
30/01/2012	68	-	-	-	<5	183	-
27/04/2012	21	-	-	-	5	-	-
22/08/2012	50	-	-	-	<5	132	-
01/09/2015	60	-	-	-	97	<5	-
11/12/2015	70	-	-	-	<5	131	-
18/01/2016	59	-	340	<5	<5	140	140
11/05/2016	6	-	-	-	<5	-	-
02/09/2016	10	-	-	-	<5	144	-
30/06/2018	10	-	-	-	<5	170	-
15/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
17/11/2020	<5	11.6	410	<1	<1	105	105
04/12/2020	-	-	-	-	-	-	-
11/01/2021	18	1.7	396	<1	<1	53	53
03/02/2021	-	-	-	-	-	-	-
11/03/2021	8	6.6	441	<1	<1	110	110
16/04/2021	-	-	-	-	-	-	-
28/04/2021	14	28.6	400	<1	<1	105	105
09/07/2021	8	24.8	379	<1	<1	94	94
Q29MB02							
22/11/2011	65	-	-	-	<5	171	-
30/01/2012	59	-	-	-	5	195	-
22/08/2012	60	-	-	-	<5	116	-
01/09/2015	70	-	455	<5	<5	107	107
11/12/2015	70	-	-	-	<5	129	-
18/01/2016	-	-	340	<5	<5	140	140
11/05/2016	24	-	-	-	5	134	-
02/09/2016	10	-	-	-	<5	154	-
11/01/2017	10	-	-	-	133	<5	-
26/03/2017	10	-	-	-	<5	192	-
30/06/2018	5	-	-	-	5	134	-
15/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
17/11/2020	<5	16.5	115	<1	<1	132	132
04/12/2020	-	-	-	-	-	-	-
11/01/2021	<5	7.5	128	<1	<1	145	145
03/02/2021	-	-	-	-	-	-	-
11/03/2021	<5	7.4	135	<1	<1	136	136
16/04/2021	-	-	-	-	-	-	-
28/04/2021	6	11.5	119	<1	<1	130	130
08/07/2021	<5	2.2	94	<1	<1	102	102
Q29MB03							
16/11/2020	<5	1	24	<1	<1	34	34
04/12/2020	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
11/01/2021	<5	0.6	28	<1	<1	33	33
03/02/2021	-	-	-	-	-	-	-
11/03/2021	<5	0.7	10	<1	<1	16	16
16/04/2021	-	-	-	-	-	-	-
29/04/2021	<5	<0.1	7	<1	<1	12	12
09/07/2021	<5	0.2	10	<1	<1	12	12
Q29MB04							
16/11/2020	<5	0.3	170	<1	<1	195	195
04/12/2020	-	-	-	-	-	-	-
07/01/2021	7	2.2	172	<1	<1	184	184
03/02/2021	-	-	-	-	-	-	-
09/03/2021	<5	4.7	181	<1	<1	194	194
16/04/2021	-	-	-	-	-	-	-
28/04/2021	8	5.8	186	<1	<1	177	177
09/07/2021	<5	6.6	170	<1	<1	171	171
Q29MB05							
17/11/2020	5	8.7	188	<1	<1	210	210
04/12/2020	-	-	-	-	-	-	-
07/01/2021	7	10.5	186	<1	<1	200	200
03/02/2021	-	-	-	-	-	-	-
08/03/2021	<5	9.3	191	<1	<1	210	210
16/04/2021	-	-	-	-	-	-	-
28/04/2021	10	8.2	200	<1	<1	185	185
09/07/2021	<5	6.1	112	<1	<1	125	125
Q29MB06							
16/11/2020	<5	0.6	63	<1	<1	97	97
04/12/2020	-	-	-	-	-	-	-
11/01/2021	<5	1.2	55	<1	<1	84	84
03/02/2021	-	-	-	-	-	-	-
11/03/2021	<5	0.4	70	<1	<1	84	84
16/04/2021	-	-	-	-	-	-	-
28/04/2021	7	5.7	55	<1	<1	78	78
09/07/2021	<5	1.2	58	<1	<1	80	80
Q29MB07							
16/11/2020	<5	8.9	172	<1	<1	177	177
04/12/2020	-	-	-	-	-	-	-
07/01/2021	7	28.2	173	<1	<1	182	182
03/02/2021	-	-	-	-	-	-	-
11/03/2021	7	22.6	172	<1	<1	178	178
16/04/2021	-	-	-	-	-	-	-
28/04/2021	11	12.4	176	<1	<1	171	171
09/07/2021	8	23.3	167	<1	<1	162	162
Q29MB08							
16/11/2020	<5	1.1	159	<1	<1	183	183
04/12/2020	-	-	-	-	-	-	-
07/01/2021	8	5.6	162	<1	<1	186	186
03/02/2021	-	-	-	-	-	-	-
09/03/2021	<5	10.5	162	<1	<1	202	202
16/04/2021	-	-	-	-	-	-	-
29/04/2021	12	7.2	165	<1	<1	182	182

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
09/07/2021	6	29.9	193	<1	<1	255	255
16/11/2020	12	5.8	75	<1	<1	111	111
04/12/2020	-	-	-	-	-	-	-
07/01/2021	7	3.2	74	<1	<1	99	99
03/02/2021	-	-	-	-	-	-	-
11/03/2021	<5	<0.1	63	<1	<1	86	86
16/04/2021	-	-	-	-	-	-	-
06/05/2021	5	9.6	74	<1	<1	86	86
08/07/2021	<5	5.2	77	<1	<1	81	81

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Q29MB01							
08/11/2010	-	-	-	-	-	-	-
03/12/2010	<5	-	-	-	390	12	140
25/01/2011	<5	-	-	-	440	13	140
09/05/2011	<5	-	-	-	350	14	130
22/11/2011	<5	-	-	-	6	3	17
30/01/2012	<5	-	-	-	350	13	130
27/04/2012	5	-	-	-	300	9	120
22/08/2012	12	-	-	-	330	10.4	128
01/09/2015	14	-	-	-	44	9.9	132
11/12/2015	29	-	-	-	445	9.2	118
18/01/2016	12	-	-	-	250	6	87
11/05/2016	<5	-	-	-	-	4	18
02/09/2016	<5	-	-	-	6.1	5.4	24.7
30/06/2018	19	-	-	-	8.4	4.8	29.2
15/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
17/11/2020	22	<1	22	21	380	7	110
04/12/2020	-	-	-	-	-	-	-
11/01/2021	16	<1	16	15	355	7	109
03/02/2021	-	-	-	-	-	-	-
11/03/2021	12	<1	12	11	386	6	119
16/04/2021	-	-	-	-	-	-	-
28/04/2021	13	<1	13	13	393	7	109
09/07/2021	9	<1	9	9	373	6	104
Q29MB02							
22/11/2011	<5	-	-	-	300	12	110
30/01/2012	<5	-	-	-	6	10	110
22/08/2012	23	-	-	-	418	10.2	131
01/09/2015	29	-	-	-	397	9.2	118
11/12/2015	21	-	-	-	397	9.3	124
18/01/2016	13	-	-	-	250	6	87
11/05/2016	5	-	-	-	5	3	23
02/09/2016	12	-	-	-	6.1	5.1	24.6
11/01/2017	12	-	-	-	4.9	4.8	26.4
26/03/2017	<5	-	-	-	1.6	5.3	25.4
30/06/2018	-	-	-	-	-	-	24
15/09/2020	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-
17/11/2020	17	<1	17	16	14	4	28
04/12/2020	-	-	-	-	-	-	-
11/01/2021	17	<1	17	17	16	5	30
03/02/2021	-	-	-	-	-	-	-
11/03/2021	12	<1	12	11	25	4	31
16/04/2021	-	-	-	-	-	-	-
28/04/2021	14	<1	15	14	19	5	28
08/07/2021	11	<1	11	10	8	5	21
Q29MB03							
16/11/2020	14	<1	14	13	3	3	8
04/12/2020	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
11/01/2021	21	<1	21	21	3	3	8
03/02/2021	-	-	-	-	-	-	-
11/03/2021	9	<1	9	9	2	2	4
16/04/2021	-	-	-	-	-	-	-
29/04/2021	22	<1	22	21	2	2	3
09/07/2021	11	<1	11	11	1	2	4
Q29MB04							
16/11/2020	19	<1	19	18	19	5	45
04/12/2020	-	-	-	-	-	-	-
07/01/2021	13	<1	13	13	14	5	44
03/02/2021	-	-	-	-	-	-	-
09/03/2021	9	<1	9	9	15	6	46
16/04/2021	-	-	-	-	-	-	-
28/04/2021	12	<1	12	12	15	9	48
09/07/2021	7	<1	7	7	15	4	45
Q29MB05							
17/11/2020	12	<1	12	11	10	5	49
04/12/2020	-	-	-	-	-	-	-
07/01/2021	9	<1	9	9	9	6	48
03/02/2021	-	-	-	-	-	-	-
08/03/2021	8	<1	8	8	9	6	50
16/04/2021	-	-	-	-	-	-	-
28/04/2021	8	<1	8	8	9	6	52
09/07/2021	10	<1	10	10	4	4	25
Q29MB06							
16/11/2020	20	<1	20	19	5	3	12
04/12/2020	-	-	-	-	-	-	-
11/01/2021	28	<1	28	27	2	3	9
03/02/2021	-	-	-	-	-	-	-
11/03/2021	11	<1	11	11	2	3	10
16/04/2021	-	-	-	-	-	-	-
28/04/2021	13	<1	13	13	2	5	9
09/07/2021	11	<1	11	10	4	3	10
Q29MB07							
16/11/2020	27	<1	27	26	16	8	39
04/12/2020	-	-	-	-	-	-	-
07/01/2021	14	<1	14	14	14	8	38
03/02/2021	-	-	-	-	-	-	-
11/03/2021	12	<1	12	11	11	6	39
16/04/2021	-	-	-	-	-	-	-
28/04/2021	17	<1	17	17	14	8	41
09/07/2021	8	<1	8	8	11	6	39
Q29MB08							
16/11/2020	28	<1	28	27	22	4	39
04/12/2020	-	-	-	-	-	-	-
07/01/2021	17	<1	17	16	21	6	40
03/02/2021	-	-	-	-	-	-	-
09/03/2021	20	<1	20	19	19	6	42
16/04/2021	-	-	-	-	-	-	-
29/04/2021	19	<1	19	19	19	7	43

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
09/07/2021	10	<1	10	9	15	16	56
16/11/2020	26	<1	26	25	11	4	17
04/12/2020	-	-	-	-	-	-	-
07/01/2021	20	<1	20	19	12	5	15
03/02/2021	-	-	-	-	-	-	-
11/03/2021	16	<1	16	16	12	4	12
16/04/2021	-	-	-	-	-	-	-
06/05/2021	33	<1	33	33	18	4	15
08/07/2021	17	<1	17	16	24	4	16

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
Q29MB01									
08/11/2010	-	-	-	-	-	-	-	-	-
03/12/2010	43	20	6.9	0.31	0.011	0.0006	0.011	0.001	0.005
25/01/2011	41	19	6.6	0.019	0.011	0.0001	0.008	0.001	0.001
09/05/2011	38	22	6.8	0.024	0.035	0.0001	0.006	0.001	0.001
22/11/2011	6.4	6	4.8	0.01	0.013	0.0001	0.001	0.001	0.006
30/01/2012	42	22	6.7	0.01	0.012	0.0001	0.006	0.001	0.001
27/04/2012	38	22	7.5	0.01	0.064	0.0001	0.005	0.001	0.001
22/08/2012	41.5	23	7.2	<0.01	0.026	0.0005	0.00354	<0.001	<0.001
01/09/2015	43.1	26.9	7.2	<0.01	0.00185	<0.0001	0.00305	<0.001	<0.001
11/12/2015	39	25.6	6.5	<0.01	0.0032	<0.0001	0.00336	<0.001	<0.001
18/01/2016	30	23	6	<0.01	0.036	<0.0001	<0.001	0.001	<0.001
11/05/2016	7.5	-	5.3	0.015	0.024	0.0001	0.001	0.001	0.001
02/09/2016	9.7	7.7	6.2	<0.01	0.024	0.00113	0.00129	<0.001	0.00285
30/06/2018	11.5	8.6	5.4	-	-	-	-	-	-
15/09/2020	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-
17/11/2020	33	30	6	<0.01	0.09	<0.0001	<0.001	<0.001	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
11/01/2021	30	27	6	<0.01	0.093	<0.0001	<0.001	<0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	35	31	6	<0.01	0.106	<0.0001	<0.001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	31	28	6	<0.01	0.098	<0.0001	<0.001	<0.001	<0.001
09/07/2021	29	28	6	<0.01	0.099	<0.0001	<0.001	<0.001	<0.001
Q29MB02									
22/11/2011	38	18	6.2	0.014	0.011	0.0001	0.005	0.001	0.001
30/01/2012	36	6.9	7.2	0.01	0.012	0.0001	0.006	0.001	0.001
22/08/2012	42.5	26.6	7.3	<0.01	0.00185	<0.0001	0.00323	<0.001	<0.001
01/09/2015	39	25	6.5	<0.01	0.0032	<0.0001	<0.001	0.00336	<0.001
11/12/2015	40.4	25	6.9	-	-	-	-	-	-
18/01/2016	29	23	6	<0.01	0.036	<0.0001	<0.001	0.001	<0.001
11/05/2016	8.8	7.7	5.1	0.018	0.024	0.0001	0.001	0.001	0.001
02/09/2016	10	8	6.7	<0.01	0.0145	<0.0001	<0.001	<0.001	<0.001
11/01/2017	10.9	7.7	6.9	<0.01	0.0185	<0.0001	<0.001	<0.001	<0.001
26/03/2017	10.8	7.6	5.9	<0.01	0.0175	<0.0001	<0.001	<0.001	<0.001
30/06/2018	10	7.4	4.5	0.01	0.006	0.0001	0.001	0.001	0.001
15/09/2020	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-
17/11/2020	11	8	5	<0.01	0.023	<0.0001	<0.001	<0.001	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
11/01/2021	13	9	5	<0.01	0.021	<0.0001	<0.001	<0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	14	9	5	<0.01	0.013	<0.0001	<0.001	0.005	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	12	8	4	<0.01	0.024	<0.0001	<0.001	<0.001	<0.001
08/07/2021	10	6	4	<0.01	0.015	<0.0001	<0.001	0.002	<0.001
Q29MB03									
16/11/2020	1	2	1	<0.01	<0.001	<0.0001	<0.001	<0.001	0.003
04/12/2020	-	-	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
11/01/2021	2	2	1	<0.01	<0.001	<0.0001	<0.001	0.001	0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	<1	2	<1	<0.01	<0.001	0.0001	<0.001	<0.001	0.006
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	<1	2	<1	<0.01	<0.001	<0.0001	<0.001	0.001	0.007
09/07/2021	<1	2	<1	<0.01	<0.001	0.0002	<0.001	0.002	0.009
Q29MB04									
16/11/2020	14	5	4	<0.01	0.2	<0.0001	<0.001	0.003	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
07/01/2021	15	5	4	<0.01	0.172	<0.0001	<0.001	0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
09/03/2021	16	5	4	<0.01	0.168	<0.0001	<0.001	0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	16	5	4	<0.01	0.157	<0.0001	<0.001	<0.001	<0.001
09/07/2021	14	5	3	<0.01	0.132	<0.0001	<0.001	<0.001	<0.001
Q29MB05									
17/11/2020	16	6	4	<0.01	0.079	<0.0001	<0.001	<0.001	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
07/01/2021	16	5	4	<0.01	0.083	<0.0001	<0.001	<0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
08/03/2021	16	5	4	<0.01	0.082	<0.0001	<0.001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	17	6	4	<0.01	0.076	<0.0001	<0.001	<0.001	<0.001
09/07/2021	12	5	7	<0.01	0.003	<0.0001	<0.001	<0.001	<0.001
Q29MB06									
16/11/2020	8	8	3	<0.01	0.009	<0.0001	<0.001	<0.001	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
11/01/2021	8	7	3	<0.01	0.012	<0.0001	<0.001	<0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	11	8	4	<0.01	0.012	<0.0001	<0.001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	8	7	2	<0.01	0.012	<0.0001	<0.001	<0.001	<0.001
09/07/2021	8	6	3	<0.01	0.013	<0.0001	<0.001	<0.001	<0.001
Q29MB07									
16/11/2020	18	8	4	<0.01	0.028	<0.0001	<0.001	0.002	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
07/01/2021	19	8	4	<0.01	0.046	<0.0001	<0.001	0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	18	8	4	<0.01	0.036	<0.0001	<0.001	0.002	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
28/04/2021	18	7	4	<0.01	0.055	<0.0001	<0.001	0.001	<0.001
09/07/2021	17	7	4	0.01	0.028	<0.0001	<0.001	<0.001	<0.001
Q29MB08									
16/11/2020	15	13	3	<0.01	0.014	<0.0001	<0.001	0.003	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
07/01/2021	15	14	4	<0.01	0.018	<0.0001	<0.001	0.002	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
09/03/2021	14	17	4	<0.01	0.018	<0.0001	<0.001	0.003	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
29/04/2021	14	16	3	<0.01	0.013	<0.0001	<0.001	0.002	<0.001

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
09/07/2021	13	44	4	<0.01	0.008	<0.0001	<0.001	0.001	<0.001
16/11/2020	8	10	4	0.01	0.011	<0.0001	<0.001	<0.001	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-
07/01/2021	9	11	4	0.01	0.012	<0.0001	<0.001	<0.001	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-
11/03/2021	8	9	4	0.01	0.013	<0.0001	<0.001	<0.001	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-
06/05/2021	9	9	4	<0.01	0.01	<0.0001	<0.001	<0.001	0.004
08/07/2021	9	8	4	<0.01	0.01	<0.0001	<0.001	<0.001	<0.001

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
Q29MB01										
08/11/2010	-	-	-	-	-	-	-	-	-	-
03/12/2010	0.001	1.2	0.009	-	-	-	0.032	19	-	-
25/01/2011	0.001	1	0.001	-	-	-	0.002	17	-	-
09/05/2011	0.001	0.74	0.001	-	-	-	0.001	4.8	-	-
22/11/2011	0.001	0.12	0.002	-	-	-	0.047	0.55	-	-
30/01/2012	0.001	1.5	0.001	-	-	-	0.003	17	-	-
27/04/2012	0.001	0.78	0.001	-	-	-	0.005	5.3	-	-
22/08/2012	<0.001	1.04	<0.001	-	-	<0.0005	0.048	15.1	-	-
01/09/2015	<0.001	1.24	<0.001	-	-	<0.0005	0.0014	0.046	-	-
11/12/2015	<0.001	1.07	<0.001	-	-	<0.0005	0.0044	0.01	-	-
18/01/2016	<0.001	0.74	<0.001	-	-	<0.0005	0.009	17	-	-
11/05/2016	0.001	0.13	0.001	-	-	-	0.004	1.4	-	-
02/09/2016	<0.001	0.144	0.00188	-	-	<0.0005	0.0846	<0.01	-	-
30/06/2018	-	-	-	-	-	-	-	-	-	-
15/09/2020	-	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-	-
17/11/2020	<0.001	0.694	<0.001	<0.01	<0.001	<0.001	<0.005	4.22	0.02	0.092
04/12/2020	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.001	0.722	<0.001	<0.01	<0.001	<0.001	<0.005	3.78	0.03	0.097
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.677	<0.001	<0.01	<0.001	<0.001	<0.005	3.85	0.02	0.119
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.68	<0.001	<0.01	<0.001	<0.001	0.014	1.85	<0.01	0.123
09/07/2021	<0.001	0.676	<0.001	<0.01	<0.001	<0.001	<0.005	3.97	<0.01	0.122
Q29MB02										
22/11/2011	0.001	1.2	0.001	-	-	-	0.003	16	-	-
30/01/2012	0.001	1	0.001	-	-	-	0.004	3.6	-	-
22/08/2012	<0.001	1.31	<0.001	-	-	<0.0005	0.0089	0.012	-	-
01/09/2015	<0.001	1.07	<0.001	-	-	<0.0005	0.0044	0.01	-	-
11/12/2015	-	-	-	-	-	-	-	-	-	-
18/01/2016	<0.001	0.74	<0.001	-	-	<0.0005	0.009	17	-	-
11/05/2016	0.001	0.16	0.002	-	-	-	0.028	2.4	-	-
02/09/2016	<0.001	0.153	<0.001	-	-	<0.0005	0.0083	0.064	-	-
11/01/2017	<0.001	0.191	<0.001	-	-	<0.0005	0.0037	0.026	-	-
26/03/2017	<0.001	0.273	<0.001	-	-	<0.0005	0.0141	0.21	-	-
30/06/2018	0.005	0.25	0.001	-	-	<0.0005	0.004	0.09	-	-
15/09/2020	-	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-	-
17/11/2020	<0.001	0.134	<0.001	<0.01	<0.001	<0.001	<0.005	1.96	0.02	0.021
04/12/2020	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.001	0.202	<0.001	<0.01	<0.001	<0.001	<0.005	2.02	<0.01	0.021
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.249	0.003	<0.01	<0.001	<0.001	0.021	0.29	<0.01	0.028
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.156	<0.001	<0.01	<0.001	<0.001	0.006	1.59	<0.01	0.025
08/07/2021	<0.001	0.263	0.002	<0.01	<0.001	<0.001	0.018	1.04	<0.01	0.019
Q29MB03										
16/11/2020	<0.001	0.057	0.006	<0.01	<0.001	<0.001	0.022	0.17	<0.01	<0.001
04/12/2020	-	-	-	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
11/01/2021	<0.001	0.137	0.009	<0.01	<0.001	<0.001	0.022	0.09	<0.01	<0.001
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.013	0.012	<0.01	<0.001	<0.001	0.055	<0.05	0.01	<0.001
16/04/2021	-	-	-	-	-	-	-	-	-	-
29/04/2021	<0.001	0.016	0.013	<0.01	<0.001	<0.001	0.074	<0.05	<0.01	<0.001
09/07/2021	<0.001	0.021	0.016	<0.01	<0.001	<0.001	0.082	<0.05	0.02	<0.001
Q29MB04										
16/11/2020	<0.001	0.24	0.02	<0.01	<0.001	<0.001	0.027	<0.05	0.01	0.209
04/12/2020	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.001	0.296	0.008	<0.01	<0.001	<0.001	0.027	0.24	<0.01	0.159
03/02/2021	-	-	-	-	-	-	-	-	-	-
09/03/2021	<0.001	0.284	0.006	<0.01	<0.001	<0.001	0.062	0.46	<0.01	0.169
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.287	0.005	<0.01	<0.001	<0.001	0.039	0.43	0.29	0.177
09/07/2021	<0.001	0.278	0.004	<0.01	<0.001	<0.001	0.028	0.46	<0.01	0.173
Q29MB05										
17/11/2020	<0.001	0.198	<0.001	<0.01	<0.001	<0.001	0.011	0.84	<0.01	0.072
04/12/2020	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.001	0.226	<0.001	<0.01	<0.001	<0.001	0.006	0.73	<0.01	0.072
03/02/2021	-	-	-	-	-	-	-	-	-	-
08/03/2021	<0.001	0.219	<0.001	<0.01	<0.001	<0.001	0.007	0.76	<0.01	0.079
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.237	<0.001	<0.01	<0.001	<0.001	0.012	0.93	<0.01	0.085
09/07/2021	<0.001	0.265	<0.001	<0.01	<0.001	<0.001	<0.005	1.38	0.01	0.004
Q29MB06										
16/11/2020	<0.001	0.167	<0.001	<0.01	<0.001	<0.001	0.008	0.25	<0.01	0.009
04/12/2020	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.001	0.204	<0.001	<0.01	<0.001	<0.001	0.027	0.66	<0.01	0.012
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.198	<0.001	<0.01	<0.001	<0.001	<0.005	0.94	<0.01	0.013
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.182	<0.001	<0.01	<0.001	<0.001	0.015	0.49	<0.01	0.014
09/07/2021	<0.001	0.182	<0.001	<0.01	<0.001	<0.001	0.007	0.98	<0.01	0.016
Q29MB07										
16/11/2020	<0.001	0.517	0.001	<0.01	<0.001	<0.001	<0.005	2.37	0.02	0.028
04/12/2020	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.001	0.485	<0.001	<0.01	<0.001	<0.001	<0.005	1.63	<0.01	0.043
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.78	<0.001	<0.01	<0.001	<0.001	<0.005	4.35	<0.01	0.039
16/04/2021	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.001	0.478	<0.001	<0.01	<0.001	<0.001	0.014	1.92	<0.01	0.058
09/07/2021	<0.001	0.563	<0.001	<0.01	<0.001	<0.001	0.006	2.21	<0.01	0.037
Q29MB08										
16/11/2020	<0.001	0.552	0.005	<0.01	<0.001	<0.001	0.009	0.82	0.02	0.014
04/12/2020	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.001	0.765	0.002	<0.01	<0.001	<0.001	<0.005	1.36	0.01	0.018
03/02/2021	-	-	-	-	-	-	-	-	-	-
09/03/2021	<0.001	0.905	0.002	<0.01	<0.001	<0.001	0.024	1.67	0.02	0.018
16/04/2021	-	-	-	-	-	-	-	-	-	-
29/04/2021	<0.001	0.867	<0.001	<0.01	<0.001	<0.001	<0.005	1.36	<0.01	0.013

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
09/07/2021	<0.001	1.16	<0.001	<0.01	<0.001	<0.001	<0.005	2.3	<0.01	0.014
16/11/2020	<0.001	0.192	0.003	<0.01	<0.001	<0.001	0.023	0.76	0.28	0.01
04/12/2020	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.001	0.259	0.004	<0.01	<0.001	<0.001	0.018	1.09	0.07	0.011
03/02/2021	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.001	0.251	0.004	<0.01	<0.001	<0.001	0.018	1.41	0.01	0.014
16/04/2021	-	-	-	-	-	-	-	-	-	-
06/05/2021	<0.001	0.299	0.002	<0.01	<0.001	<0.001	0.052	1.45	0.02	0.013
08/07/2021	<0.001	0.302	0.002	<0.01	<0.001	<0.001	0.019	1.89	<0.01	0.011

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
Q29MB01												
08/11/2010	-	-	-	-	-	-	-	-	-	-	-	-
03/12/2010	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	0.0052	-
25/01/2011	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	0.0023	-
09/05/2011	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
22/11/2011	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
30/01/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
27/04/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
22/08/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
01/09/2015	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
11/12/2015	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
18/01/2016	<0.0001	<0.001	0.002	<0.001	<0.001	<0.001	-	-	-	-	0.007	-
11/05/2016	<0.0001	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.0018	-
02/09/2016	0.0004	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.031	-
30/06/2018	-	-	-	-	-	-	-	-	-	-	-	-
15/09/2020	-	-	-	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-	-	-	-
17/11/2020	<0.0001	<0.001	<0.001	<0.001	<0.001	0.738	<0.001	<0.01	<0.001	<0.001	<0.005	3.88
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.776	0.001	<0.01	<0.001	<0.001	0.01	4.24
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.734	0.001	<0.01	<0.001	<0.001	<0.005	3.97
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.712	<0.001	<0.01	<0.001	<0.001	0.015	4.56
09/07/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.712	<0.001	<0.01	<0.001	<0.001	0.009	4.34
Q29MB02												
22/11/2011	<0.0001	<0.001	<0.001	0.003	<0.001	<0.001	-	-	-	-	0.0232	-
30/01/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	<0.001	-
22/08/2012	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	0.045	-
01/09/2015	<0.0001	<0.001	0.00325	<0.001	<0.001	0.0005	-	-	-	-	0.0093	-
11/12/2015	-	-	-	-	-	-	-	-	-	-	-	-
18/01/2016	-	-	-	-	-	-	-	-	-	-	-	-
11/05/2016	<0.0001	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.0106	-
02/09/2016	<0.0001	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.0029	-
11/01/2017	<0.0001	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.0012	-
26/03/2017	<0.0001	<0.001	-	<0.001	<0.001	<0.001	-	-	-	-	0.0048	-
30/06/2018	<0.0001	<0.001	-	<0.001	<0.001	0.0011	-	-	-	-	0.0014	-
15/09/2020	-	-	-	-	-	-	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-	-	-	-	-	-	-
17/11/2020	<0.0001	<0.001	<0.001	<0.001	<0.001	0.145	<0.001	<0.01	<0.001	<0.001	<0.005	1.97
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.192	<0.001	<0.01	<0.001	<0.001	<0.005	1.78
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	0.004	<0.001	<0.001	0.228	0.002	<0.01	<0.001	<0.001	0.013	1.71
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.0001	<0.001	<0.001	0.003	<0.001	0.17	<0.001	<0.01	<0.001	<0.001	0.01	2.19
08/07/2021	<0.0001	<0.001	0.003	<0.001	<0.001	0.27	0.002	<0.01	<0.001	<0.001	0.026	1.13
Q29MB03												
16/11/2020	<0.0001	<0.001	<0.001	0.004	<0.001	0.06	0.007	<0.01	<0.001	<0.001	0.025	0.19
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
11/01/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.141	0.01	<0.01	<0.001	<0.001	0.032	0.13
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	<0.001	0.007	<0.001	0.013	0.012	<0.01	<0.001	<0.001	0.056	<0.05
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
29/04/2021	0.0001	<0.001	0.001	0.008	<0.001	0.014	0.01	<0.01	<0.001	<0.001	0.076	<0.05
09/07/2021	0.0001	<0.001	0.002	0.012	<0.001	0.02	0.018	<0.01	0.001	<0.001	0.09	<0.05
Q29MB04												
16/11/2020	0.0001	<0.001	0.003	<0.001	<0.001	0.268	0.025	<0.01	<0.001	<0.001	0.031	<0.05
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.0001	<0.001	0.001	<0.001	<0.001	0.29	0.008	<0.01	<0.001	<0.001	0.028	0.28
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
09/03/2021	<0.0001	<0.001	<0.001	0.004	<0.001	0.254	0.006	<0.01	<0.001	<0.001	0.061	0.54
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	0.0028	<0.001	0.001	0.013	0.044	0.301	0.008	<0.01	<0.001	<0.001	0.472	0.87
09/07/2021	<0.0001	<0.001	<0.001	0.009	0.002	0.27	0.004	<0.01	<0.001	<0.001	0.071	0.72
Q29MB05												
17/11/2020	<0.0001	<0.001	<0.001	<0.001	<0.001	0.215	<0.001	<0.01	<0.001	<0.001	0.013	0.8
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.214	<0.001	<0.01	<0.001	<0.001	0.006	0.87
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
08/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.242	<0.001	<0.01	<0.001	<0.001	0.009	0.75
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.0001	<0.001	<0.001	<0.001	0.002	0.226	<0.001	<0.01	<0.001	<0.001	0.024	0.86
09/07/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.274	<0.001	<0.01	<0.001	<0.001	0.008	1.47
Q29MB06												
16/11/2020	<0.0001	<0.001	<0.001	<0.001	<0.001	0.198	<0.001	<0.01	<0.001	<0.001	0.01	0.27
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.0001	<0.001	<0.001	0.004	<0.001	0.186	<0.001	<0.01	<0.001	<0.001	0.029	0.6
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.211	<0.001	<0.01	<0.001	<0.001	0.006	1.05
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.0001	<0.001	<0.001	0.008	<0.001	0.2	<0.001	<0.01	<0.001	<0.001	0.02	0.95
09/07/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.195	<0.001	<0.01	<0.001	<0.001	0.011	1.07
Q29MB07												
16/11/2020	<0.0001	<0.001	0.002	<0.001	<0.001	0.541	<0.001	<0.01	<0.001	<0.001	<0.005	2.28
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.0001	<0.001	0.001	<0.001	<0.001	0.498	<0.001	<0.01	<0.001	<0.001	<0.005	1.85
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.82	<0.001	<0.01	<0.001	<0.001	<0.005	4.25
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
28/04/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.49	<0.001	<0.01	<0.001	<0.001	0.016	2.29
09/07/2021	<0.0001	<0.001	0.001	<0.001	<0.001	0.583	<0.001	<0.01	<0.001	<0.001	<0.005	2.78
Q29MB08												
16/11/2020	<0.0001	<0.001	0.004	<0.001	<0.001	0.574	0.006	<0.01	<0.001	<0.001	0.008	0.81
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.752	0.002	<0.01	<0.001	<0.001	<0.005	1.5
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
09/03/2021	<0.0001	<0.001	0.003	<0.001	<0.001	0.943	0.002	<0.01	<0.001	<0.001	0.028	2.04
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
29/04/2021	<0.0001	<0.001	0.002	<0.001	<0.001	0.745	<0.001	<0.01	<0.001	<0.001	<0.005	1.49

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
09/07/2021	<0.0001	<0.001	0.002	<0.001	<0.001	1.08	0.001	<0.01	<0.001	<0.001	<0.005	2.82
16/11/2020	<0.0001	<0.001	<0.001	0.003	0.001	0.236	0.005	<0.01	<0.001	<0.001	0.031	1.08
04/12/2020	-	-	-	-	-	-	-	-	-	-	-	-
07/01/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.257	0.003	<0.01	<0.001	<0.001	0.02	1.28
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
11/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.266	0.004	<0.01	<0.001	<0.001	0.022	1.56
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
06/05/2021	<0.0001	<0.001	<0.001	0.007	<0.001	0.331	0.004	<0.01	<0.001	<0.001	0.058	1.95
08/07/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.327	0.003	<0.01	<0.001	<0.001	0.028	1.98

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
Q29MB01						
08/11/2010	-	-	-	-	-	-
03/12/2010	-	-	-	-	-	-
25/01/2011	-	-	-	-	-	-
09/05/2011	-	-	-	-	-	-
22/11/2011	-	-	-	-	-	-
30/01/2012	-	-	-	-	-	-
27/04/2012	-	-	-	-	-	-
22/08/2012	-	-	-	-	-	-
01/09/2015	-	-	-	-	-	-
11/12/2015	-	-	-	-	-	-
18/01/2016	-	-	-	-	-	-
11/05/2016	-	-	-	-	-	-
02/09/2016	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
15/09/2020	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-
17/11/2020	5	0.01	0.05	<0.1	<0.1	0.06
04/12/2020	-	-	-	-	-	-
11/01/2021	4.47	<0.01	<0.01	<0.1	<0.1	0.09
03/02/2021	-	-	-	-	-	-
11/03/2021	2.89	0.02	<0.01	<0.1	<0.1	0.09
16/04/2021	-	-	-	-	-	-
28/04/2021	<0.05	0.02	<0.01	<0.1	<0.1	0.09
09/07/2021	4.83	0.01	<0.01	<0.1	<0.1	0.09
Q29MB02						
22/11/2011	-	-	-	-	-	-
30/01/2012	-	-	-	-	-	-
22/08/2012	-	-	-	-	-	-
01/09/2015	-	-	-	-	-	-
11/12/2015	-	-	-	-	-	-
18/01/2016	-	-	-	-	-	-
11/05/2016	-	-	-	-	-	-
02/09/2016	-	-	-	-	-	-
11/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
15/09/2020	-	-	-	-	-	-
21/10/2020	-	-	-	-	-	-
17/11/2020	0.39	0.23	0.02	0.3	0.3	0.1
04/12/2020	-	-	-	-	-	-
11/01/2021	2.12	0.21	<0.01	0.2	0.2	0.13
03/02/2021	-	-	-	-	-	-
11/03/2021	0.38	0.12	<0.01	0.1	0.1	0.09
16/04/2021	-	-	-	-	-	-
28/04/2021	2.3	0.12	<0.01	0.2	0.2	0.11
08/07/2021	1.08	0.02	<0.01	<0.1	<0.1	0.14
Q29MB03						
16/11/2020	0.17	<0.01	0.03	<0.1	<0.1	<0.01
04/12/2020	-	-	-	-	-	-

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
11/01/2021	0.1	<0.01	0.02	<0.1	<0.1	<0.01
03/02/2021	-	-	-	-	-	-
11/03/2021	<0.05	0.01	0.08	<0.1	<0.1	0.01
16/04/2021	-	-	-	-	-	-
29/04/2021	<0.05	0.04	0.12	0.2	0.3	<0.01
09/07/2021	<0.05	<0.01	0.15	<0.1	0.2	<0.01
Q29MB04						
16/11/2020	<0.05	<0.01	0.03	<0.1	<0.1	0.05
04/12/2020	-	-	-	-	-	-
07/01/2021	0.29	<0.01	<0.01	<0.1	<0.1	0.05
03/02/2021	-	-	-	-	-	-
09/03/2021	0.55	<0.01	0.03	<0.1	<0.1	0.07
16/04/2021	-	-	-	-	-	-
28/04/2021	<0.05	0.02	<0.01	<0.1	<0.1	0.1
09/07/2021	0.73	<0.01	<0.01	<0.1	<0.1	0.08
Q29MB05						
17/11/2020	0.98	0.02	0.03	<0.1	<0.1	0.03
04/12/2020	-	-	-	-	-	-
07/01/2021	0.91	<0.01	<0.01	<0.1	<0.1	0.02
03/02/2021	-	-	-	-	-	-
08/03/2021	0.96	<0.01	0.03	<0.1	<0.1	0.04
16/04/2021	-	-	-	-	-	-
28/04/2021	0.98	<0.01	<0.01	<0.1	<0.1	0.05
09/07/2021	1.61	0.02	<0.01	<0.1	<0.1	0.11
Q29MB06						
16/11/2020	0.25	0.02	0.02	<0.1	<0.1	0.02
04/12/2020	-	-	-	-	-	-
11/01/2021	0.2	0.03	<0.01	<0.1	<0.1	0.05
03/02/2021	-	-	-	-	-	-
11/03/2021	1.11	<0.01	<0.01	<0.1	<0.1	0.05
16/04/2021	-	-	-	-	-	-
28/04/2021	1.1	<0.01	<0.01	<0.1	<0.1	0.08
09/07/2021	1.1	<0.01	<0.01	<0.1	<0.1	0.1
Q29MB07						
16/11/2020	2.95	<0.01	0.05	0.1	0.2	0.02
04/12/2020	-	-	-	-	-	-
07/01/2021	2.37	0.02	<0.01	<0.1	<0.1	0.01
03/02/2021	-	-	-	-	-	-
11/03/2021	5.38	<0.01	<0.01	<0.1	<0.1	0.03
16/04/2021	-	-	-	-	-	-
28/04/2021	<0.05	0.01	<0.01	<0.1	<0.1	0.05
09/07/2021	2.85	<0.01	<0.01	<0.1	<0.1	0.02
Q29MB08						
16/11/2020	0.81	0.01	0.09	<0.1	<0.1	<0.01
04/12/2020	-	-	-	-	-	-
07/01/2021	0.54	0.06	<0.01	<0.1	<0.1	<0.01
03/02/2021	-	-	-	-	-	-
09/03/2021	2.07	0.17	0.03	0.2	0.2	0.02
16/04/2021	-	-	-	-	-	-
29/04/2021	2.41	0.06	<0.01	0.2	0.2	<0.01

Table B.2 - Quest 29 Groundwater Quality

Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
09/07/2021	3.46	0.11	<0.01	0.2	0.2	0.01
16/11/2020	0.18	<0.01	0.05	<0.1	<0.1	0.06
04/12/2020	-	-	-	-	-	-
07/01/2021	1.27	0.01	<0.01	<0.1	<0.1	0.04
03/02/2021	-	-	-	-	-	-
11/03/2021	1.47	<0.01	<0.01	<0.1	<0.1	0.09
16/04/2021	-	-	-	-	-	-
06/05/2021	1.96	<0.01	0.03	<0.1	<0.1	0.13
08/07/2021	2.27	<0.01	<0.01	<0.1	<0.1	0.12

B.2 Quest 29 Open Pit Monitoring Results (2020-2021)

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
Q29SW BHS Pit								
06/06/2015	317	7.5	-	7	-	-	-	-
11/04/2016	317	7.5	-	6	-	-	-	-
07/07/2016	323	7.6	-	3	-	-	-	-
04/11/2016	380	7.8	-	1.8	-	-	-	-
20/12/2016	330	7.5	-	35	-	-	-	-
26/03/2017	460	6.9	-	3.5	-	-	-	-
30/06/2018	440	7.2	-	0.5	-	-	-	-
09/02/2019	379	7.54	-	-	-	-	-	-
22/02/2019	370	7.8	-	1.8	-	-	-	-
20/08/2019	400	7.4	-	6.5	-	-	-	-
30/10/2019	510	7.8	-	1.5	-	-	-	-
06/04/2020	220	7.8	-	1.1	-	-	-	-
17/11/2020	483	8.31	32.8	14.6	0.23	312	42.4	71.4
03/02/2021	285.2	6.34	31.2	28.6	0.13	185	-5.8	90.1
08/03/2021	-	-	-	-	-	-	-	-
27/04/2021	297.5	7.58	30.2	1.73	0.14	193	82.8	88.7

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Q29SW BHS Pit							
06/06/2015	<10	-	44.9	<5	<5	27	27
11/04/2016	<5	-	45	<5	<5	24	<5
07/07/2016	<5	-	49.7	<5	<5	28	28
04/11/2016	8	-	67	<5	<5	47	47
20/12/2016	<5	-	51	<5	<5	35	35
26/03/2017	<5	-	81	<5	<5	12	12
30/06/2018	<5	-	92	<5	<5	16	16
09/02/2019	-	-	-	<5	<5	31	31
22/02/2019	7	-	64	<5	<5	28	28
20/08/2019	19	-	75	<5	<5	41	41
30/10/2019	8	-	85	<5	<5	47	47
06/04/2020	<5	-	37	<5	<5	44	44
17/11/2020	28	8.2	78	<1	<1	76	76
03/02/2021	<5	1.2	87	<1	<1	22	22
08/03/2021	-	-	-	-	-	-	-
27/04/2021	<5	0.9	56	<1	<1	38	38

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Q29SW BHS Pit							
06/06/2015	<5	-	-	-	101	4.5	12.8
11/04/2016	<5	-	-	-	102	5.7	13
07/07/2016	<5	-	-	-	111	4.9	14.4
04/11/2016	<5	-	-	-	140	6	19
20/12/2016	<5	-	-	-	96	5	14
26/03/2017	<5	-	-	-	170	3	25
30/06/2018	<5	-	-	-	180	3	28
09/02/2019	<5	-	-	-	114	4	20
22/02/2019	<5	-	-	-	130	3	19
20/08/2019	<5	-	-	-	130	4	23
30/10/2019	<5	-	-	-	160	5	25
06/04/2020	<5	-	-	-	60	3	13
17/11/2020	7	<1	7	7	117	7	23
03/02/2021	5	<1	5	4	162	4	25
08/03/2021	-	-	-	-	-	-	-
27/04/2021	4	-	-	-	79	2	16

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
Q29SW BHS Pit									
06/06/2015	3.1	41.9	4.3	0.0824	0.00145	<0.0001	-	<0.001	0.00466
11/04/2016	3.1	41.3	4.5	0.0485	0.0026	0.0001	-	<0.001	0.0052
07/07/2016	46	3.4	4.5	0.0427	0.0013	0.0001	-	<0.001	0.00276
04/11/2016	4.4	55	5.6	0.02	0.002	<0.0001	-	<0.001	0.003
20/12/2016	3.7	41	4.3	0.01	0.002	<0.0001	-	<0.001	0.002
26/03/2017	4.4	53	3.8	<0.01	0.001	0.0003	-	<0.001	0.001
30/06/2018	5.3	53	3.7	0.01	0.001	0.0001	-	<0.001	0.002
09/02/2019	4	46	4	0.15	0.003	<0.0001	-	<0.001	0.002
22/02/2019	3.8	41	3.4	<0.01	0.002	<0.0001	-	<0.001	0.002
20/08/2019	4.5	45	4.4	<0.01	0.002	<0.0001	-	<0.001	0.002
30/10/2019	5.5	57	5.3	0.02	0.003	<0.0001	-	<0.001	0.003
06/04/2020	1.3	91	4	<0.01	0.004	<0.0001	-	<0.001	0.002
17/11/2020	5	49	6	<0.01	0.007	<0.0001	<0.001	<0.001	0.003
03/02/2021	6	48	4	0.08	0.006	<0.0001	<0.001	<0.001	0.001
08/03/2021	-	-	-	-	-	-	-	-	-
27/04/2021	4	24	3	0.01	0.005	<0.0001	<0.001	<0.001	0.002

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
Q29SW BHS Pit										
06/06/2015	<0.001	0.00887	<0.001	-	-	<0.0005	0.0244	0.032	0.191	0.0017
11/04/2016	<0.001	0.0102	0.00201	-	-	<0.0005	0.0452	0.02	0.163	0.0037
07/07/2016	<0.001	<0.005	0.00066	-	-	<0.0005	0.013	0.006	0.0997	0.0017
04/11/2016	<0.001	0.02	<0.001	-	-	<0.0005	0.013	0.02	0.02	0.002
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	<0.01	0.18	0.003
26/03/2017	<0.001	<0.005	0.006	-	-	<0.0005	0.017	<0.01	0.02	0.002
30/06/2018	<0.001	<0.005	0.002	-	-	<0.0005	0.006	<0.01	0.02	0.001
09/02/2019	<0.001	0.007	0.001	-	-	<0.0005	<0.001	0.07	-	-
22/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	0.02	0.002
20/08/2019	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	0.07	0.003
30/10/2019	<0.001	<0.005	0.002	-	-	<0.0005	0.014	<0.01	0.04	0.003
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.01	0.03	0.005
17/11/2020	<0.001	0.002	0.002	<0.01	<0.001	<0.001	<0.005	<0.05	0.08	0.008
03/02/2021	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.12	0.006
08/03/2021	-	-	-	-	-	-	-	-	-	-
27/04/2021	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.01	0.005

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
Q29SW BHS Pit												
06/06/2015	<0.0001	<0.001	<0.001	0.00688	0.00053	0.0173	0.00106	-	-	<0.0005	0.0239	0.118
11/04/2016	0.00012	<0.001	<0.0001	0.00676	0.00095	0.0303	0.00214	-	-	<0.0005	0.06	0.14
07/07/2016	0.00008	<0.001	<0.001	0.00439	<0.001	0.0146	0.00096	-	-	0.00009	0.0313	0.096
04/11/2016	<0.0001	<0.001	<0.001	0.003	<0.001	0.019	<0.001	-	-	<0.0005	0.005	0.03
20/12/2016	<0.0001	<0.001	<0.001	0.005	0.06	0.003	0.002	-	-	<0.0005	0.008	0.19
26/03/2017	0.0004	<0.001	<0.001	0.002	<0.001	0.011	0.006	-	-	<0.0005	0.018	0.03
30/06/2018	0.0002	<0.001	<0.001	0.003	<0.001	0.008	0.003	-	-	<0.0005	0.007	0.03
09/02/2019	-	-	-	-	-	-	-	-	-	-	-	-
22/02/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.012	<0.001	-	-	<0.0005	0.002	0.03
20/08/2019	<0.0001	<0.001	<0.001	0.003	<0.001	0.055	0.001	-	-	<0.0005	0.003	0.23
30/10/2019	<0.0001	<0.001	<0.001	0.004	<0.001	0.027	0.003	-	-	<0.0005	0.014	0.08
06/04/2020	<0.0001	<0.001	<0.001	0.003	<0.001	0.028	0.001	-	-	<0.0005	0.013	0.07
17/11/2020	<0.0001	<0.001	<0.001	0.004	<0.001	0.169	0.003	<0.01	<0.001	<0.001	<0.005	0.12
03/02/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.011	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
08/03/2021	-	-	-	-	-	-	-	-	-	-	-	-
27/04/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05

Table B.2 - Quest 29 Open Pit Water Quality

Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
Q29SW BHS Pit						
06/06/2015	-	-	-	-	-	-
11/04/2016	-	-	-	-	-	-
07/07/2016	-	-	-	-	-	-
04/11/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
20/08/2019	-	-	-	-	-	-
30/10/2019	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
17/11/2020	<0.05	0.03	0.03	0.6	0.6	0.01
03/02/2021	<0.05	<0.01	0.04	0.2	0.2	<0.01
08/03/2021	-	-	-	-	-	-
27/04/2021	<0.05	<0.01	0.02	0.1	0.1	<0.01

B.3 Quest 29 Surface Water Monitoring Results (2020-2021)

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
Date	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Q29SW Leach								
06/06/2015	793	5.1	-	7	-	-	-	-
29/03/2016	729	5.2	-	3	-	-	-	-
11/04/2016	761	5.1	-	1	-	-	-	-
11/05/2016	737	5	-	5	-	-	-	-
07/07/2016	840	5	-	4	-	-	-	-
04/11/2016	920	5.5	-	0.8	-	-	-	-
28/11/2016	870	5	-	2.6	-	-	-	-
20/12/2016	980	3.9	-	0.8	-	-	-	-
26/01/2017	750	5.8	-	3	-	-	-	-
26/03/2017	590	6.5	-	4.8	-	-	-	-
30/06/2018	660	7.1	-	15	-	-	-	-
09/02/2019	552	7.53	-	-	-	-	-	-
22/02/2019	550	7.7	-	0.7	-	-	-	-
20/08/2019	660	7.4	-	2	-	-	-	-
30/10/2019	1000	7.8	-	1.4	-	-	-	-
06/04/2020	450	8.8	-	0.6	-	-	-	-
15/09/2020	943	8.31	29.1	2.17	-	612	181	99.8
21/10/2020	1344	8.28	33.5	1.2	0.66	873	195.4	109.4
11/11/2020	1574	8.47	37.3	4.32	0.77	1020.5	74.6	83
04/12/2020	1002	7.7	34.1	10.23	0.49	651	183	109.6
11/01/2021	522	7.01	34.2	4.06	0.2	340.2	195	88.9
03/02/2021	428.9	7.95	31.9	5.36	0.2	278.85	88.4	98.4
11/03/2021	467	7.21	33.3	1.77	0.22	305.5	53.5	77.1
16/04/2021	476.8	7.97	32.5	2.1	0.23	310	124.3	110.2
27/04/2021	509	7.96	30.8	2.33	0.24	331.5	75.7	94.8
16/06/2021	597	8.06	28.3	0.42	0.29	388	177.9	110.5
09/07/2021	595	7.23	26	6.51	0.27	383.5	64.7	65.7
Q29SW1								
29/03/2016	150	6.99	-	-	-	-	-	-
11/04/2016	152	7.4	-	9	-	-	-	-
07/07/2016	212	6.9	-	5	-	-	-	-
04/11/2016	456	7	-	6	-	-	-	-
28/11/2016	270	6.6	-	2.7	-	-	-	-
20/12/2016	78	6.6	-	72	-	-	-	-
26/01/2017	98	6.5	-	17	-	-	-	-
26/03/2017	120	6.9	-	5.8	-	-	-	-
09/02/2019	150	6.99	-	5.8	-	-	-	-
22/02/2019	170	6.6	-	6.4	-	-	-	-
16/02/2020	220	6.3	-	12	-	-	-	-
06/04/2020	270	6.6	-	2.7	-	-	-	-
12/11/2020	49.2	7.25	28.9	over	0.02	31.85	93.5	53.8
09/12/2020	145	6.6	29.5	478	0.07	94	66.2	38.4
11/01/2021	147.8	5.26	32.8	21.5	0.1	96.3	161	116
03/02/2021	144.9	6.05	30.2	29.8	0.07	94.25	110.6	93.1
11/03/2021	185.6	6.08	29.1	4.88	0.09	120.9	53.1	77.7
16/04/2021	223	6.24	29.2	8.2	0.1	145	161	83
27/04/2021	272.6	6.44	29.2	4.17	0.13	176.8	92.2	87.5
Q29SW2								

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
29/03/2016	35	6.88	-	-	-	-	-	-
11/04/2016	37	7.3	-	43	-	-	-	-
28/11/2016	32	6.7	-	18	-	-	-	-
20/12/2016	16	6.3	-	1500	-	-	-	-
26/01/2017	22	6.5	-	61	-	-	-	-
26/03/2017	24	6.7	-	9.1	-	-	-	-
09/02/2019	35	6.88	-	9.1	-	-	-	-
22/02/2019	35	6.6	-	62	-	-	-	-
16/02/2020	43	6.4	-	52	-	-	-	-
06/04/2020	32	6.7	-	18	-	-	-	-
04/12/2020	22.5	5.94	27	360	0.01	15	300	81.1
07/01/2021	37.9	7.44	29	80	0	24.6	201	60.5
03/02/2021	23.9	5.91	28.5	152	0.01	15.6	121.7	91..0
08/03/2021	30.6	6.27	28	83.2	0.01	20.1	87.5	74.7
16/04/2021	44.6	6.6	27.3	21	0.02	29	190.8	80.6
06/05/2021	46.1	6.24	25.1	41	0.02	29.9	85.6	64.2
Q29SW3								
29/03/2016	63	7.37	-	-	-	-	-	-
11/05/2016	29	7.3	-	17	-	-	-	-
20/12/2016	74	4.4	-	120	-	-	-	-
26/03/2017	55	7.1	-	18	-	-	-	-
09/02/2019	63	7.37	-	18	-	-	-	-
06/04/2020	64	7.1	-	3.2	-	-	-	-
03/02/2021	-	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-	-
Q29SW4								
20/12/2016	12	6.1	-	1300	-	-	-	-
26/01/2017	34	6.6	-	38	-	-	-	-
26/03/2017	32	6.7	-	54	-	-	-	-
09/02/2019	40	7.07	-	54	-	-	-	-
22/02/2019	37	6.8	-	17	-	-	-	-
16/02/2020	44	6.6	-	39	-	-	-	-
06/04/2020	28	6.6	-	91	-	-	-	-
04/12/2020	20.6	5.81	32.4	220	0.01	13	172	81.2
11/01/2021	41.3	5.71	34.4	26.1	0	26.8	140	105.9
03/02/2021	24.8	5.72	29.5	74.6	0.01	16.25	126.9	95.5
08/03/2021	35.8	5.78	32.3	15.5	0.01	12.4	96.1	78.5
16/04/2021	64	6.77	29.4	60.1	0.03	42	157	97.6
29/04/2021	34.7	5.7	29.4	13.8	0.01	22.75	98	97.8
Q29SW5								
07/07/2016	44	7.1	-	8	-	-	-	-
20/12/2016	24	6.3	-	46	-	-	-	-
26/03/2017	29	6.7	-	20	-	-	-	-
09/02/2019	26	7.05	-	20	-	-	-	-
22/02/2019	28	7	-	7.2	-	-	-	-
30/10/2019	51	7	-	2.7	-	-	-	-
16/02/2020	41	6.7	-	13	-	-	-	-
06/04/2020	37	7.6	-	1.3	-	-	-	-
11/11/2020	52.1	8.11	34.6	7.36	0.02	33.8	40.5	54.7
03/02/2021	28.7	6.48	32.5	27.1	0.01	18.85	99.1	95.8

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements	Field Measurements
Analyte	Electrical Conductivity	pH	Temperature	Turbidity	Salinity	Total Dissolved Solids	Oxidation-Reduction Potential	Dissolved Oxygen
Analyte Short Name	EC (field)	pH (field)	Temp (field)	Turbidity (field)	Salinity (field)	TDS (field)	ORP (field)	DO %sat (field)
Units	µS/cm	-	°C	NTU	ppt	mg/L	mV	%
Toms Gully SSTV (80th percentile)	41	5.8 - 8.0	-	87	-	-	-	-
Tropical Australia Lowland Rivers	20 - 250	6.0 - 8.0	-	2 - 15	-	-	-	85-120
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	4000	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-	-
27/04/2021	51	7.34	29.1	5.14	0.02	32.5	85.9	79.2
Q29SW6								
20/12/2016	32	6.5	-	44	-	-	-	-
26/01/2017	34	6.5	-	20	-	-	-	-
26/03/2017	29	6.8	-	18	-	-	-	-
30/06/2018	29	6.77	-	-	-	-	-	-
09/02/2019	29	6.77	-	18	-	-	-	-
06/04/2020	51	6.6	-	3.3	-	-	-	-
11/01/2021	29.9	6.56	29.5	15.1	0	19.5	174	86.9
03/02/2021	27.4	6.3	30.8	28.9	0.01	17.55	102.9	89.7
08/03/2021	39.7	6.08	33.5	9.7	0.02	26	31.5	68.1
16/04/2021	48.3	6.33	29.2	25	0.02	31	166	66.5
27/04/2021	53.7	6.53	28.3	8.54	0.02	34.5	93.7	77.2
Q29SW7								
20/12/2016	49	6.6	-	66	-	-	-	-
26/01/2017	58	7.1	-	18	-	-	-	-
26/03/2017	67	7.2	-	16	-	-	-	-
30/06/2018	64	7.41	-	-	-	-	-	-
22/02/2019	67	7.2	-	16	-	-	-	-
16/02/2020	19	6	-	2.7	-	-	-	-
12/11/2020	38.4	8.33	29.2	over	0.02	24.7	58.9	74.3
11/01/2021	80.9	7.75	36.1	17.9	0	52.5	161	167.2
03/02/2021	66.1	6.64	33.3	45.4	0.03	42.9	92.1	112.6
16/04/2021	-	-	-	-	-	-	-	-
Q29SW7								
27/04/2021	-	-	-	-	-	-	-	-
20/12/2016	34	6.6	-	67	-	-	-	-
09/02/2019	20	6.39	-	-	-	-	-	-
11/01/2021	20.9	4.1	32.5	19.1	0	13.7	132	45.7
03/02/2021	31.7	6.2	30.9	39.7	0.01	20.8	109.8	102.4
08/03/2021	75.5	6.51	31.8	9.41	0.03	49.4	45.3	87.4
16/04/2021	114	7.12	87.9	13.2	0.05	74	153	77
27/04/2021	124	6.76	29.6	12.2	0.06	80	64.7	66

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Date	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Q29SW Leach							
06/06/2015	<10	-	151	<5	<5	<5	<5
29/03/2016	20	-	142	<5	<5	<5	<5
11/04/2016	<10	-	145	<5	<5	<5	<5
11/05/2016	10	-	137	<5	<5	<5	<5
07/07/2016	<5	-	167	<5	<5	<5	<5
04/11/2016	23	-	210	<5	<5	<5	<5
28/11/2016	22	-	190	<5	<5	<5	<5
20/12/2016	<5	-	190	<5	<5	<5	<5
26/01/2017	7	-	140	<5	<5	<5	<5
26/03/2017	6	-	120	<5	<5	6	<5
30/06/2018	98	-	150	<5	<5	22	22
09/02/2019	-	-	-	<5	<5	26	26
22/02/2019	8	-	120	<5	<5	26	26
20/08/2019	51	-	140	<5	<5	35	35
30/10/2019	7	-	200	<5	<5	44	44
06/04/2020	<5	-	93	<5	14	18	33
15/09/2020	<5	-	211	<1	<1	43	43
21/10/2020	5	-	258	<1	<1	43	43
11/11/2020	6	0.9	275	<1	<1	37	37
04/12/2020	6	3.3	183	<1	<1	35	35
11/01/2021	6	1.3	85	<1	<1	26	26
03/02/2021	<5	11.7	45	<1	<1	41	41
11/03/2021	<5	0.8	90	<1	<1	24	24
16/04/2021	<5	2.8	100	<1	<1	31	31
27/04/2021	<5	0.5	108	<1	<1	28	28
16/06/2021	<5	0.8	128	<1	<1	31	31
09/07/2021	<5	0.7	144	<1	<1	38	38
Q29SW1							
29/03/2016	-	-	-	<5	<5	24	24
11/04/2016	30	-	35.5	<5	<5	<5	20
07/07/2016	<5	-	46.2	<5	<5	<5	23
04/11/2016	10	-	132	<5	<5	<5	35
28/11/2016	<5	-	86	<5	<5	27	27
20/12/2016	9	-	25	<5	<5	11	11
26/01/2017	<5	-	20	<5	<5	16	16
26/03/2017	<5	-	26	<5	<5	24	24
09/02/2019	<5	-	26	<5	<5	24	24
22/02/2019	6	-	37	<5	<5	22	22
16/02/2020	9	-	54	<5	<5	25	25
06/04/2020	<5	-	86	<5	<5	27	27
12/11/2020	812	879	9	<1	<1	9	9
09/12/2020	16	46.1	34	<1	<1	26	26
11/01/2021	14	8	22	<1	<1	26	26
03/02/2021	<5	13.6	38	<1	<1	24	24
11/03/2021	<5	3.4	45	<1	<1	24	24
16/04/2021	<5	5.6	60	<1	<1	29	29
27/04/2021	<5	2.3	60	<1	<1	30	30
Q29SW2							

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
29/03/2016	-	-	-	<5	<5	10	10
11/04/2016	40	-	5.6	<5	<5	<5	8
28/11/2016	8	-	5	<5	<5	14	14
20/12/2016	17	-	<3	<5	<5	<5	<5
26/01/2017	49	-	4	<5	<5	7	7
26/03/2017	120	-	4	<5	<5	9.9	6
09/02/2019	120	-	4	<5	<5	10	10
22/02/2019	140	-	7	<5	<5	13	13
16/02/2020	28	-	11	<5	<5	17	17
06/04/2020	8	-	5	<5	<5	14	14
04/12/2020	214	336	<1	<1	<1	5	5
07/01/2021	26	52	<1	<1	<1	8	8
03/02/2021	57	70	<1	<1	<1	7	7
08/03/2021	32	41.9	<1	<1	<1	12	12
16/04/2021	8	14.8	<1	<1	<1	12	12
06/05/2021	12	29.9	7	<1	<1	18	18
Q29SW3							
29/03/2016	-	-	-	<5	<5	27	27
11/05/2016	20	-	8.3	<5	<5	<5	9
20/12/2016	8	-	19	<5	<5	<5	<5
26/03/2017	<5	-	21	<5	<5	24	24
09/02/2019	<5	-	21	<5	<5	27	27
06/04/2020	8	-	25	<5	<5	29	29
03/02/2021	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-
Q29SW4							
20/12/2016	71	-	<3	<5	<5	<5	<5
26/01/2017	18	-	6	<5	<5	10	10
26/03/2017	64	-	5	<5	<5	12	12
09/02/2019	64	-	5	<5	<5	10	10
22/02/2019	9	-	6	<5	<5	12	12
16/02/2020	32	-	12	<5	<5	17	17
06/04/2020	71	-	5	<5	<5	10	10
04/12/2020	90	194	<1	<1	<1	4	4
11/01/2021	7	18.6	4	<1	<1	12	12
03/02/2021	22	34.2	<1	<1	<1	7	7
08/03/2021	<5	9.3	<1	<1	<1	13	13
16/04/2021	26	46.4	13	<1	<1	10	10
29/04/2021	8	7.2	<1	<1	<1	11	11
Q29SW5							
07/07/2016	<5	-	13.3	<5	<5	14	14
20/12/2016	6	-	7	<5	<5	<5	<5
26/03/2017	12	-	7	<5	<5	13	13
09/02/2019	12	-	7	<5	<5	12	12
22/02/2019	9	-	7	<5	<5	10	10
30/10/2019	5	-	14	<5	<5	17	17
16/02/2020	20	-	8	<5	<5	11	11
06/04/2020	14	-	8	<5	<5	25	25
11/11/2020	6	2.9	13	<1	<1	14	14
03/02/2021	6	9.5	<1	<1	<1	9	9

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Physico-chemical	Physico-chemical	Physico-chemical	Alkalinity	Alkalinity	Alkalinity	Alkalinity
Analyte	Total Suspended Solids	Turbidity	Total Hardness	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3
Analyte Short Name	TSS	Turbidity (lab)	Total Hardness	Alk OH	Alk CO3	Alk HCO3	Alk Tot
Units	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	54	87	-	-	-	-	-
Tropical Australia Lowland Rivers	2 - 15	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
27/04/2021	<5	3.1	13	<1	<1	14	14
Q29SW6							
20/12/2016	30	-	10	<5	<5	11	11
26/01/2017	9	-	8	<5	<5	11	11
26/03/2017	<5	-	7	<5	<5	13	13
30/06/2018	-	-	-	<5	<5	10	10
09/02/2019	<5	-	7	<5	<5	10	10
06/04/2020	30	-	18	<5	<5	19	19
11/01/2021	6	11	<1	<1	<1	8	8
03/02/2021	<5	9.2	<1	<1	<1	9	9
08/03/2021	<5	5.6	13	<1	<1	23	23
16/04/2021	8	13	13	<1	<1	15	15
27/04/2021	<5	5.3	17	<1	<1	16	16
Q29SW7							
20/12/2016	-	-	17	<5	<5	15	15
26/01/2017	<5	-	21	<5	<5	23	23
26/03/2017	<5	-	25	<5	<5	29	29
30/06/2018	-	-	-	<5	<5	31	31
22/02/2019	<5	-	25	<5	<5	29	29
16/02/2020	<5	-	4	<5	<5	<5	<5
12/11/2020	2000	2100	4	<1	<1	7	7
11/01/2021	<5	15.7	25	<1	<1	30	30
03/02/2021	7	22.1	18	<1	<1	25	25
16/04/2021	-	-	-	-	-	-	-
Q29SW7							
27/04/2021	-	-	-	-	-	-	-
20/12/2016	-	-	11	<5	<5	13	13
09/02/2019	-	-	-	<5	<5	11	11
11/01/2021	<5	11.4	7	<1	<1	12	12
03/02/2021	6	9.7	7	<1	<1	17	17
08/03/2021	<5	6.3	29	<1	<1	38	38
16/04/2021	7	8.1	40	<1	<1	48	48
27/04/2021	10	3.2	45	<1	<1	50	50

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
Date	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Q29SW Leach							
06/06/2015	16	-	-	-	341	6	48.6
29/03/2016	10	-	-	-	320	4.4	45.8
11/04/2016	11	-	-	-	324	5.6	46.7
11/05/2016	14	-	-	-	312	4.9	44.1
07/07/2016	13	-	-	-	370	8.9	53.9
04/11/2016	12	-	-	-	460	7	66
28/11/2016	10	-	-	-	430	12	62
20/12/2016	17	-	-	-	390	6	61
26/01/2017	9	-	-	-	320	5	45
26/03/2017	<5	-	-	-	230	6	39
30/06/2018	<5	-	-	-	280	3	45
09/02/2019	<5	-	-	-	187	4	34
22/02/2019	<5	-	-	-	220	3	35
20/08/2019	<5	-	-	-	260	4	42
30/10/2019	<5	-	-	-	380	7	60
06/04/2020	<5	-	-	-	170	3	26
15/09/2020	8	-	-	-	383	8	63
21/10/2020	2	-	-	-	539	12	77
11/11/2020	11	<1	10	10	559	12	82
04/12/2020	4	<1	4	4	380	8	55
11/01/2021	4	<1	4	4	172	4	24
03/02/2021	4	<1	4	4	55	4	13
11/03/2021	3	<1	3	3	164	2	26
16/04/2021	4	<1	4	4	164	2	27
27/04/2021	4	-	-	-	175	2	30
16/06/2021	2	<1	<1	<1	201	3	35
09/07/2021	3	<1	3	2	240	2	41
Q29SW1							
29/03/2016	2	-	-	-	38	4	6
11/04/2016	9	-	-	-	41.2	2.9	6.6
07/07/2016	10	-	-	-	61	3.4	8.4
04/11/2016	<5	-	-	-	162	8.2	24.3
28/11/2016	8	-	-	-	91	4	16
20/12/2016	<5	-	-	-	17	2	5
26/01/2017	9	-	-	-	22	3	3.8
26/03/2017	6	-	-	-	27	3	5.2
09/02/2019	<5	-	-	-	38	4	5.2
22/02/2019	9	-	-	-	43	3	6.7
16/02/2020	9	-	-	-	66	7	10
06/04/2020	8	-	-	-	91	4	16
12/11/2020	11	<1	11	10	<1	2	2
09/12/2020	6	<1	6	6	31	5	7
11/01/2021	6	<1	6	6	26	4	4
03/02/2021	7	<1	7	7	35	4	7
11/03/2021	5	<1	5	4	51	2	8
16/04/2021	9	<1	9	8	60	4	11
27/04/2021	6	-	-	-	76	3	11
Q29SW2							

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
29/03/2016	1	-	-	-	2	3	<1
11/04/2016	<5	-	-	-	3.6	2	0.8
28/11/2016	<5	-	-	-	1	2	0.6
20/12/2016	<5	-	-	-	<1	<1	<0.5
26/01/2017	7	-	-	-	<1	2	0.6
26/03/2017	<5	-	-	-	<1	2	0.6
09/02/2019	<5	-	-	-	2	3	0.6
22/02/2019	<5	-	-	-	<1	2	1
16/02/2020	6	-	-	-	<1	3	1.7
06/04/2020	<5	-	-	-	1	2	0.6
04/12/2020	5	<1	5	5	<1	1	<1
07/01/2021	4	<1	4	4	<1	2	<1
03/02/2021	4	<1	4	4	<1	2	<1
08/03/2021	4	<1	4	4	1	2	<1
16/04/2021	4	<1	4	4	3	2	<1
06/05/2021	7	<1	7	7	1	4	1
Q29SW3							
29/03/2016	1	-	-	-	2	3	3
11/05/2016	6	-	-	-	<1	1.3	1.2
20/12/2016	10	-	-	-	1	2	2.4
26/03/2017	<5	-	-	-	2	2	3.8
09/02/2019	<5	-	-	-	2	3	3.8
06/04/2020	<5	-	-	-	2	3	4.1
03/02/2021	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-
Q29SW4							
20/12/2016	<5	-	-	-	<1	<1	<0.5
26/01/2017	7	-	-	-	1	3	0.9
26/03/2017	<5	-	-	-	2	2	0.7
09/02/2019	<5	-	-	-	3	3	0.7
22/02/2019	<5	-	-	-	1	2	0.7
16/02/2020	<5	-	-	-	<1	3	1.7
06/04/2020	<5	-	-	-	<1	2	0.6
04/12/2020	6	<1	6	6	<1	<1	<1
11/01/2021	4	<1	4	4	<1	3	<1
03/02/2021	4	<1	4	3	<1	2	<1
08/03/2021	4	<1	4	4	2	2	<1
16/04/2021	5	<1	5	5	12	2	2
29/04/2021	5	<1	5	5	1	3	<1
Q29SW5							
07/07/2016	<5	-	-	-	1.8	1.5	2
20/12/2016	6	-	-	-	<1	1	1.1
26/03/2017	<5	-	-	-	<1	2	1.1
09/02/2019	<5	-	-	-	<1	2	1.1
22/02/2019	<5	-	-	-	<1	1	0.9
30/10/2019	<5	-	-	-	3	2	2.1
16/02/2020	<5	-	-	-	1	4	1.3
06/04/2020	<5	-	-	-	1	2	1.2
11/11/2020	7	<1	7	7	<1	2	2
03/02/2021	4	<1	4	3	<1	2	<1

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Acidity	Acidity	Acidity	Acidity	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)
Analyte	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	Sulfate as SO4	Chloride	Calcium
Analyte Short Name	Acidity as CaCO3	Acidity as CaCO3 (pH 3.7)	Acidity as CaCO3 (pH 8.3)	Acidity as H2SO4	SO4	Cl	Ca
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	210	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	1000	-	1000
ANZECC 2000 long term irrigation	-	-	-	-	-	-	-
27/04/2021	5	-	-	-	2	1	2
Q29SW6							
20/12/2016	<5	-	-	-	<1	1	1.8
26/01/2017	7	-	-	-	<1	2	1.2
26/03/2017	<5	-	-	-	<1	2	1.1
30/06/2018	1	-	-	-	<1	2	1
09/02/2019	<5	-	-	-	<1	2	1.1
06/04/2020	6	-	-	-	1	3	2.8
11/01/2021	3	<1	3	3	<1	2	<1
03/02/2021	4	<1	4	3	<1	2	<1
08/03/2021	5	<1	5	4	<1	2	2
16/04/2021	6	<1	6	6	1	2	2
27/04/2021	5	-	-	-	2	2	2
Q29SW7							
20/12/2016	5	-	-	-	2	2	3.4
26/01/2017	6	-	-	-	2	3	4.3
26/03/2017	<5	-	-	-	2	2	5.2
30/06/2018	2	-	-	-	2	5	6
22/02/2019	<5	-	-	-	2	2	5.2
16/02/2020	5	-	-	-	<1	4	0.5
12/11/2020	9	<1	9	9	<1	2	<1
11/01/2021	4	<1	4	4	2	5	5
03/02/2021	5	<1	5	5	3	4	4
16/04/2021	-	-	-	-	-	-	-
Q29SW7							
27/04/2021	-	-	-	-	-	-	-
20/12/2016	<5	-	-	-	<1	2	2.1
09/02/2019	<5	-	-	-	<1	1	<1
11/01/2021	4	<1	4	3	<1	3	1
03/02/2021	3	<1	3	3	<1	2	1
08/03/2021	5	<1	5	5	2	3	5
16/04/2021	6	<1	6	6	2	3	8
27/04/2021	6	<1	6	6	3	4	8

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
Date	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Q29SW Leach									
06/06/2015	7.2	98.5	6.3	1.36	0.0013	0.00598	-	0.0202	0.0579
29/03/2016	6.8	87.9	5.4	1.44	0.0019	0.00512	-	0.0191	0.0654
11/04/2016	6.8	91.1	5.5	1.3	0.0016	0.00516	-	0.019	0.0595
11/05/2016	6.6	86.4	5.3	1.28	0.00135	0.00528	-	0.0188	0.0584
07/07/2016	108	7.8	7.5	1.42	0.00125	0.00516	-	0.019	0.0618
04/11/2016	10	130	7.9	1.6	0.001	0.0069	-	0.026	0.054
28/11/2016	9.5	110	7.4	1.3	0.001	0.0064	-	0.021	0.036
20/12/2016	9.4	120	6.9	0.83	0.001	0.0056	-	0.02	0.035
26/01/2017	7.1	91	5.4	0.36	0.002	0.0045	-	0.014	0.015
26/03/2017	5.2	66	3.8	0.07	0.002	0.0031	-	0.006	0.007
30/06/2018	8.9	77	5.2	0.06	0.004	0.0004	-	<0.001	0.003
09/02/2019	6	62	4	0.08	0.007	<0.0001	-	<0.001	<0.001
22/02/2019	6.6	59	4.3	0.099	0.007	<0.0001	-	<0.001	0.002
20/08/2019	8.9	76	5.4	0.12	0.006	<0.0001	-	<0.001	0.002
30/10/2019	13	110	8.2	0.18	0.014	<0.0001	-	<0.001	0.002
06/04/2020	6.8	56	3.7	0.1	0.004	<0.0001	-	<0.001	0.002
15/09/2020	13	131	9	0.11	0.018	<0.0001	-	<0.001	0.003
21/10/2020	16	161	11	0.1	0.018	<0.0001	<0.001	<0.001	0.002
11/11/2020	17	172	13	0.13	0.013	<0.0001	<0.001	<0.001	0.002
04/12/2020	11	110	7	0.08	0.011	<0.0001	<0.001	<0.001	0.001
11/01/2021	6	51	4	0.05	0.006	<0.0001	<0.001	<0.001	<0.001
03/02/2021	3	23	4	0.06	0.003	<0.0001	<0.001	<0.001	0.002
11/03/2021	6	42	3	0.03	0.003	0.0002	<0.001	<0.001	0.002
16/04/2021	8	45	3	0.03	0.005	<0.0001	0.001	<0.001	<0.001
27/04/2021	8	47	3	0.04	0.006	<0.0001	<0.001	<0.001	0.003
16/06/2021	10	54	4	0.05	0.008	<0.0001	<0.001	<0.001	0.004
09/07/2021	10	61	4	0.04	0.008	<0.0001	<0.001	<0.001	<0.001
Q29SW1									
29/03/2016	4	15	2	0.16	0.003	<0.0001	-	<0.001	0.003
11/04/2016	4.6	13.6	1.6	0.106	0.0033	<0.0001	-	0.00107	0.00272
07/07/2016	6.1	20.6	1.8	0.0428	0.0026	<0.0001	-	0.001	0.0013
04/11/2016	17.4	33.5	3.2	0.0403	0.00305	<0.0001	-	0.00273	0.00217
28/11/2016	11	23	2	<0.01	0.002	<0.0001	-	<0.001	0.002
20/12/2016	3.1	3.6	2.7	0.21	0.006	<0.0001	-	<0.001	0.003
26/01/2017	2.6	9.4	1.6	0.13	0.003	<0.0001	-	<0.001	0.003
26/03/2017	3.3	9.8	1.7	0.05	0.003	<0.0001	-	<0.001	0.002
09/02/2019	3.3	9.8	1.7	0.16	0.003	<0.0001	-	<0.001	0.003
22/02/2019	5	15	1.8	<0.01	0.002	<0.0001	-	<0.001	0.001
16/02/2020	7.1	20	3	<0.01	0.004	<0.0001	-	0.002	0.002
06/04/2020	11	23	2	<0.01	0.002	<0.0001	-	<0.001	0.002
12/11/2020	1	1	3	0.09	0.004	<0.0001	<0.001	<0.001	<0.001
09/12/2020	4	8	4	<0.01	0.004	<0.0001	<0.001	<0.001	0.002
11/01/2021	3	11	2	<0.01	0.002	<0.0001	<0.001	<0.001	<0.001
03/02/2021	5	12	2	0.01	0.004	<0.0001	<0.001	<0.001	0.003
11/03/2021	6	12	2	0.1	0.003	<0.0001	<0.001	<0.001	0.002
16/04/2021	8	15	2	0.15	0.003	<0.0001	<0.001	<0.001	<0.001
27/04/2021	8	20	2	0.06	0.002	<0.0001	<0.001	0.001	0.005
Q29SW2									

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
29/03/2016	<1	4	1	0.18	0.001	<0.0001	-	<0.001	<0.001
11/04/2016	0.9	4.1	1.2	0.14	0.001	<0.0001	-	<0.001	0.00159
28/11/2016	0.8	4.2	1.5	0.11	<0.001	<0.0001	-	<0.001	<0.001
20/12/2016	<0.5	1.2	1.3	0.07	<0.001	<0.0001	-	<0.001	<0.001
26/01/2017	0.7	2.3	0.6	0.19	<0.001	<0.0001	-	<0.001	0.001
26/03/2017	0.6	2.6	0.7	0.17	0.001	<0.0001	-	<0.001	<0.001
09/02/2019	0.6	2.6	0.7	0.18	0.001	<0.0001	-	<0.001	<0.001
22/02/2019	1	4	1.5	0.06	0.001	<0.0001	-	<0.001	<0.001
16/02/2020	1.7	3.7	1.3	0.08	0.002	<0.0001	-	<0.001	0.001
06/04/2020	0.8	4.2	1.5	0.11	<0.001	<0.0001	-	<0.001	<0.001
04/12/2020	<1	1	2	0.52	<0.001	<0.0001	<0.001	<0.001	0.001
07/01/2021	<1	3	<1	0.11	<0.001	<0.0001	<0.001	<0.001	<0.001
03/02/2021	<1	3	<1	0.1	<0.001	<0.0001	0.002	<0.001	0.001
08/03/2021	<1	3	<1	0.4	0.002	<0.0001	<0.001	<0.001	<0.001
16/04/2021	<1	5	1	0.11	0.001	<0.0001	<0.001	<0.001	<0.001
06/05/2021	1	4	2	0.21	0.001	<0.0001	<0.001	<0.001	<0.001
Q29SW3									
29/03/2016	3	3	2	0.2	0.278	<0.0001	-	<0.001	0.002
11/05/2016	1.3	1.8	1.3	0.38	0.00785	<0.0001	-	<0.001	0.00204
20/12/2016	3.1	1.5	1.8	0.07	0.28	<0.0001	-	<0.001	0.002
26/03/2017	2.8	2	1.4	0.08	0.033	<0.0001	-	<0.001	<0.001
09/02/2019	2.8	2	1.4	0.2	0.278	<0.0001	-	<0.001	0.002
06/04/2020	3.5	4.4	2	0.02	0.12	<0.0001	-	<0.001	0.001
03/02/2021	-	-	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-	-	-
Q29SW4									
20/12/2016	<0.5	1.2	1	0.07	<0.001	<0.0001	-	<0.001	<0.001
26/01/2017	0.99	3.8	1.1	0.18	<0.001	<0.0001	-	<0.001	0.001
26/03/2017	0.8	3.7	1.1	0.29	<0.001	<0.0001	-	<0.001	<0.001
09/02/2019	0.8	3.7	1.1	0.08	0.002	<0.0001	-	<0.001	<0.001
22/02/2019	0.9	3.9	1.4	0.04	<0.001	<0.0001	-	<0.001	<0.001
16/02/2020	1.8	3.6	1.8	0.07	0.001	<0.0001	-	<0.001	0.001
06/04/2020	0.8	3.7	1	0.17	<0.001	<0.0001	-	<0.001	<0.001
04/12/2020	<1	1	2	0.32	<0.001	<0.0001	<0.001	<0.001	<0.001
11/01/2021	1	4	1	0.04	<0.001	<0.0001	<0.001	<0.001	<0.001
03/02/2021	<1	3	<1	0.08	<0.001	<0.0001	0.001	<0.001	<0.001
08/03/2021	<1	4	1	0.22	<0.001	<0.0001	<0.001	<0.001	<0.001
16/04/2021	2	6	2	0.34	<0.001	<0.0001	<0.001	<0.001	<0.001
29/04/2021	<1	4	1	0.18	<0.001	<0.0001	<0.001	<0.001	<0.001
Q29SW5									
07/07/2016	2.2	2	1.6	0.0316	0.0165	<0.0001	-	<0.001	0.00282
20/12/2016	1	1.1	1.7	0.08	0.005	<0.0001	-	<0.001	0.001
26/03/2017	1.2	2.5	1	0.16	0.004	<0.0001	-	<0.001	<0.001
09/02/2019	1.2	2.5	1	0.09	0.002	<0.0001	-	<0.001	<0.001
22/02/2019	1.1	1.9	1	0.03	0.009	<0.0001	-	<0.001	0.001
30/10/2019	2.2	2.4	2.1	0.03	0.026	<0.0001	-	<0.001	0.002
16/02/2020	1.2	2.7	1.7	0.07	0.009	<0.0001	-	<0.001	0.003
06/04/2020	1.2	2.5	1.2	0.03	0.017	<0.0001	-	<0.001	0.001
11/11/2020	2	2	1	0.02	0.03	<0.0001	<0.001	<0.001	<0.001
03/02/2021	<1	2	<1	0.38	0.004	<0.0001	<0.001	<0.001	<0.001

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Major Ions (dissolved)	Major Ions (dissolved)	Major Ions (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)
Analyte	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Cobalt	Copper
Analyte Short Name	Mg	Na	K	Al F	As F	Cd F	Cr F	Co F	Cu F
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	0.295	0.042	0.0004	0.006	-	0.0018
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	-	-	-	insufficient data	0.024	0.0002	0.001	-	0.0014
ANZECC 2000 Livestock Watering (beef cattle)	2000	-	-	5	0.5	0.01	1	1	2
ANZECC 2000 long term irrigation	-	-	-	5	0.1	0.01	0.1	0.05	0.2
27/04/2021	2	4	1	0.12	0.022	0.0001	<0.001	0.001	0.007
Q29SW6									
20/12/2016	1.4	1.4	1.9	0.04	0.008	<0.0001	-	<0.001	0.001
26/01/2017	1.2	2.6	1.5	0.11	0.006	<0.0001	-	<0.001	0.002
26/03/2017	1.2	2.3	1	0.13	0.005	<0.0001	-	<0.001	<0.001
30/06/2018	1	2	1	0.11	0.012	<0.0001	-	<0.001	<0.001
09/02/2019	1.2	2.3	1	0.11	0.012	<0.0001	-	<0.001	<0.001
06/04/2020	2.7	4.3	1.6	<0.01	0.015	<0.0001	-	<0.001	0.001
11/01/2021	<1	2	1	0.06	0.003	<0.0001	<0.001	<0.001	<0.001
03/02/2021	<1	2	<1	0.49	0.005	<0.0001	<0.001	<0.001	<0.001
08/03/2021	2	2	1	0.15	0.007	<0.0001	<0.001	<0.001	<0.001
16/04/2021	2	2	2	0.2	0.011	<0.0001	<0.001	<0.001	<0.001
27/04/2021	3	4	1	0.14	0.009	<0.0001	<0.001	0.001	0.004
Q29SW7									
20/12/2016	2.1	1.7	2	0.13	0.005	<0.0001	-	<0.001	0.003
26/01/2017	2.6	2.3	1.3	0.07	0.006	<0.0001	-	<0.001	0.002
26/03/2017	3	2.3	1.5	0.08	0.006	<0.0001	-	<0.001	<0.001
30/06/2018	3	3	2	0.11	0.011	<0.0001	-	<0.001	0.001
22/02/2019	3	2.3	1.5	0.08	0.006	<0.0001	-	<0.001	<0.001
16/02/2020	0.6	1.9	<0.5	0.02	<0.001	<0.0001	-	0.001	<0.001
12/11/2020	1	1	2	0.16	0.037	<0.0001	<0.001	<0.001	0.002
11/01/2021	3	3	2	<0.01	0.014	<0.0001	<0.001	<0.001	<0.001
03/02/2021	2	3	1	0.47	0.011	<0.0001	<0.001	<0.001	0.001
16/04/2021	-	-	-	-	-	-	-	-	-
Q29SW7									
27/04/2021	-	-	-	-	-	-	-	-	-
20/12/2016	1.4	1.4	1.9	0.04	0.007	<0.0001	-	<0.001	0.001
09/02/2019	<1	2	<1	0.02	<0.001	<0.0001	-	<0.001	<0.001
11/01/2021	1	2	1	0.05	0.004	<0.0001	<0.001	<0.001	<0.001
03/02/2021	1	2	<1	0.41	0.006	<0.0001	<0.001	<0.001	<0.001
08/03/2021	4	3	1	0.21	0.008	<0.0001	<0.001	<0.001	<0.001
16/04/2021	5	3	2	0.12	0.007	<0.0001	<0.001	<0.001	<0.001
27/04/2021	6	4	2	0.05	0.008	<0.0001	<0.001	<0.001	<0.001

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
Date	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Q29SW Leach										
06/06/2015	<0.001	0.291	0.0926	-	-	<0.0005	0.339	0.01	1.48	0.0015
29/03/2016	<0.001	0.257	0.0869	-	-	0.00119	0.292	<0.01	1.68	0.00265
11/04/2016	<0.001	0.255	0.0862	-	-	0.00101	0.306	0.006	1.36	0.002
11/05/2016	<0.001	0.273	0.0893	-	-	<0.0005	0.321	0.008	1.4	0.00155
07/07/2016	<0.001	0.317	0.1	-	-	<0.0005	0.369	0.018	1.54	0.0015
04/11/2016	<0.001	0.37	0.11	-	-	0.0007	0.38	0.01	1.5	0.001
28/11/2016	<0.001	0.35	0.095	-	-	<0.0005	0.32	0.02	1.1	0.001
20/12/2016	0.31	0.084	<0.001	-	-	<0.0005	0.28	<0.01	0.86	0.002
26/01/2017	0.24	0.065	<0.001	-	-	<0.0005	0.21	<0.01	0.82	0.002
26/03/2017	<0.001	0.12	0.039	-	-	<0.0005	0.12	<0.01	0.14	0.002
30/06/2018	<0.001	<0.005	0.005	-	-	<0.0005	0.005	<0.01	0.41	0.006
09/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	<0.05	-	-
22/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	<0.01	0.15	0.007
20/08/2019	<0.001	<0.005	<0.001	-	-	0.0007	<0.001	<0.01	0.13	0.006
30/10/2019	<0.001	<0.005	<0.001	-	-	0.002	0.002	<0.01	0.2	0.015
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	<0.01	0.11	0.006
15/09/2020	<0.001	0.005	<0.001	<0.01	<0.001	0.001	<0.005	<0.05	0.13	0.02
21/10/2020	<0.001	0.033	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.13	0.019
11/11/2020	<0.001	0.017	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.15	0.013
04/12/2020	<0.001	<0.001	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.17	0.013
11/01/2021	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.08	0.006
03/02/2021	<0.001	0.032	<0.001	<0.01	<0.001	<0.001	<0.005	0.06	0.13	0.003
11/03/2021	<0.001	0.002	0.002	<0.01	<0.001	<0.001	<0.005	<0.05	0.04	0.004
16/04/2021	<0.001	<0.001	0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.12	0.006
27/04/2021	<0.001	0.004	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.04	0.005
16/06/2021	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.07	0.008
09/07/2021	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.05	0.009
Q29SW1										
29/03/2016	<0.001	0.043	<0.001	-	-	<0.0005	<0.001	0.17	-	-
11/04/2016	<0.001	0.0565	<0.001	-	-	<0.0005	0.0095	0.118	0.953	0.00405
07/07/2016	<0.001	0.0355	<0.001	-	-	<0.0005	0.01	0.072	0.246	0.0037
04/11/2016	<0.001	0.194	0.00163	-	-	<0.0005	0.0229	0.118	0.305	0.0052
28/11/2016	<0.001	0.044	<0.001	-	-	<0.0005	0.003	0.01	0.05	0.004
20/12/2016	<0.001	0.001	<0.001	-	-	<0.0005	0.003	0.17	0.42	0.011
26/01/2017	0.025	<0.005	<0.001	-	-	<0.0005	0.001	0.12	0.2	0.003
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.09	0.05	0.004
09/02/2019	<0.001	0.043	<0.001	-	-	<0.0005	<0.001	0.17	0.05	0.004
22/02/2019	<0.001	0.041	<0.001	-	-	<0.0005	0.004	0.02	0.11	0.004
16/02/2020	<0.001	0.25	0.001	-	-	<0.0005	0.01	0.02	0.15	0.011
06/04/2020	<0.001	0.044	<0.001	-	-	<0.0005	0.003	0.01	0.05	0.004
12/11/2020	0.003	<0.001	<0.001	<0.01	<0.001	<0.001	<0.005	0.22	9.03	0.068
09/12/2020	<0.001	0.175	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.69	0.006
11/01/2021	<0.001	0.037	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.11	0.004
03/02/2021	0.001	0.006	0.001	<0.01	<0.001	<0.001	<0.005	0.48	0.92	0.004
11/03/2021	<0.001	0.04	<0.001	<0.01	<0.001	<0.001	<0.005	0.1	0.2	0.004
16/04/2021	<0.001	0.048	<0.001	<0.01	<0.001	<0.001	<0.005	0.13	0.14	0.004
27/04/2021	<0.001	0.033	<0.001	<0.01	<0.001	<0.001	<0.005	0.09	0.08	0.002
Q29SW2										

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
29/03/2016	<0.001	0.034	0.001	-	-	<0.0005	<0.001	0.38	-	-
11/04/2016	<0.001	0.0152	<0.001	-	-	<0.0005	0.0087	0.132	4.34	0.002
28/11/2016	<0.001	0.006	<0.001	-	-	<0.0005	<0.001	0.16	0.31	<0.001
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.11	6.9	0.004
26/01/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.01	0.22	0.72	0.002
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.18	0.1	0.002
09/02/2019	<0.001	0.034	<0.001	-	-	<0.0005	<0.001	0.38	0.1	0.002
22/02/2019	<0.001	0.015	<0.001	-	-	<0.0005	0.005	0.21	0.84	0.002
16/02/2020	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.5	0.69	0.003
06/04/2020	<0.001	0.006	<0.001	-	-	<0.0005	<0.001	0.16	0.31	<0.001
04/12/2020	<0.001	0.01	<0.001	<0.01	<0.001	<0.001	<0.005	0.5	6.68	0.003
07/01/2021	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	0.3	1.25	0.001
03/02/2021	<0.001	0.005	0.001	<0.01	<0.001	<0.001	<0.005	1.39	2.61	<0.001
08/03/2021	<0.001	0.009	<0.001	<0.01	<0.001	<0.001	<0.005	0.34	1.11	0.002
16/04/2021	<0.001	0.025	<0.001	<0.01	<0.001	<0.001	<0.005	0.42	0.34	0.001
06/05/2021	<0.001	0.06	<0.001	<0.01	<0.001	<0.001	<0.005	0.63	0.5	0.002
Q29SW3										
29/03/2016	<0.001	0.003	<0.001	-	-	<0.0005	<0.001	0.13	-	-
11/05/2016	<0.001	0.0221	0.00118	-	-	<0.0005	0.0085	0.224	1.68	0.0105
20/12/2016	0.021	0.001	<0.001	-	-	<0.0005	0.003	0.08	0.97	0.35
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.1	0.05	0.037
09/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.13	0.05	0.037
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.05	0.13	0.14
03/02/2021	-	-	-	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-	-	-	-
Q29SW4										
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.1	4.7	0.002
26/01/2017	0.008	<0.005	<0.001	-	-	<0.0005	0.006	0.23	0.51	0.001
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.25	0.15	<0.001
09/02/2019	<0.001	0.028	<0.001	-	-	<0.0005	<0.001	0.3	0.15	<0.001
22/02/2019	<0.001	0.018	<0.001	-	-	<0.0005	<0.001	0.14	0.21	0.001
16/02/2020	<0.001	0.028	<0.001	-	-	<0.0005	<0.001	0.38	0.49	0.002
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.29	1.6	0.001
04/12/2020	0.001	0.015	<0.001	<0.01	<0.001	<0.001	<0.005	0.34	4.2	0.003
11/01/2021	<0.001	0.042	<0.001	<0.01	<0.001	<0.001	<0.005	0.19	0.05	<0.001
03/02/2021	<0.001	0.004	<0.001	<0.01	<0.001	<0.001	<0.005	1.16	1.18	<0.001
08/03/2021	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	0.19	0.32	<0.001
16/04/2021	<0.001	0.016	<0.001	<0.01	<0.001	<0.001	<0.005	0.26	0.76	<0.001
29/04/2021	<0.001	0.027	<0.001	<0.01	<0.001	<0.001	<0.005	0.15	0.4	<0.001
Q29SW5										
07/07/2016	<0.001	0.00394	<0.001	-	-	<0.0005	0.0123	0.23	0.239	0.023
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.003	0.09	0.3	0.007
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.13	0.13	0.005
09/02/2019	<0.001	0.016	<0.001	-	-	<0.0005	<0.001	0.09	0.13	0.005
22/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.07	0.16	0.014
30/10/2019	<0.001	<0.005	<0.001	-	-	<0.0005	0.007	0.03	0.03	0.03
16/02/2020	<0.001	0.006	0.001	-	-	<0.0005	0.023	0.12	0.22	0.02
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	0.005	0.09	0.1	0.026
11/11/2020	<0.001	0.006	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.05	0.029
03/02/2021	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	0.22	0.36	0.006

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (dissolved)	Metals (Total)	Metals (Total)
Analyte	Lead	Manganese	Nickel	Selenium Se (Total)	Tin	Uranium	Zinc	Iron	Aluminium	Arsenic
Analyte Short Name	Pb F	Mn F	Ni F	Se F	Sn F	U F	Zn F	Fe F	Al T	As T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	0.0056	2.5	0.013	-	-	-	0.015	2.7	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-	insufficient data	0.024
ANZECC 2000 Livestock Watering (beef cattle)	0.1	-	1	0.02	-	0.2	20	-	5	0.5
ANZECC 2000 long term irrigation	2	0.2	0.2	0.02	-	0.01	2	0.2	5	0.1
27/04/2021	<0.001	0.035	0.001	<0.01	<0.001	<0.001	0.008	0.15	0.08	0.027
Q29SW6										
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.003	0.08	0.26	0.011
26/01/2017	<0.001	0.001	<0.001	-	-	<0.0005	0.024	0.1	0.24	0.008
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	<0.001	0.12	0.14	0.007
30/06/2018	<0.001	0.01	<0.001	-	-	<0.0005	<0.001	0.08	-	-
09/02/2019	<0.001	0.01	<0.001	-	-	<0.0005	<0.001	0.08	0.14	0.007
06/04/2020	<0.001	<0.005	<0.001	-	-	<0.0005	0.007	0.03	0.28	0.039
11/01/2021	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	0.1	0.36	0.004
03/02/2021	<0.001	0.006	<0.001	<0.01	<0.001	<0.001	<0.005	0.22	0.62	0.006
08/03/2021	<0.001	0.014	<0.001	<0.01	<0.001	<0.001	<0.005	0.17	0.21	0.007
16/04/2021	<0.001	0.051	0.002	<0.01	<0.001	<0.001	<0.005	0.17	0.33	0.015
27/04/2021	<0.001	0.089	<0.001	<0.01	<0.001	<0.001	<0.005	0.12	0.13	0.01
Q29SW7										
20/12/2016	<0.001	0.001	<0.001	-	-	<0.0005	0.005	0.17	0.46	0.011
26/01/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.002	0.13	0.21	0.009
26/03/2017	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.13	0.07	0.009
30/06/2018	0.001	0.014	0.001	-	-	<0.0005	<0.001	0.24	-	-
22/02/2019	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.13	0.07	0.009
16/02/2020	<0.001	0.23	<0.001	-	-	<0.0005	<0.001	0.11	0.04	<0.001
12/11/2020	<0.001	0.003	0.002	<0.01	<0.001	<0.001	0.021	0.26	9.9	0.418
11/01/2021	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05	0.28	0.021
03/02/2021	<0.001	0.008	<0.001	<0.01	<0.001	<0.001	<0.005	0.32	0.53	0.016
16/04/2021	-	-	-	-	-	-	-	-	-	-
Q29SW7										
27/04/2021	-	-	-	-	-	-	-	-	-	-
20/12/2016	<0.001	<0.005	<0.001	-	-	<0.0005	0.001	0.08	0.39	0.014
09/02/2019	<0.001	0.069	<0.001	-	-	<0.0005	0.007	0.17	-	-
11/01/2021	<0.001	0.019	<0.001	<0.01	<0.001	<0.001	<0.005	0.11	0.33	0.006
03/02/2021	<0.001	0.009	<0.001	<0.01	<0.001	<0.001	<0.005	0.26	0.39	0.008
08/03/2021	<0.001	0.023	<0.001	<0.01	<0.001	<0.001	<0.005	0.2	0.23	0.006
16/04/2021	<0.001	0.041	<0.001	<0.01	<0.001	<0.001	<0.005	0.19	0.2	0.01
27/04/2021	<0.001	0.083	<0.001	<0.01	<0.001	<0.001	<0.005	0.25	0.06	0.01

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
Date	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Q29SW Leach												
06/06/2015	0.00608	<0.001	0.0204	0.0639	0.00068	0.29	0.0931	-	-	0.00121	0.339	0.102
29/03/2016	0.00502	<0.001	0.0186	0.0671	0.00072	0.252	0.0856	-	-	0.00131	0.285	0.074
11/04/2016	0.00516	0.0002	0.0189	0.061	<0.001	0.258	0.0866	-	-	0.00111	0.302	0.036
11/05/2016	0.00522	<0.001	0.0187	0.0624	0.00065	0.275	0.0877	-	-	0.00115	0.32	0.098
07/07/2016	0.00614	<0.001	0.0226	0.0643	0.00083	0.331	0.103	-	-	0.000968	0.357	0.076
04/11/2016	0.0069	<0.001	0.024	0.053	<0.001	0.35	0.1	-	-	0.0009	0.36	0.02
28/11/2016	0.0063	<0.001	0.021	0.048	<0.001	0.35	0.098	-	-	0.0006	0.3	0.05
20/12/2016	0.0058	<0.001	0.021	0.04	0.31	0.09	<0.001	-	-	0.0006	0.29	0.05
26/01/2017	0.0046	<0.001	0.015	0.022	0.24	0.065	<0.001	-	-	<0.0005	0.2	0.04
26/03/2017	0.0032	<0.001	0.006	0.01	<0.001	0.12	0.04	-	-	<0.0005	0.12	<0.01
30/06/2018	0.0026	0.006	0.001	0.02	<0.001	0.084	0.023	-	-	0.0008	0.047	0.08
09/02/2019	-	-	-	-	-	-	-	-	-	-	-	-
22/02/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.032	0.001	-	-	<0.0005	0.004	0.03
20/08/2019	<0.0001	<0.001	<0.001	0.003	<0.001	0.026	<0.001	-	-	0.0007	0.002	<0.01
30/10/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.066	0.001	-	-	0.0021	0.004	0.03
06/04/2020	<0.0001	<0.001	<0.001	0.002	<0.001	<0.005	<0.001	-	-	<0.0005	0.009	0.04
15/09/2020	<0.0001	<0.001	<0.001	0.004	<0.001	0.063	<0.001	<0.01	<0.01	0.001	<0.005	<0.05
21/10/2020	<0.0001	<0.001	<0.001	0.003	<0.001	0.106	0.001	<0.01	<0.001	<0.001	<0.005	<0.05
11/11/2020	<0.0001	<0.001	<0.001	0.002	<0.001	0.044	0.001	<0.01	<0.001	<0.001	<0.005	<0.05
04/12/2020	0.0001	<0.001	<0.001	0.003	<0.001	0.05	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
11/01/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.019	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
03/02/2021	<0.0001	<0.001	<0.001	0.003	<0.001	0.046	0.001	<0.01	<0.001	<0.001	<0.005	0.27
11/03/2021	0.0002	<0.001	<0.001	0.002	<0.001	0.009	0.003	<0.01	<0.001	<0.001	0.005	<0.05
16/04/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.011	<0.001	<0.01	<0.001	<0.001	<0.005	0.09
27/04/2021	0.0001	<0.001	<0.001	0.001	<0.001	0.009	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
16/06/2021	<0.0001	<0.001	<0.001	0.005	<0.001	0.019	<0.001	<0.01	<0.001	<0.001	<0.005	<0.05
09/07/2021	<0.0001	<0.001	<0.001	0.003	<0.001	0.018	0.001	<0.01	<0.001	<0.001	<0.005	<0.05
Q29SW1												
29/03/2016	-	-	-	-	-	-	-	-	-	-	-	-
11/04/2016	<0.0001	<0.001	0.00111	0.00394	0.00159	0.0552	0.00101	-	-	<0.0005	0.0088	0.436
07/07/2016	<0.0001	<0.001	0.00134	0.00203	0.00069	0.0497	0.00063	-	-	<0.0005	0.0111	0.328
04/11/2016	<0.0001	<0.001	0.00298	0.00413	0.00167	0.212	0.00217	-	-	<0.0005	0.044	0.54
28/11/2016	<0.0001	<0.001	0.001	0.002	<0.001	0.05	<0.001	-	-	<0.0005	0.002	0.36
20/12/2016	<0.0001	<0.001	<0.001	0.005	0.042	0.002	0.007	-	-	<0.0005	0.005	0.5
26/01/2017	<0.0001	<0.001	<0.001	0.004	0.035	<0.001	0.001	-	-	<0.0005	0.002	0.28
26/03/2017	<0.0001	<0.001	<0.001	0.003	<0.001	0.029	<0.001	-	-	<0.0005	0.002	0.23
09/02/2019	<0.0001	<0.001	<0.001	0.003	<0.001	0.029	<0.001	-	-	<0.0005	0.002	0.23
22/02/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.053	<0.001	-	-	<0.0005	0.003	0.43
16/02/2020	<0.0001	<0.001	0.003	0.002	0.002	0.35	0.001	-	-	<0.0005	0.013	1.7
06/04/2020	<0.0001	<0.001	0.001	0.002	<0.001	0.05	<0.001	-	-	<0.0005	0.002	0.36
12/11/2020	0.0002	0.007	0.009	0.029	0.435	0.833	0.008	<0.01	<0.001	0.004	0.049	5.76
09/12/2020	<0.0001	<0.001	<0.001	0.004	0.006	0.162	0.002	<0.01	<0.001	<0.001	0.011	0.51
11/01/2021	<0.0001	<0.001	<0.001	0.002	0.001	0.049	<0.001	<0.01	<0.001	<0.001	<0.005	0.32
03/02/2021	<0.0001	<0.001	<0.001	0.002	0.001	0.044	<0.001	<0.01	<0.001	<0.001	<0.005	0.42
11/03/2021	<0.0001	<0.001	<0.001	0.003	<0.001	0.043	<0.001	<0.01	<0.001	<0.001	0.018	0.27
16/04/2021	<0.0001	0.001	<0.001	0.003	<0.001	0.056	<0.001	<0.01	<0.001	<0.001	<0.005	0.35
27/04/2021	<0.0001	0.003	<0.001	0.003	<0.001	0.034	<0.001	<0.01	<0.001	<0.001	<0.005	0.23
Q29SW2												

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
29/03/2016	-	-	-	-	-	-	-	-	-	-	-	-
11/04/2016	<0.0001	0.0024	0.00093	0.00283	0.00206	0.025	0.00195	-	-	<0.0005	0.0111	1.9
28/11/2016	<0.0001	<0.001	<0.001	<0.001	0.001	0.023	<0.001	-	-	<0.0005	0.002	0.81
20/12/2016	0.0004	0.009	0.006	0.009	0.26	0.005	0.015	-	-	0.0022	0.011	10
26/01/2017	<0.0001	0.002	<0.001	0.003	0.027	0.001	0.002	-	-	<0.0005	0.019	1.4
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	-	-	<0.0005	0.002	0.31
09/02/2019	<0.0001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	-	-	<0.0005	0.002	0.31
22/02/2019	<0.0001	0.001	0.001	0.004	0.003	0.11	0.004	-	-	<0.0005	0.035	2.4
16/02/2020	<0.0001	0.001	0.002	0.002	0.002	0.16	0.001	-	-	<0.0005	0.006	3.7
06/04/2020	<0.0001	<0.001	<0.001	<0.001	0.001	0.023	<0.001	-	-	<0.0005	0.002	0.81
04/12/2020	<0.0001	0.008	0.003	0.007	0.015	0.104	0.005	<0.01	<0.001	0.001	0.01	7.68
07/01/2021	<0.0001	0.001	<0.001	<0.001	<0.001	0.019	<0.001	<0.01	<0.001	<0.001	<0.005	1.51
03/02/2021	<0.0001	0.002	<0.001	0.001	0.002	0.019	0.001	<0.01	<0.001	<0.001	<0.005	1.59
08/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.014	<0.001	<0.01	<0.001	<0.001	<0.005	0.58
16/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.028	<0.001	<0.01	<0.001	<0.001	<0.005	0.84
06/05/2021	<0.0001	<0.001	<0.001	0.001	0.001	0.091	<0.001	<0.01	<0.001	<0.001	0.006	1.65
Q29SW3												
29/03/2016	-	-	-	-	-	-	-	-	-	-	-	-
11/05/2016	<0.0001	0.0014	0.00054	0.00313	0.00179	0.0408	0.00196	-	-	<0.0005	0.0105	0.844
20/12/2016	<0.0001	0.005	0.002	0.006	0.042	0.004	0.005	-	-	<0.0005	0.01	1.9
26/03/2017	<0.0001	<0.001	<0.001	0.001	<0.001	0.013	<0.001	-	-	<0.0005	0.002	0.14
09/02/2019	<0.0001	<0.001	<0.001	0.001	<0.001	0.013	<0.001	-	-	<0.0005	0.002	0.14
06/04/2020	<0.0001	<0.001	<0.001	0.003	0.002	0.06	0.002	-	-	<0.0005	0.016	0.37
03/02/2021	-	-	-	-	-	-	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-	-	-	-	-	-	-
Q29SW4												
20/12/2016	<0.0001	0.007	0.004	0.006	0.17	0.004	0.02	-	-	0.002	0.011	7
26/01/2017	<0.0001	0.001	<0.001	0.002	0.047	<0.001	0.002	-	-	<0.0005	0.011	1.2
26/03/2017	<0.0001	<0.001	<0.001	<0.001	0.001	0.013	<0.001	-	-	<0.0005	0.002	0.36
09/02/2019	<0.0001	<0.001	<0.001	<0.001	0.001	0.013	<0.001	-	-	<0.0005	0.002	0.36
22/02/2019	<0.0001	<0.001	<0.001	<0.001	0.001	0.035	<0.001	-	-	<0.0005	<0.001	0.78
16/02/2020	<0.0001	0.001	0.001	0.002	0.003	0.11	<0.001	-	-	<0.0005	0.002	2.5
06/04/2020	<0.0001	0.002	<0.001	0.002	0.003	0.029	0.001	-	-	<0.0005	0.003	2.6
04/12/2020	<0.0001	0.005	0.002	0.006	0.013	0.076	0.003	<0.01	<0.001	<0.001	0.009	4.02
11/01/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.037	<0.001	<0.01	<0.001	<0.001	<0.005	0.38
03/02/2021	<0.0001	0.001	<0.001	0.002	0.002	0.02	<0.001	<0.01	<0.001	<0.001	<0.005	1.23
08/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.012	<0.001	<0.01	<0.001	<0.001	<0.005	0.24
16/04/2021	<0.0001	0.001	<0.001	<0.001	0.002	0.026	<0.001	<0.01	<0.001	<0.001	<0.005	1.1
29/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.027	<0.001	<0.01	<0.001	<0.001	<0.005	0.47
Q29SW5												
07/07/2016	<0.0001	<0.001	<0.001	0.00447	0.00182	0.0374	0.00153	-	-	0.000055	0.0279	0.518
20/12/2016	<0.0001	<0.001	<0.001	0.002	0.039	0.001	0.003	-	-	<0.0005	0.005	0.42
26/03/2017	<0.0001	<0.001	<0.001	<0.001	<0.001	0.029	<0.001	-	-	<0.0005	0.002	0.29
09/02/2019	<0.0001	<0.001	<0.001	<0.001	<0.001	0.029	<0.001	-	-	<0.0005	0.002	0.29
22/02/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.037	<0.001	-	-	<0.0005	0.004	0.36
30/10/2019	<0.0001	<0.001	<0.001	0.002	<0.001	0.037	<0.001	-	-	<0.0005	0.008	0.17
16/02/2020	<0.0001	<0.001	<0.001	0.005	0.002	0.032	0.002	-	-	<0.0005	0.032	0.55
06/04/2020	<0.0001	<0.001	<0.001	0.002	<0.001	0.035	0.001	-	-	<0.0005	0.016	0.36
11/11/2020	<0.0001	<0.001	<0.001	<0.001	0.013	0.022	<0.001	<0.01	<0.001	<0.001	<0.005	0.1
03/02/2021	<0.0001	<0.001	<0.001	0.003	0.001	0.018	<0.001	<0.01	<0.001	<0.001	<0.005	0.43

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)	Metals (Total)
Analyte	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Selenium	Tin	Uranium	Zinc	Iron
Analyte Short Name	Cd T	Cr T	Co T	Cu T	Pb T	Mn T	Ni T	Se T	Sn T	U T	Zn T	Fe T
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	-	-	-	-	-	-	-	-	-	-	-
Tropical Australia Lowland Rivers	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 freshwater - 95% species protection	0.0002	0.001	-	0.0014	0.0034	1.9	0.011	0.011	-	insufficient data	0.008	-
ANZECC 2000 Livestock Watering (beef cattle)	0.01	1	1	2	0.1	-	1	0.02	-	0.2	20	-
ANZECC 2000 long term irrigation	0.01	1	0.5	0.2	2	0.2	0.2	0.02	-	0.01	2	-
27/04/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.08	<0.001	<0.01	<0.001	<0.001	<0.005	0.27
Q29SW6												
20/12/2016	<0.0001	<0.001	<0.001	0.002	0.11	0.001	0.002	-	-	<0.0005	0.006	0.48
26/01/2017	<0.0001	<0.001	<0.001	0.004	0.035	0.002	0.002	-	-	<0.0005	0.03	0.41
26/03/2017	<0.0001	<0.001	<0.001	0.001	<0.001	0.049	<0.001	-	-	<0.0005	0.002	0.32
30/06/2018	-	-	-	-	-	-	-	-	-	-	-	-
09/02/2019	<0.0001	<0.001	<0.001	0.001	<0.001	0.049	<0.001	-	-	<0.0005	0.002	0.32
06/04/2020	<0.0001	0.002	0.001	0.003	0.002	0.13	0.002	-	-	<0.0005	0.023	0.78
11/01/2021	<0.0001	<0.001	<0.001	0.001	<0.001	0.014	<0.001	<0.01	<0.001	<0.001	<0.005	0.35
03/02/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.016	<0.001	<0.01	<0.001	<0.001	<0.005	0.33
08/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.013	<0.001	<0.01	<0.001	<0.001	<0.005	0.21
16/04/2021	<0.0001	<0.001	<0.001	0.002	0.001	0.063	0.001	<0.01	<0.001	<0.001	<0.005	0.6
27/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.097	<0.001	<0.01	<0.001	<0.001	<0.005	0.23
Q29SW7												
20/12/2016	<0.0001	0.002	<0.001	0.005	0.027	0.002	0.005	-	-	<0.0005	0.014	0.64
26/01/2017	<0.0001	<0.001	<0.001	0.002	0.027	<0.001	0.002	-	-	<0.0005	0.006	0.39
26/03/2017	<0.0001	<0.001	<0.001	0.001	0.002	0.021	<0.001	-	-	<0.0005	0.003	0.27
30/06/2018	-	-	-	-	-	-	-	-	-	-	-	-
22/02/2019	<0.0001	<0.001	<0.001	0.001	0.002	0.021	<0.001	-	-	<0.0005	0.003	0.27
16/02/2020	<0.0001	<0.001	0.002	<0.001	<0.001	0.24	<0.001	-	-	<0.0005	<0.001	0.51
12/11/2020	0.0008	0.037	0.04	0.058	0.049	0.935	0.053	<0.01	<0.001	0.002	0.699	11.8
11/01/2021	<0.0001	<0.001	<0.001	0.002	0.001	0.017	<0.001	<0.01	<0.001	<0.001	<0.005	0.39
03/02/2021	<0.0001	<0.001	<0.001	0.002	0.003	0.015	<0.001	<0.01	<0.001	<0.001	0.006	0.75
16/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
Q29SW7												
27/04/2021	-	-	-	-	-	-	-	-	-	-	-	-
20/12/2016	<0.0001	0.001	0.001	0.003	0.12	0.002	0.005	-	-	<0.0005	0.01	0.7
09/02/2019	-	-	-	-	-	-	-	-	-	-	-	-
11/01/2021	<0.0001	<0.001	<0.001	0.002	<0.001	0.025	<0.001	<0.01	<0.001	<0.001	0.019	0.5
03/02/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.018	<0.001	<0.01	<0.001	<0.001	<0.005	0.44
08/03/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.017	<0.001	<0.01	<0.001	<0.001	<0.005	0.46
16/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.041	<0.001	<0.01	<0.001	<0.001	<0.005	0.46
27/04/2021	<0.0001	<0.001	<0.001	<0.001	<0.001	0.13	<0.001	<0.01	<0.001	<0.001	<0.005	0.56

Table B.3 - Quest 29 Surface Water Quality

Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
Date	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Q29SW Leach						
06/06/2015	-	-	-	-	-	-
29/03/2016	-	-	-	-	-	-
11/04/2016	-	-	-	-	-	-
11/05/2016	-	-	-	-	-	-
07/07/2016	-	-	-	-	-	-
04/11/2016	-	-	-	-	-	-
28/11/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
20/08/2019	-	-	-	-	-	-
30/10/2019	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
15/09/2020	<0.05	0.04	0.02	0.5	0.5	0.01
21/10/2020	<0.05	0.02	0.01	0.6	0.6	<0.01
11/11/2020	<0.05	0.02	0.1	0.6	0.7	<0.01
04/12/2020	<0.05	0.07	0.03	0.4	0.4	0.02
11/01/2021	<0.05	0.1	0.02	0.4	0.4	<0.01
03/02/2021	<0.05	0.01	0.11	0.2	0.3	0.02
11/03/2021	<0.05	0.04	0.38	0.2	0.6	0.01
16/04/2021	<0.05	0.06	0.14	0.2	0.3	<0.01
27/04/2021	<0.05	0.02	0.06	0.1	0.2	<0.01
16/06/2021	<0.05	0.04	<0.01	0.3	0.3	<0.01
09/07/2021	0.12	<0.01	<0.01	0.3	0.3	<0.01
Q29SW1						
29/03/2016	-	-	-	-	-	-
11/04/2016	-	-	-	-	-	-
07/07/2016	-	-	-	-	-	-
04/11/2016	-	-	-	-	-	-
28/11/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
16/02/2020	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
12/11/2020	0.96	0.5	0.79	3	3.8	0.53
09/12/2020	<0.05	0.1	0.91	0.9	1.8	0.04
11/01/2021	<0.05	0.01	0.08	0.2	0.3	<0.01
03/02/2021	0.14	0.01	0.1	0.1	0.2	0.01
11/03/2021	0.09	0.08	<0.01	0.1	0.1	<0.01
16/04/2021	0.1	0.03	0.04	0.2	0.2	<0.01
27/04/2021	<0.05	<0.01	0.03	<0.1	<0.1	<0.01
Q29SW2						

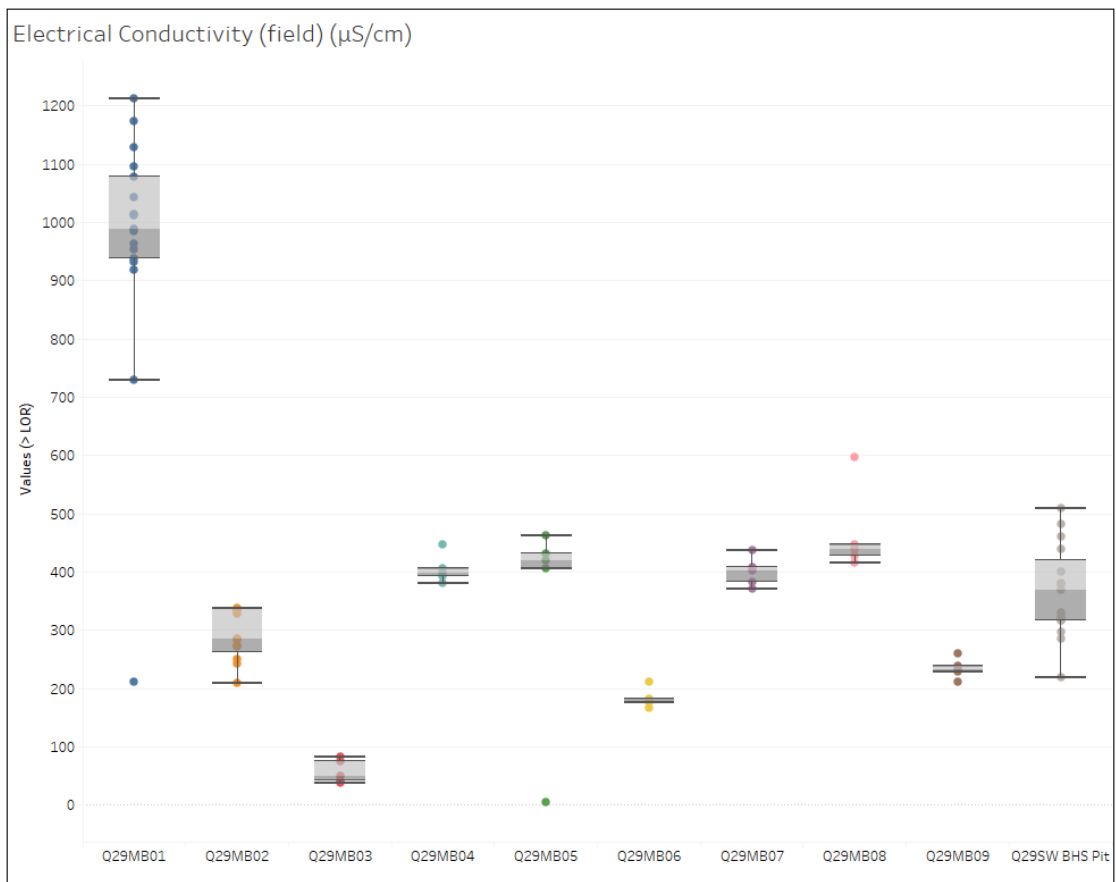
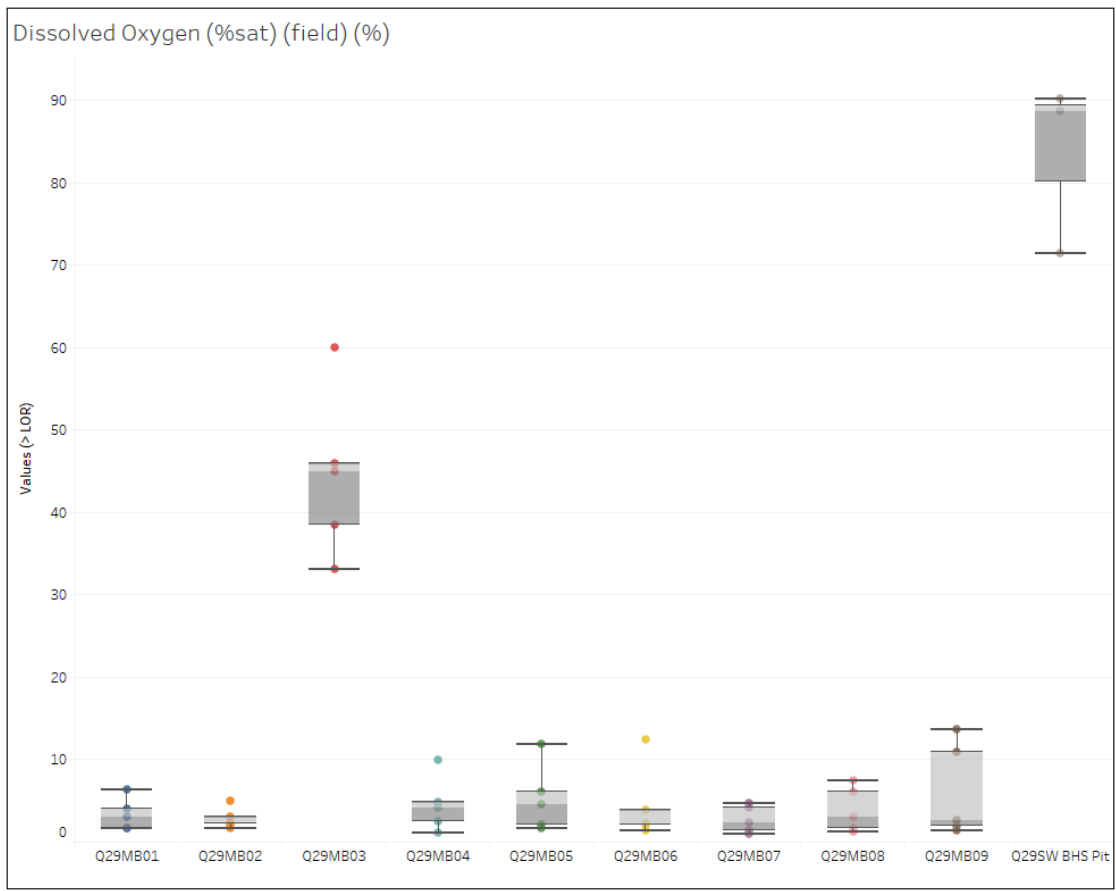
Table B.3 - Quest 29 Surface Water Quality

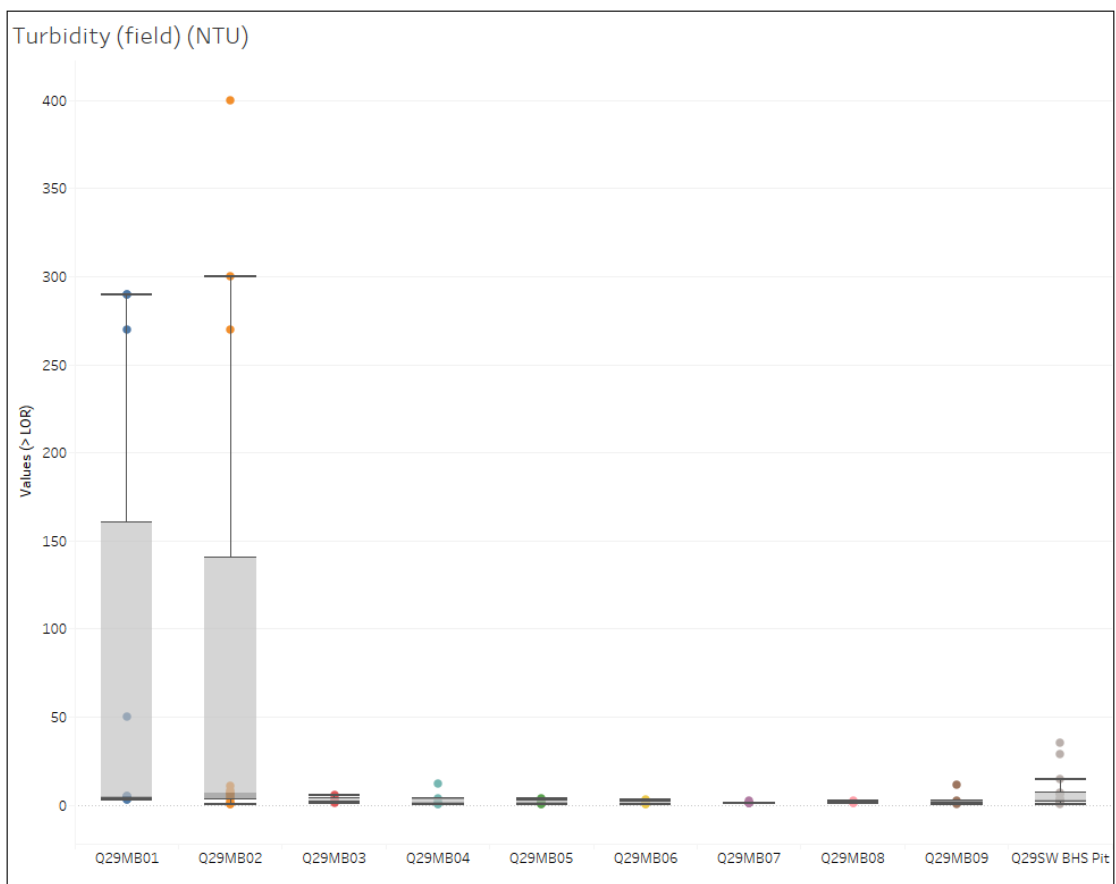
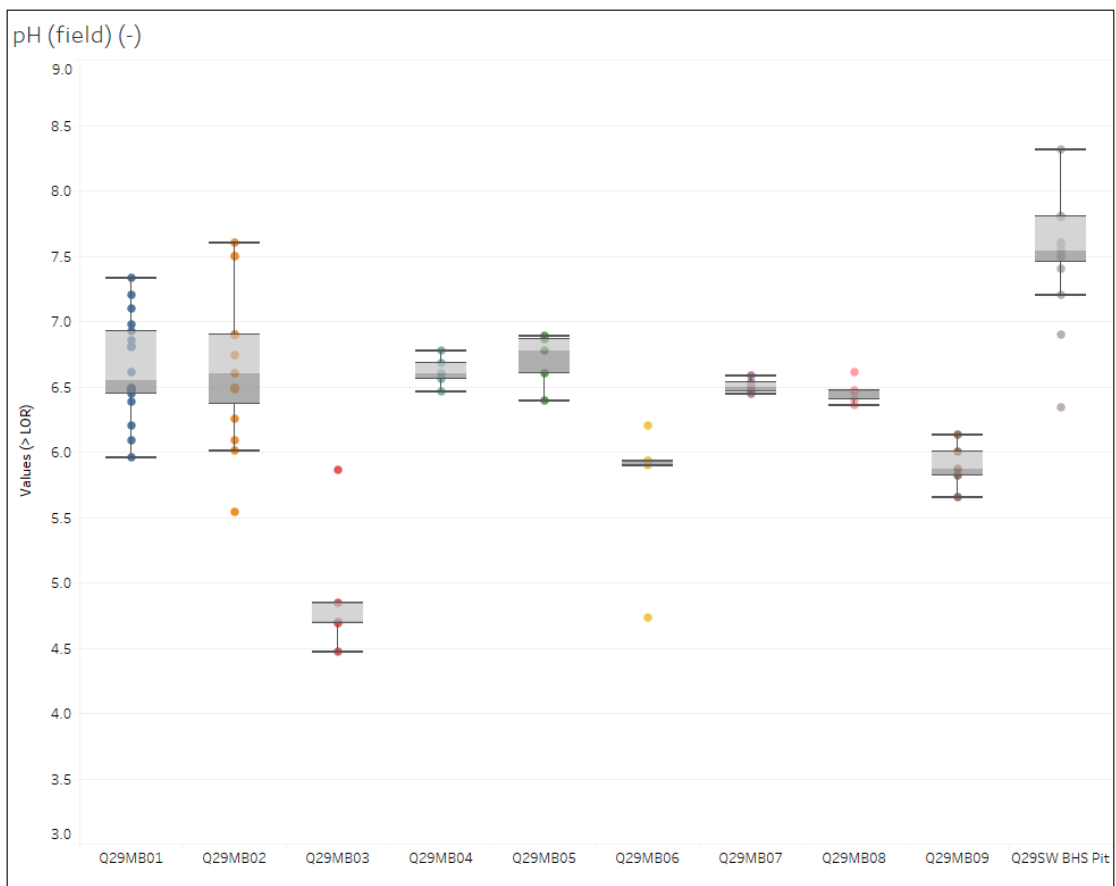
Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
29/03/2016	-	-	-	-	-	-
11/04/2016	-	-	-	-	-	-
28/11/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
16/02/2020	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
04/12/2020	0.72	0.04	0.08	0.7	0.8	0.1
07/01/2021	0.19	0.04	0.01	0.3	0.3	<0.01
03/02/2021	0.27	<0.01	0.02	0.4	0.4	0.03
08/03/2021	0.08	<0.01	0.03	0.2	0.2	<0.01
16/04/2021	0.19	0.14	0.02	0.2	0.2	<0.01
06/05/2021	0.22	0.04	0.06	0.3	0.4	0.03
Q29SW3						
29/03/2016	-	-	-	-	-	-
11/05/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
03/02/2021	-	-	-	-	-	-
06/05/2021	-	-	-	-	-	-
Q29SW4						
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
16/02/2020	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
04/12/2020	0.55	0.06	0.05	0.6	0.6	0.07
11/01/2021	0.09	0.04	0.03	0.2	0.2	<0.01
03/02/2021	0.38	<0.01	0.02	0.3	0.3	0.01
08/03/2021	<0.05	0.03	0.04	<0.1	<0.1	<0.01
16/04/2021	0.14	0.13	<0.01	0.3	0.3	0.04
29/04/2021	<0.05	0.01	<0.01	0.2	0.2	<0.01
Q29SW5						
07/07/2016	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
30/10/2019	-	-	-	-	-	-
16/02/2020	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
11/11/2020	<0.05	<0.01	0.07	0.2	0.3	0.03
03/02/2021	0.07	0.02	0.03	0.1	0.1	<0.01

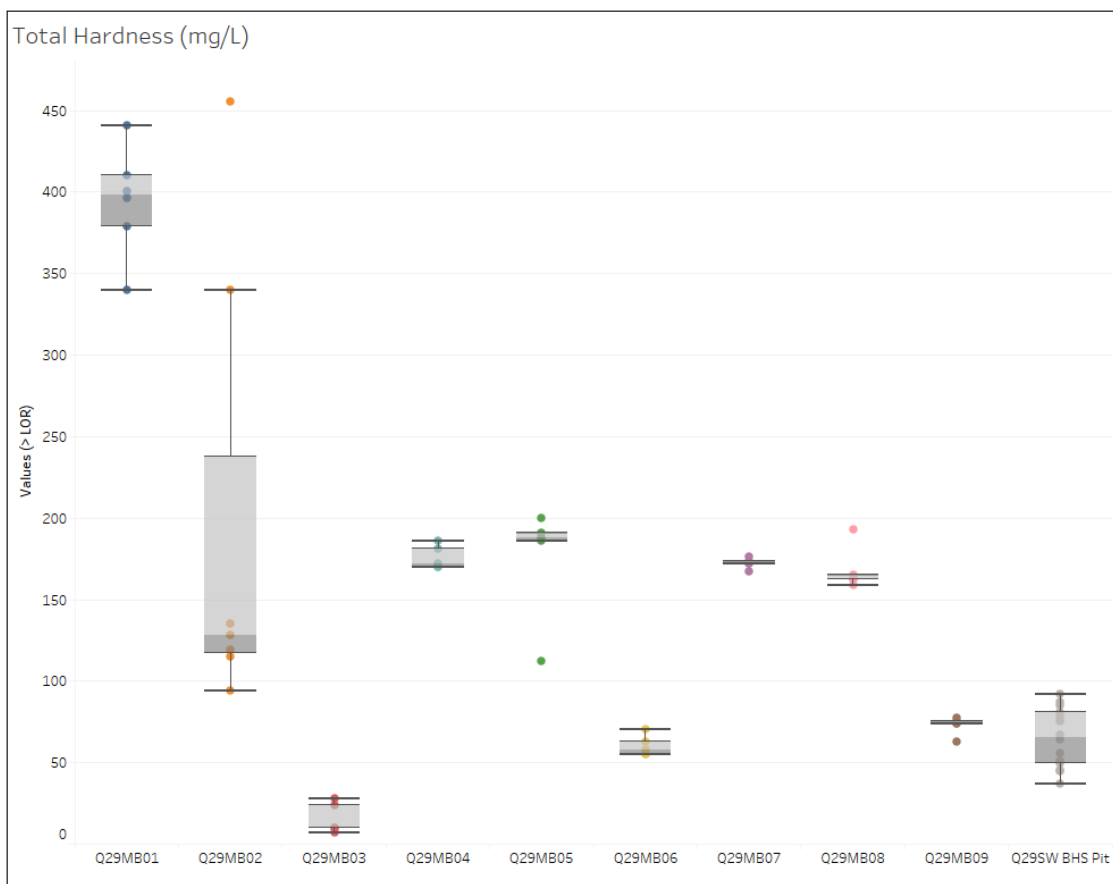
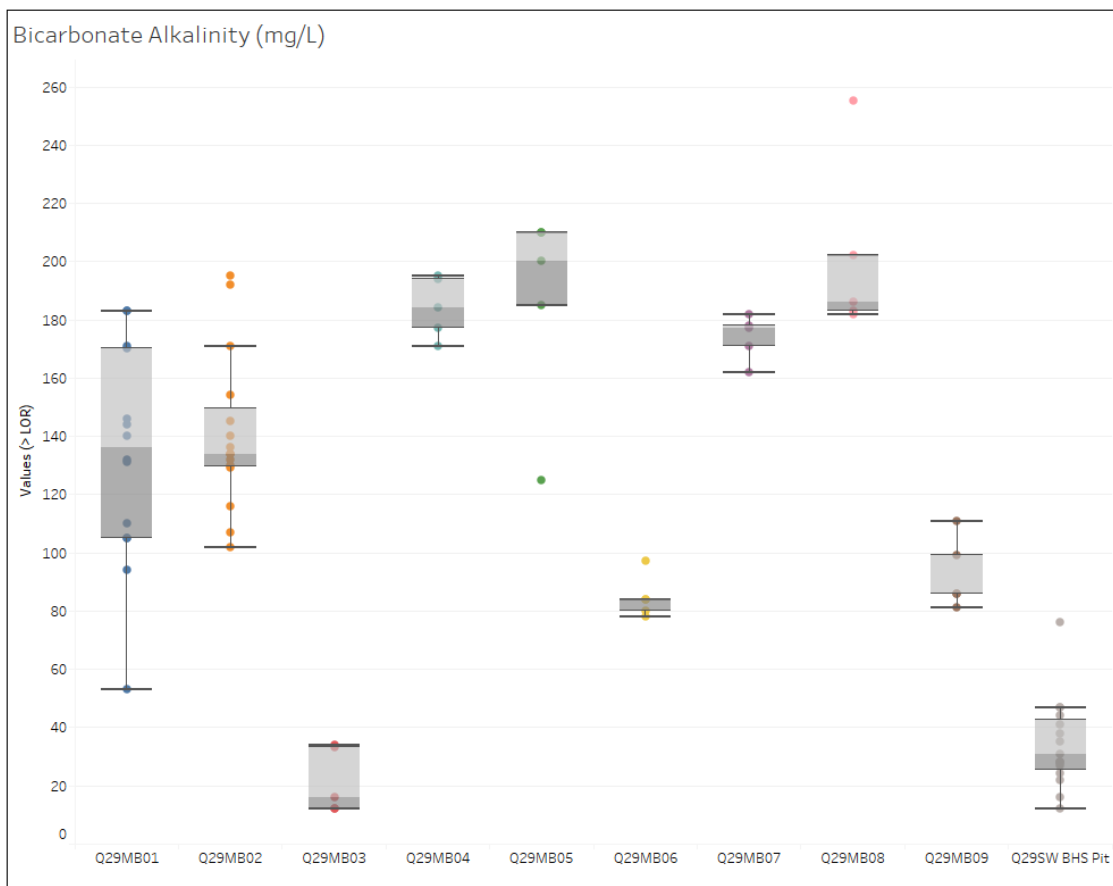
Table B.3 - Quest 29 Surface Water Quality

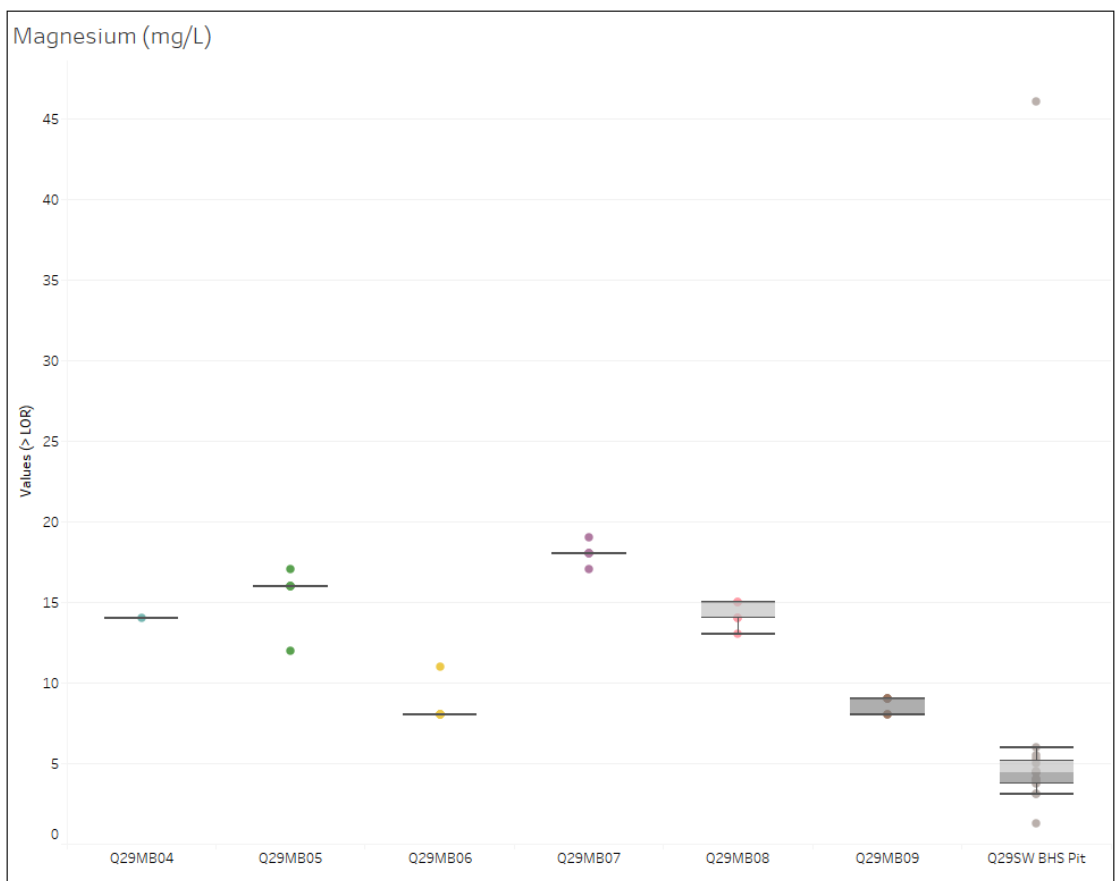
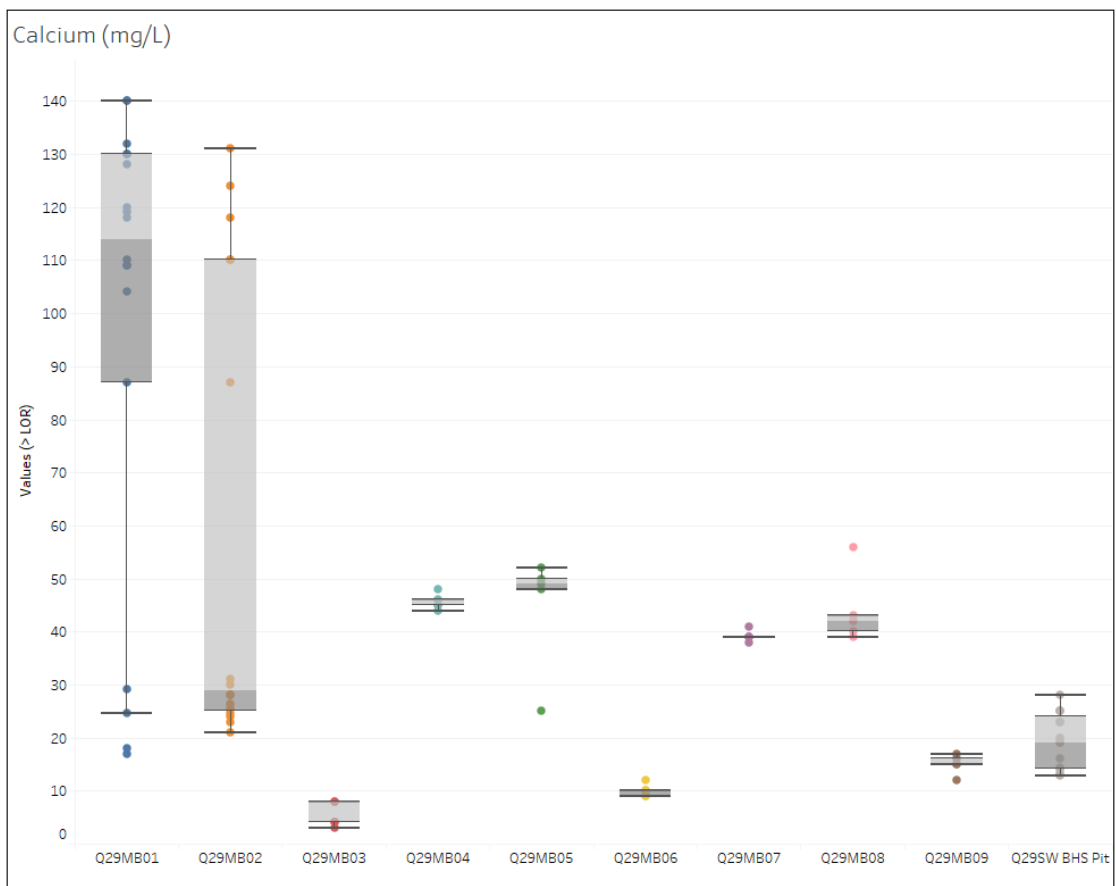
Analyte Group	Metals (Total)	Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Analyte	Ferrous Iron	Ammonia	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P
Analyte Short Name	Ferrous Iron	NH3	Nox	TKN N	TN N	P Tot
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Toms Gully SSTV (80th percentile)	-	1.4	-	-	-	-
Tropical Australia Lowland Rivers	-	0.01	-	-	0.2 - 0.3	0.01
ANZG 2018 freshwater - 95% species protection	-	0.9	-	-	-	-
ANZECC 2000 Livestock Watering (beef cattle)	-	-	-	-	-	-
ANZECC 2000 long term irrigation	-	-	-	-	5	0.05
27/04/2021	<0.05	<0.01	0.02	0.2	0.2	0.05
Q29SW6						
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
06/04/2020	-	-	-	-	-	-
11/01/2021	<0.05	0.02	0.02	0.2	0.2	0.02
03/02/2021	0.07	0.02	0.02	0.1	0.1	<0.01
08/03/2021	<0.05	0.16	0.03	0.2	0.2	<0.01
16/04/2021	0.1	0.09	0.03	0.3	0.3	0.01
27/04/2021	<0.05	0.08	0.02	0.2	0.2	<0.01
Q29SW7						
20/12/2016	-	-	-	-	-	-
26/01/2017	-	-	-	-	-	-
26/03/2017	-	-	-	-	-	-
30/06/2018	-	-	-	-	-	-
22/02/2019	-	-	-	-	-	-
16/02/2020	-	-	-	-	-	-
12/11/2020	0.9	0.2	0.46	2.3	2.8	1.54
11/01/2021	<0.05	0.14	0.09	0.2	0.3	0.01
03/02/2021	0.09	0.05	0.09	0.2	0.3	0.03
16/04/2021	-	-	-	-	-	-
Q29SW7						
27/04/2021	-	-	-	-	-	-
20/12/2016	-	-	-	-	-	-
09/02/2019	-	-	-	-	-	-
11/01/2021	0.07	0.03	0.05	0.3	0.4	<0.01
03/02/2021	0.09	<0.01	0.02	0.1	0.1	0.01
08/03/2021	<0.05	<0.01	0.03	<0.1	<0.1	<0.01
16/04/2021	0.05	0.01	0.02	0.1	0.1	<0.01
27/04/2021	<0.05	0.01	<0.01	0.4	0.4	<0.01

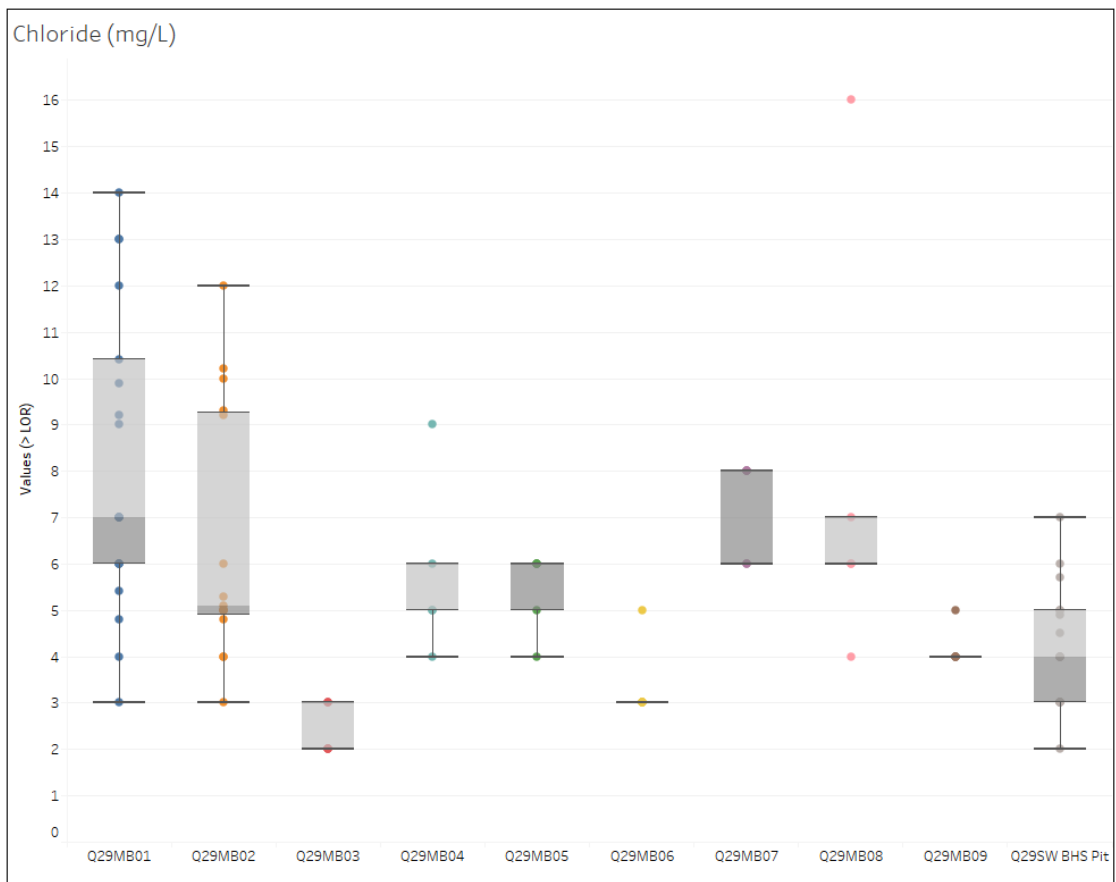
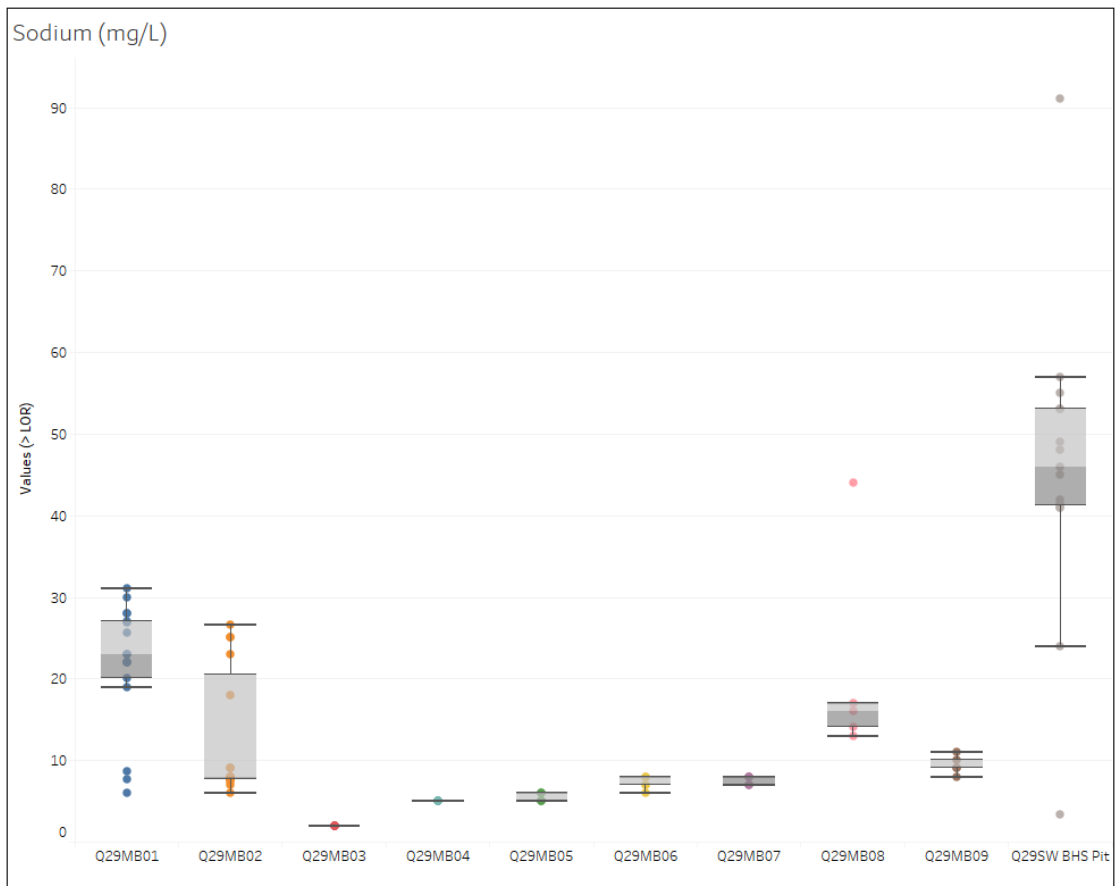
B.4 Quest 29 Groundwater Box & Whisker Plots (2020-2021)

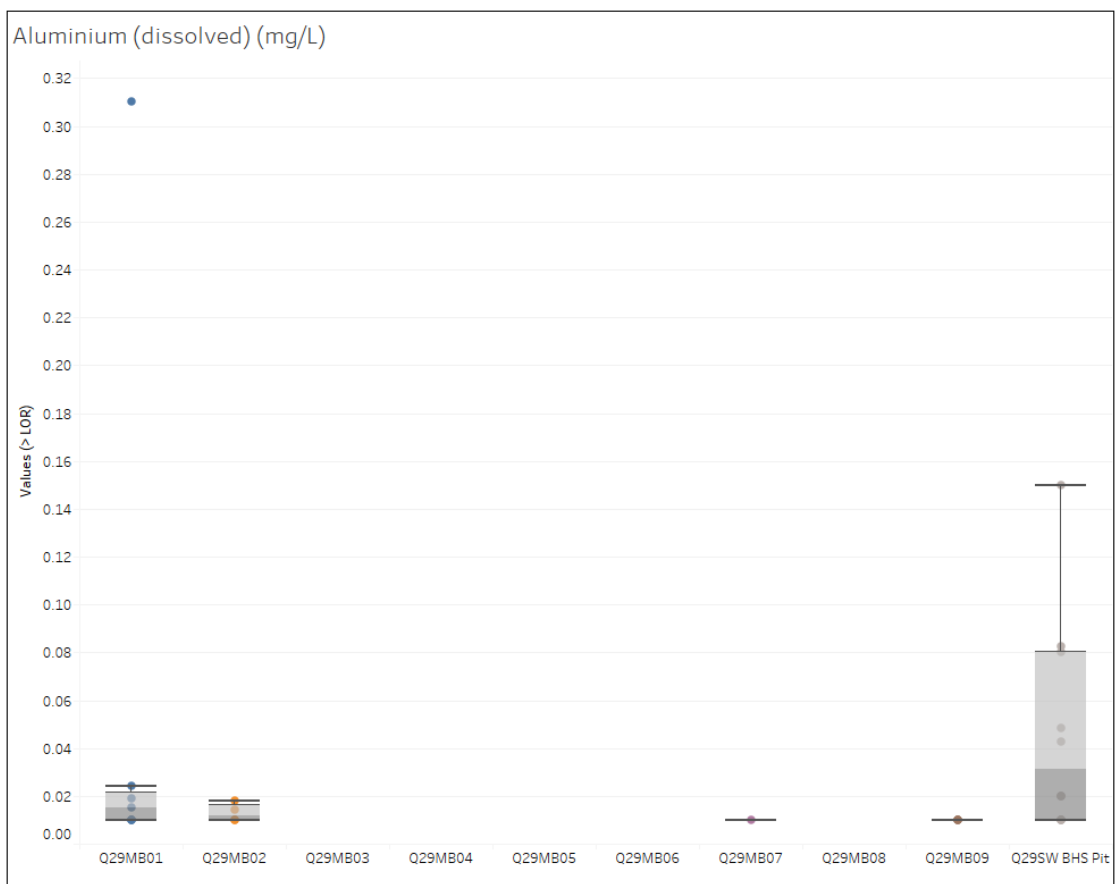
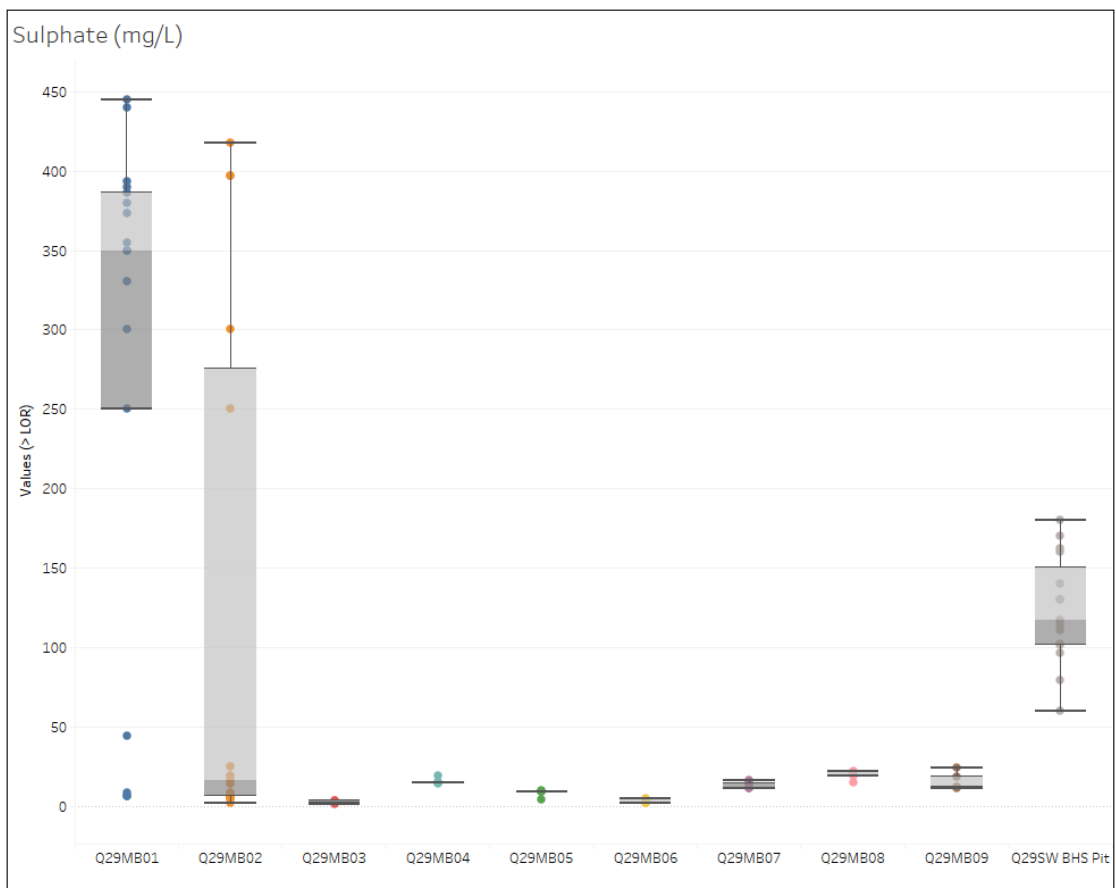


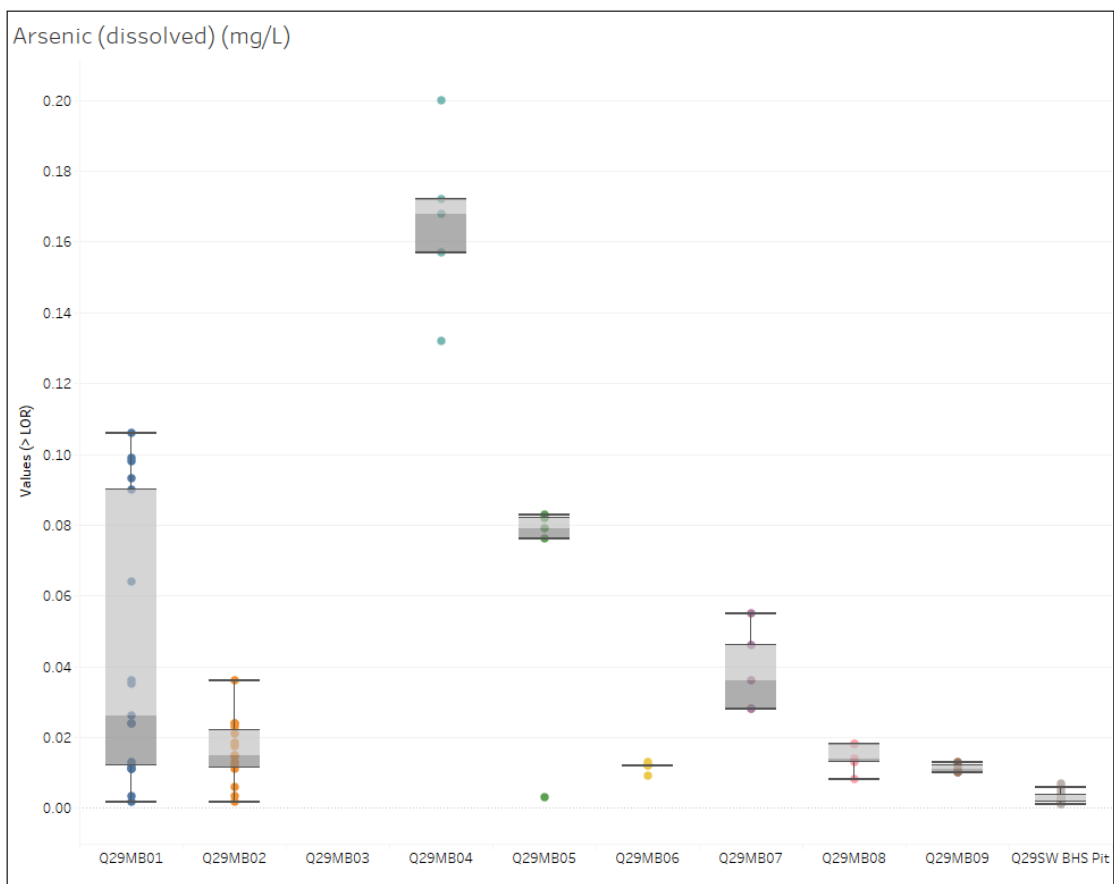
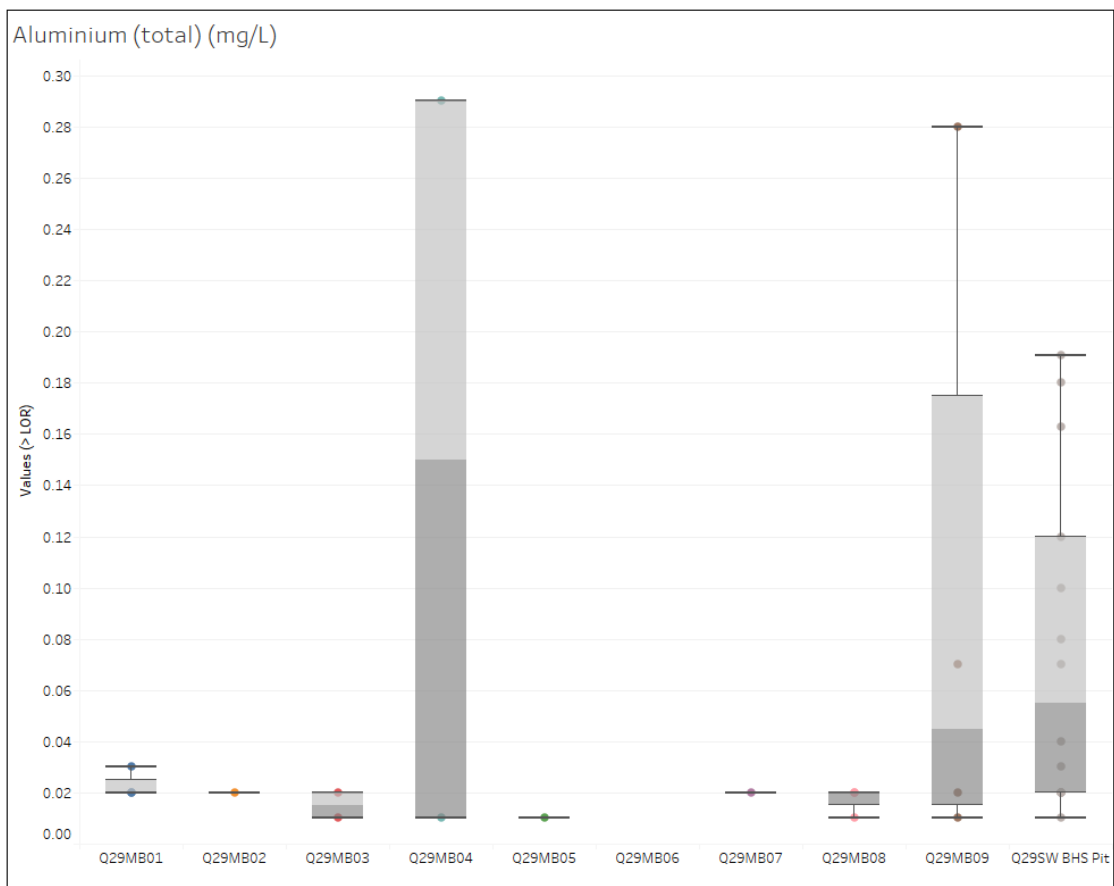


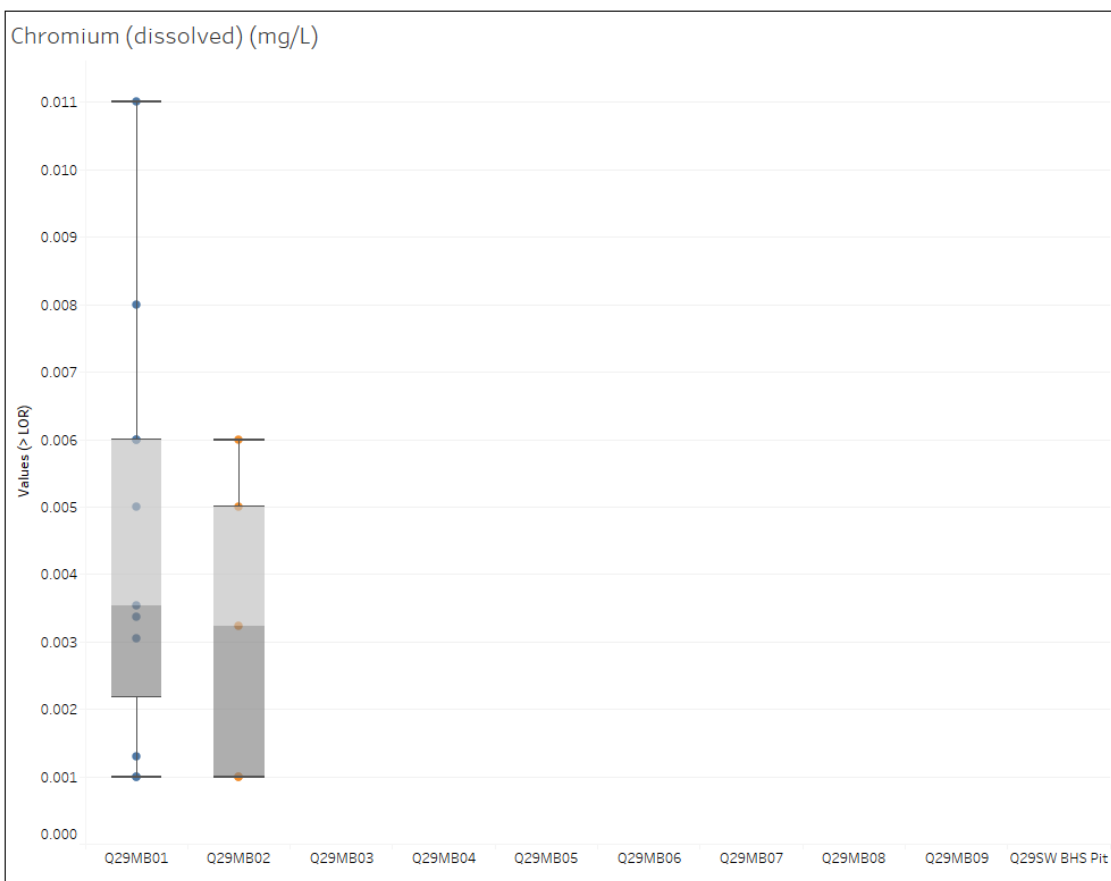
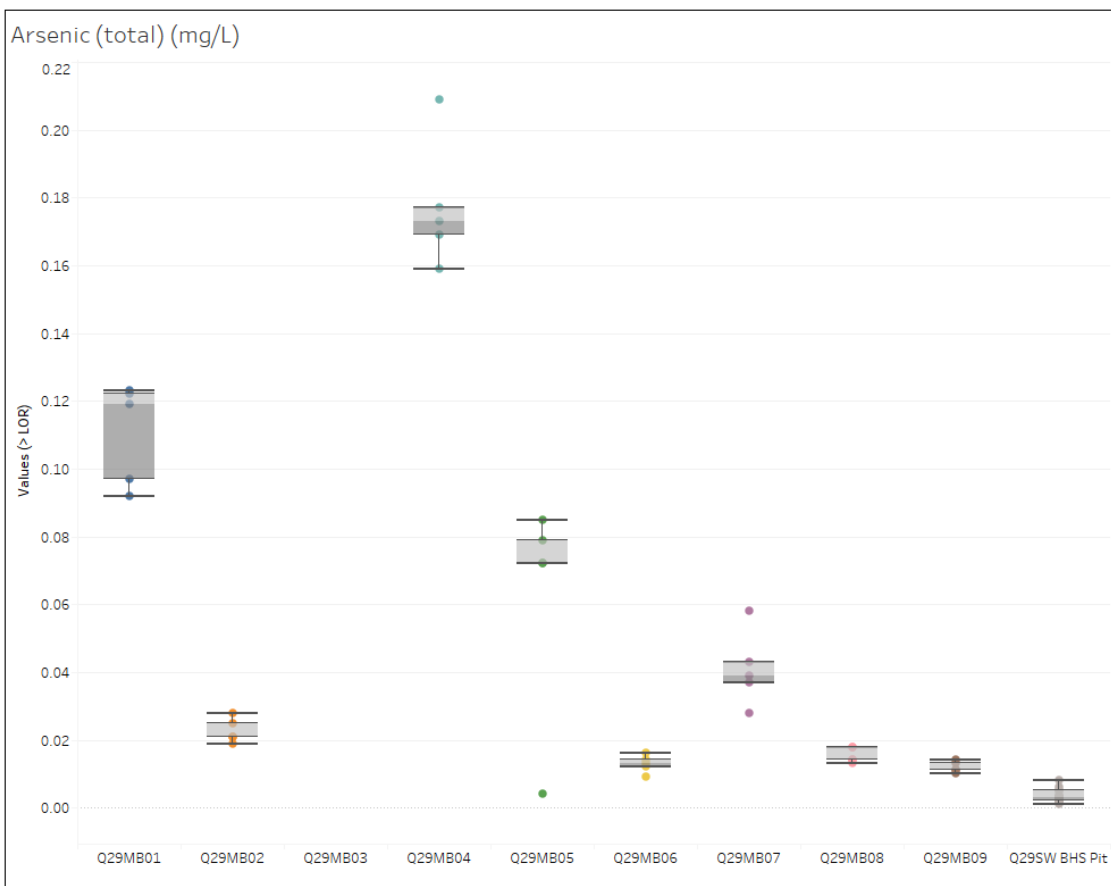


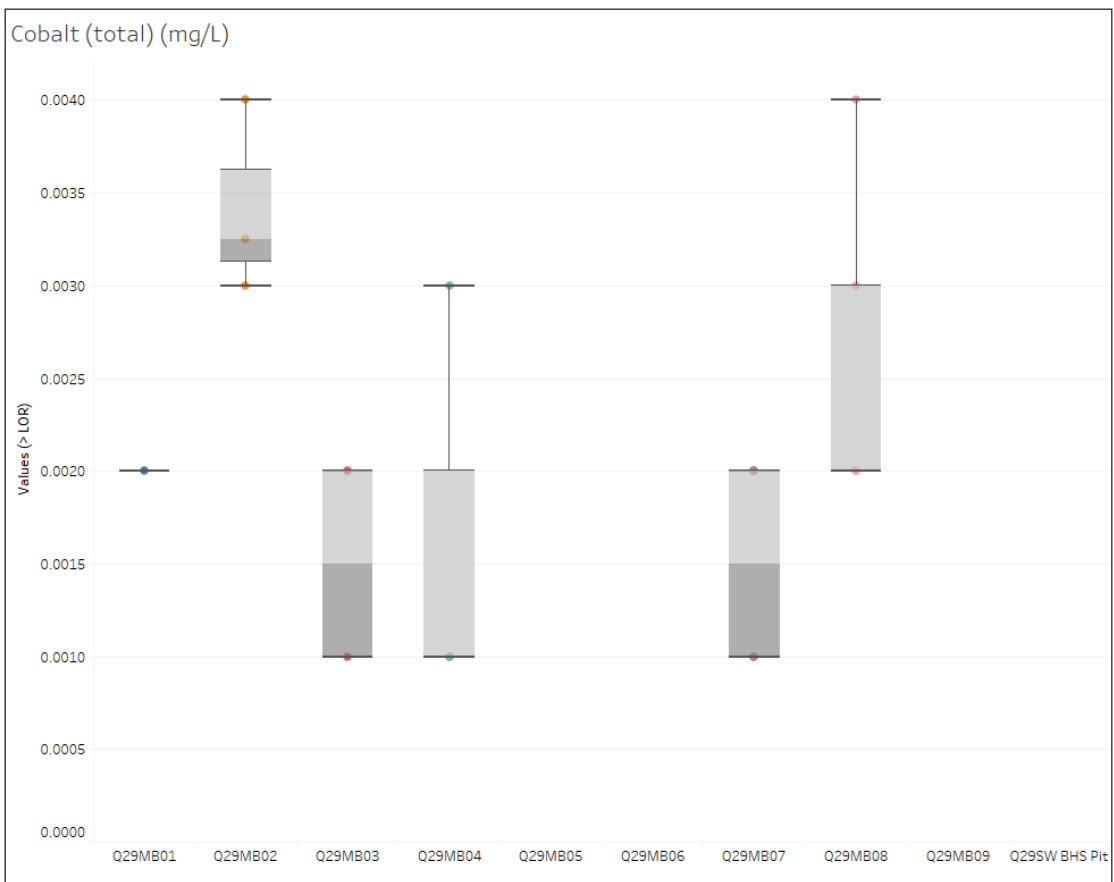
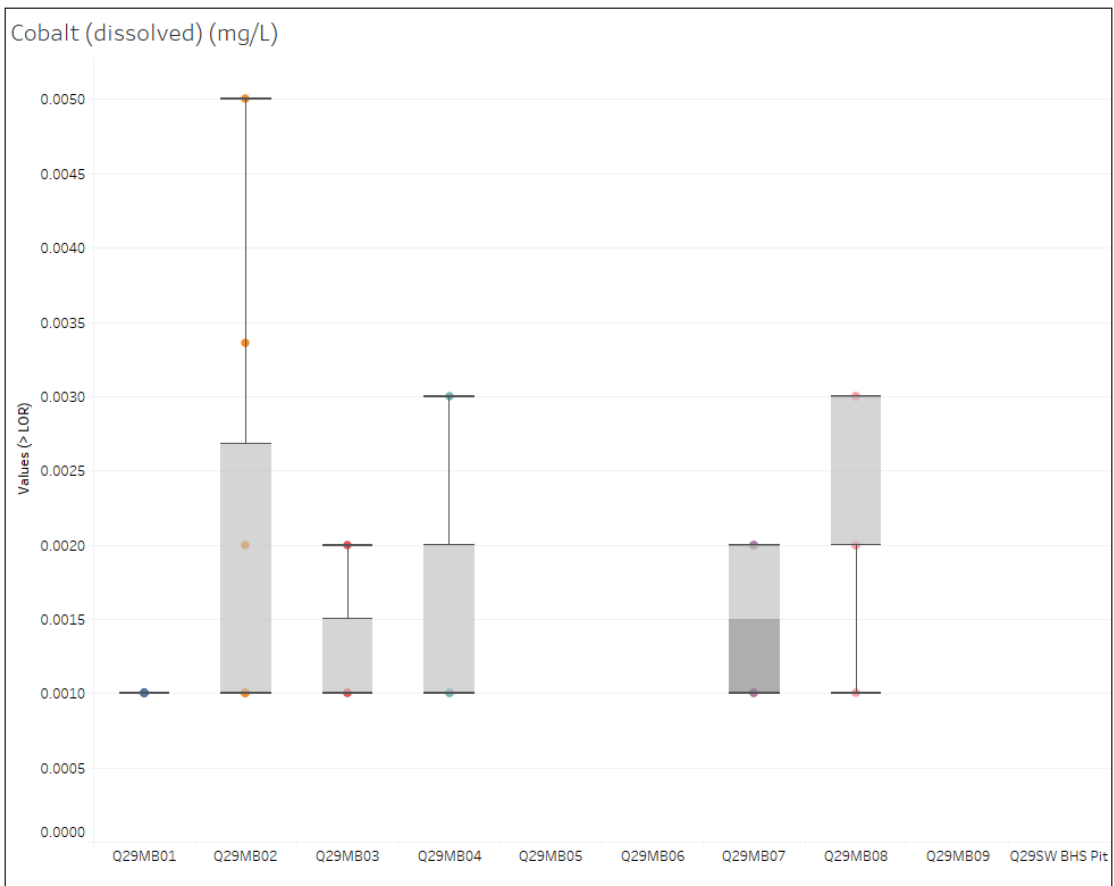


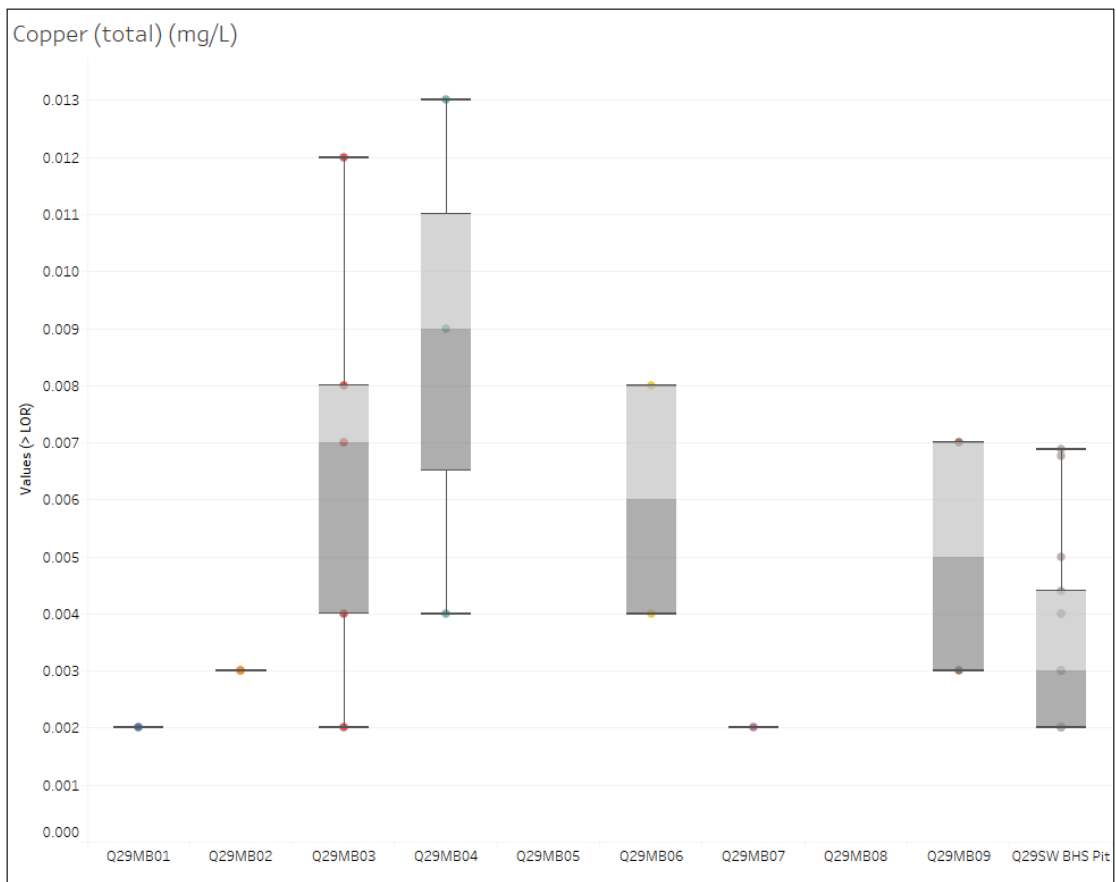
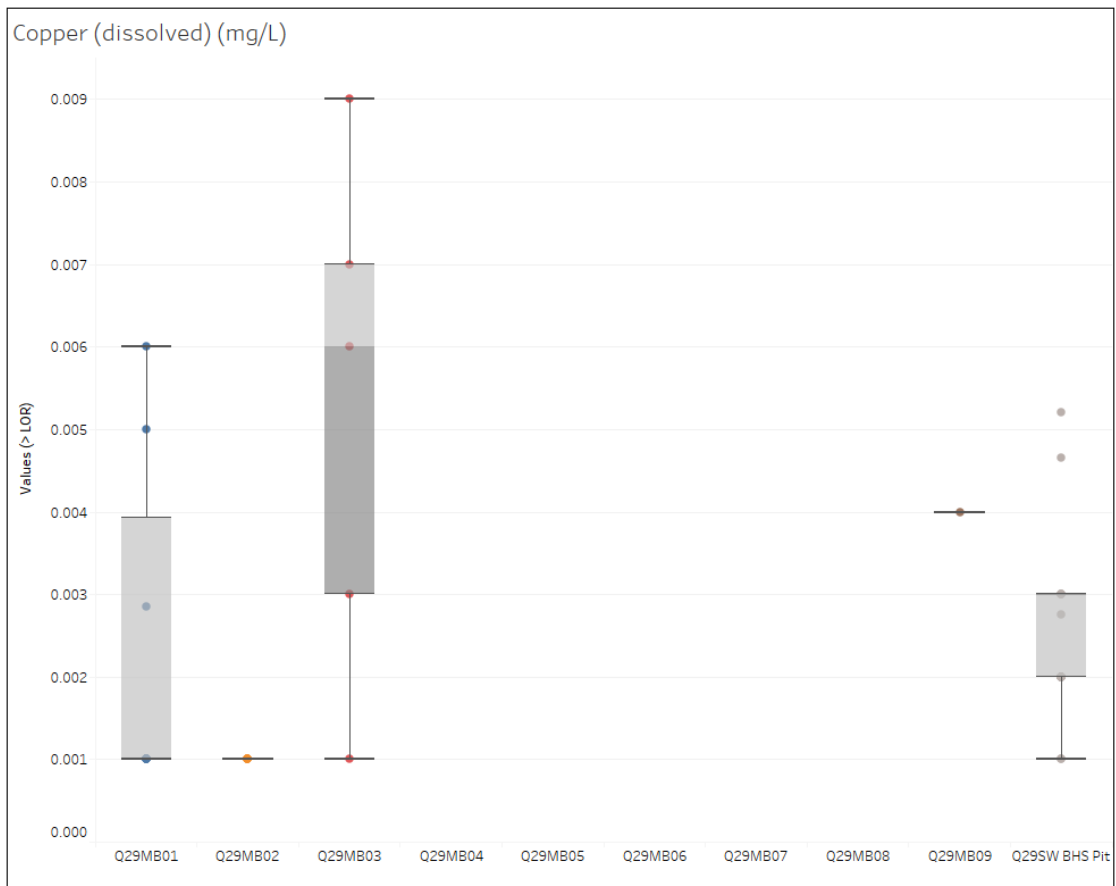


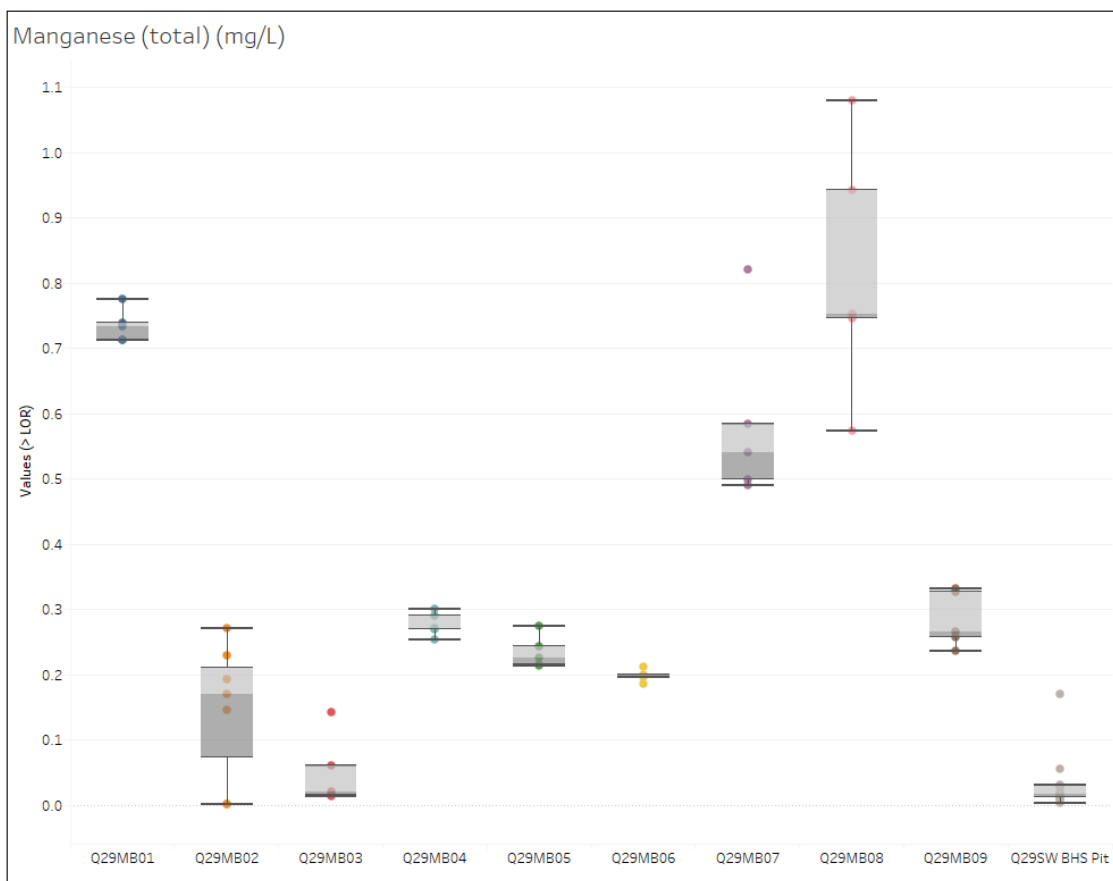
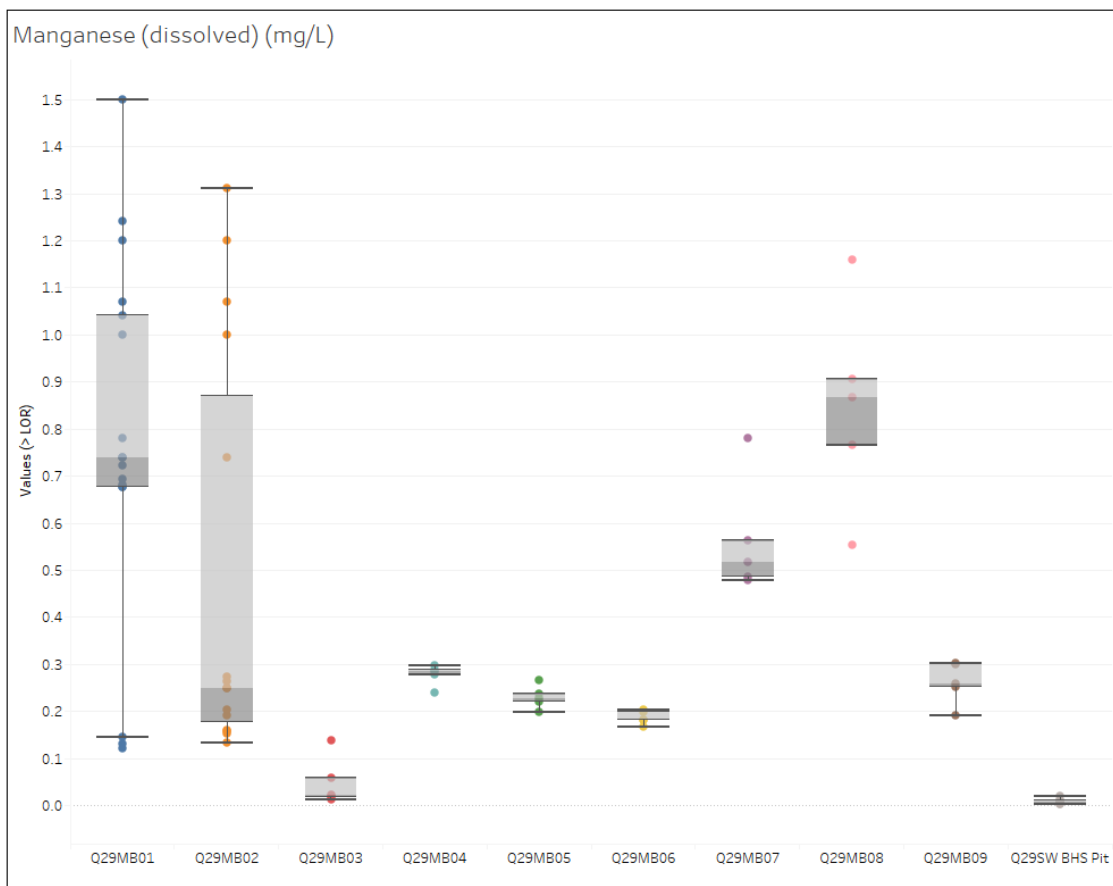


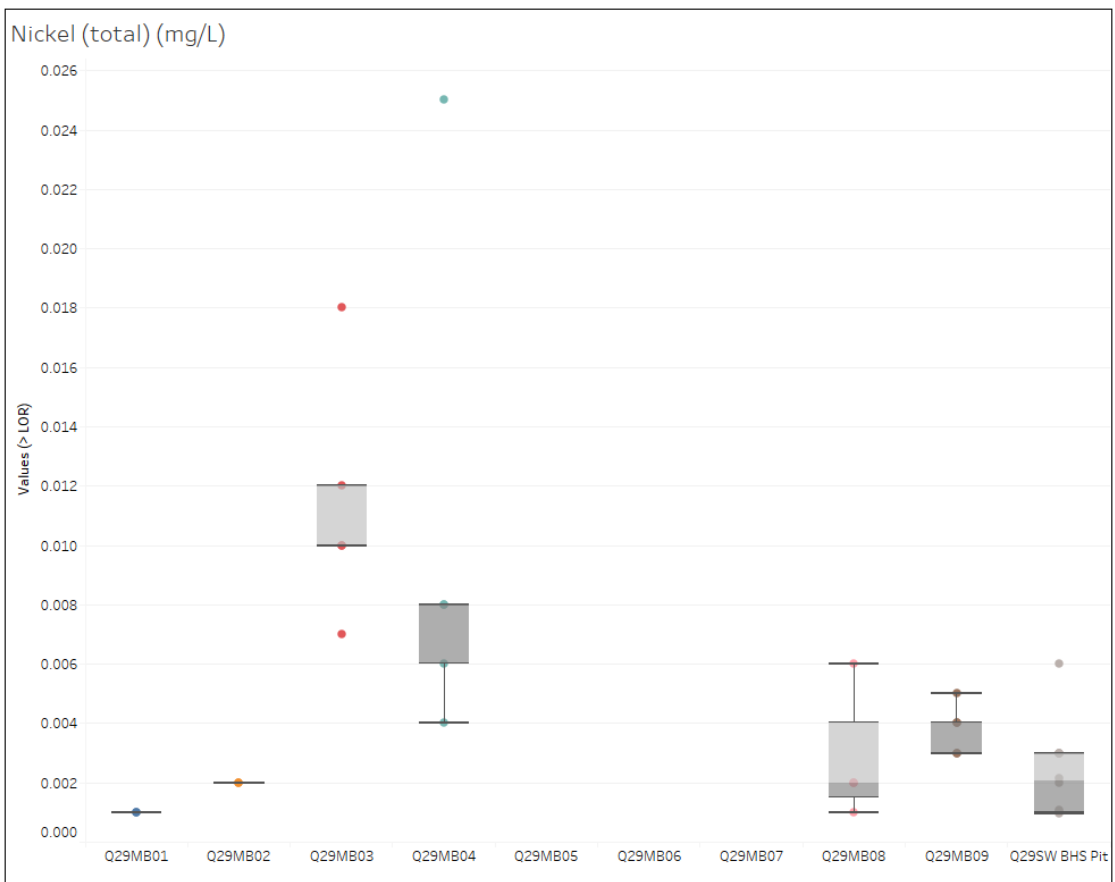
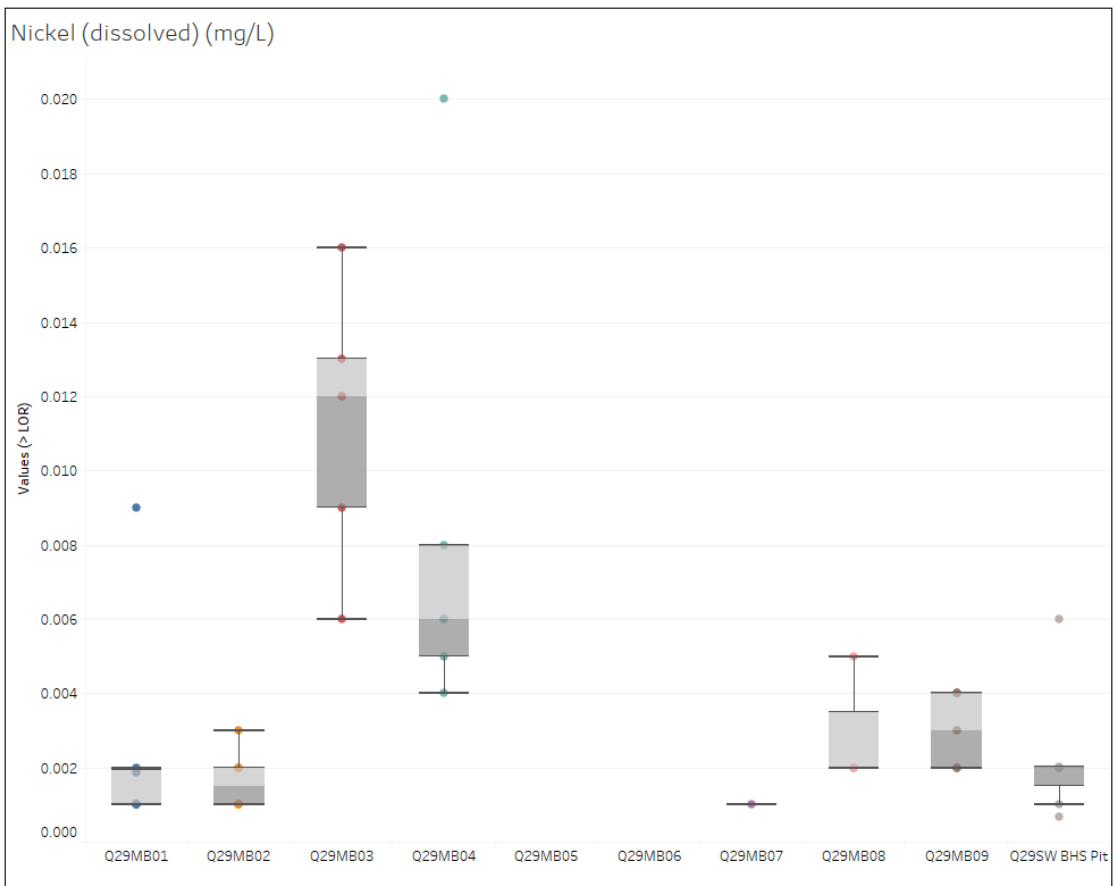


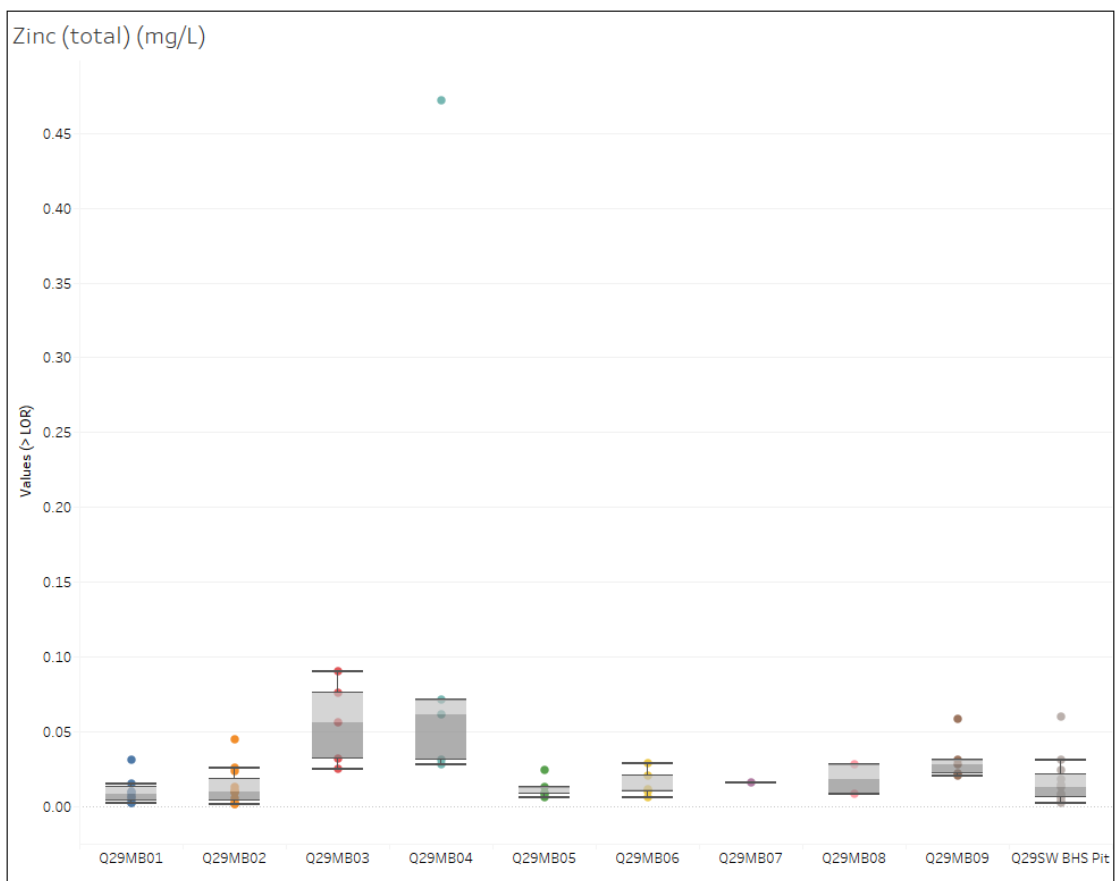
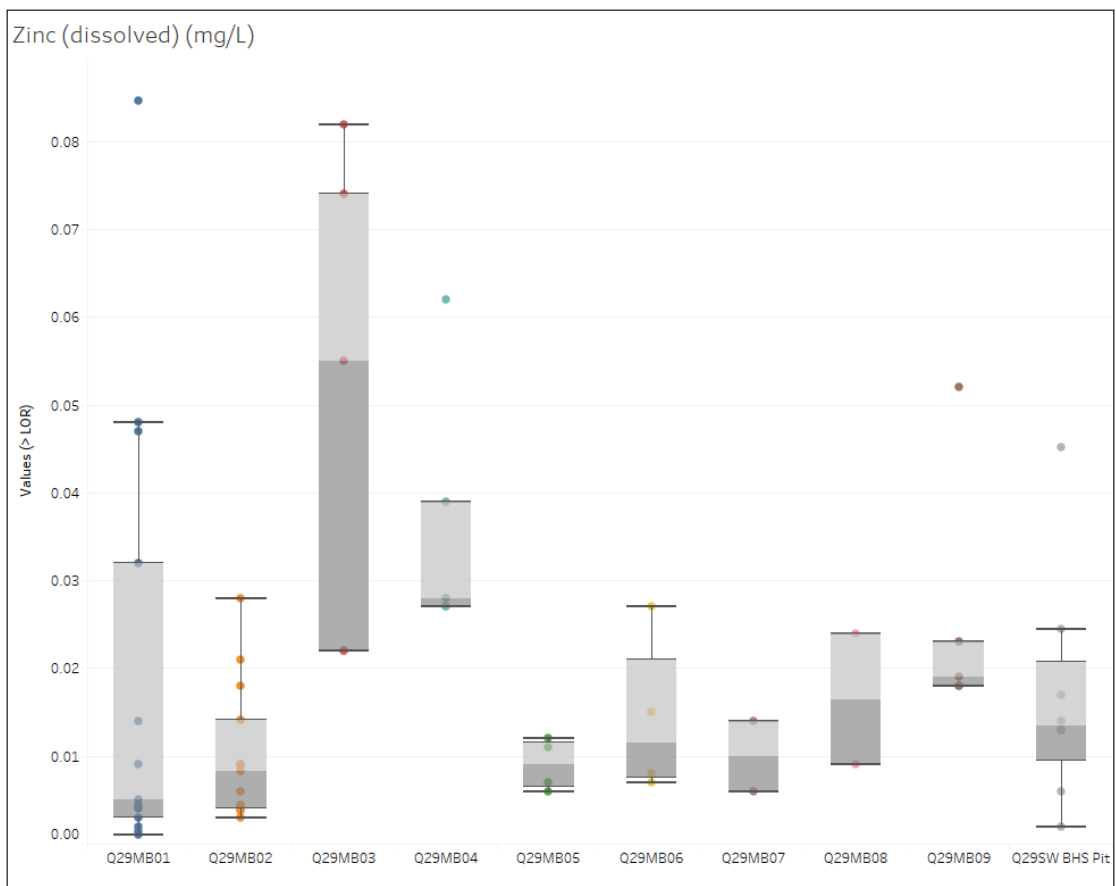


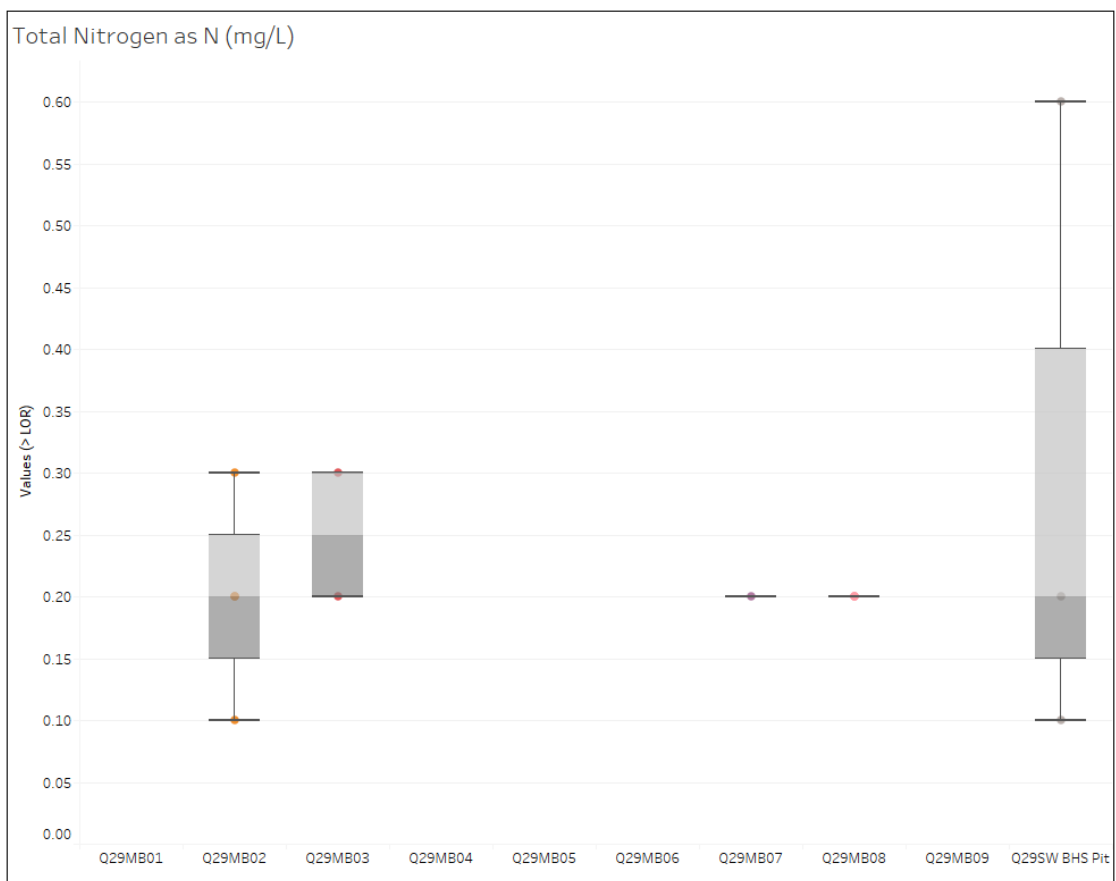
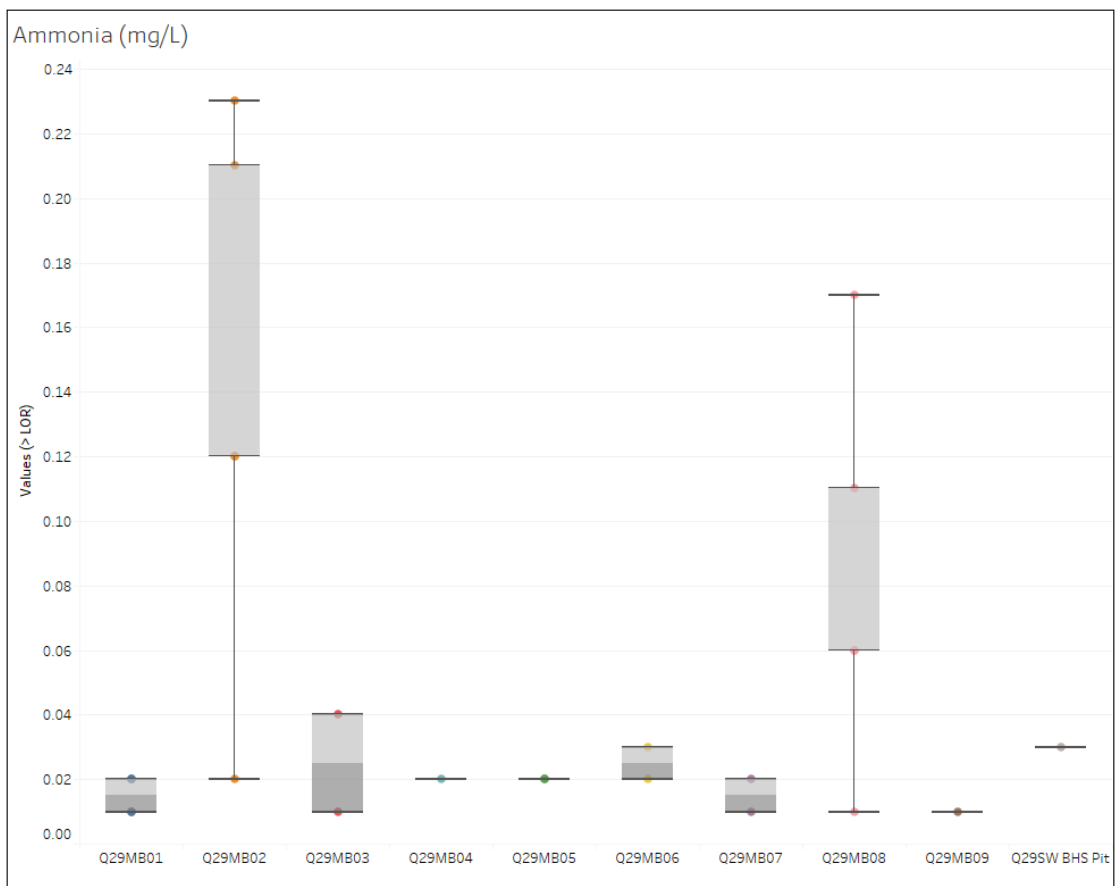


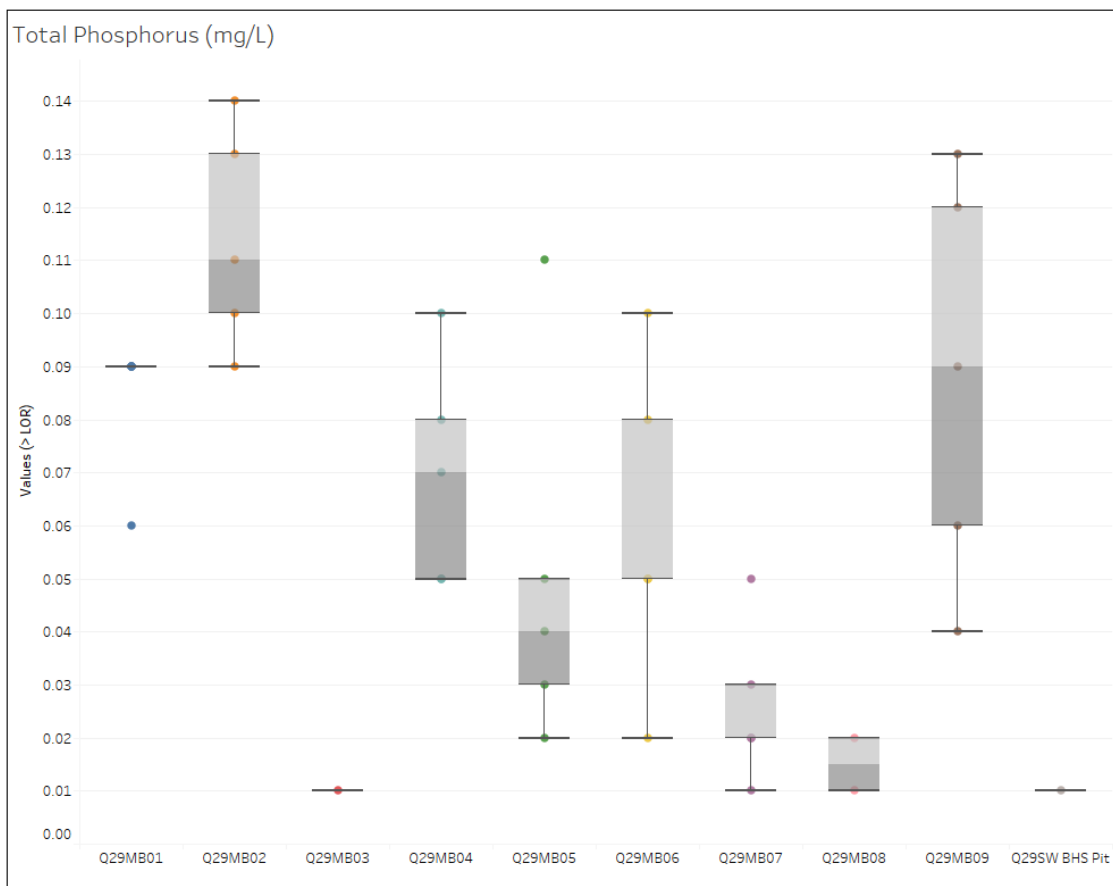






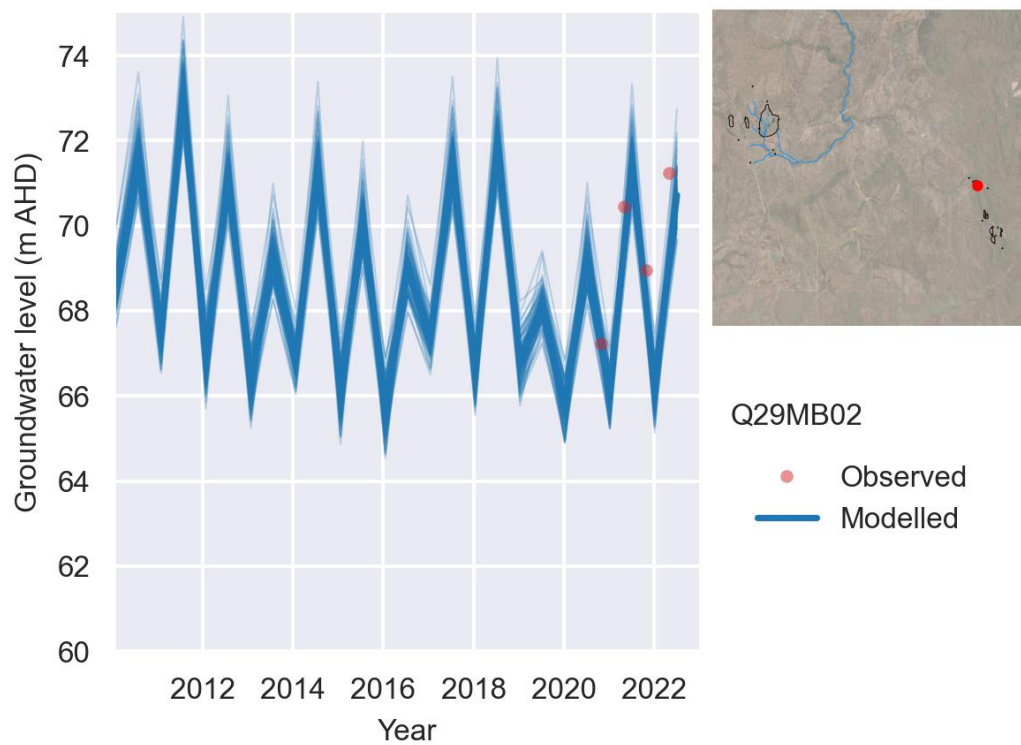
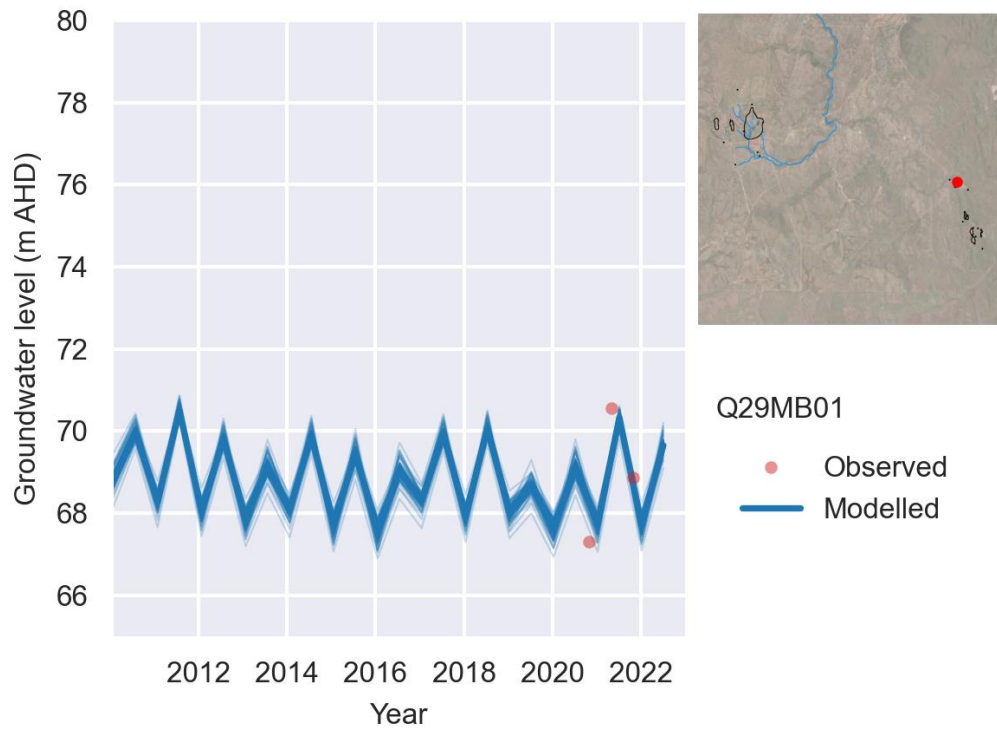


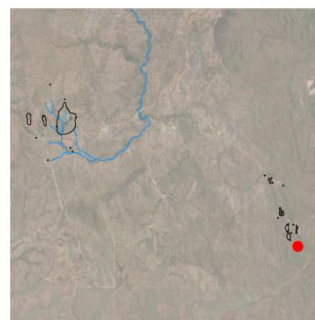
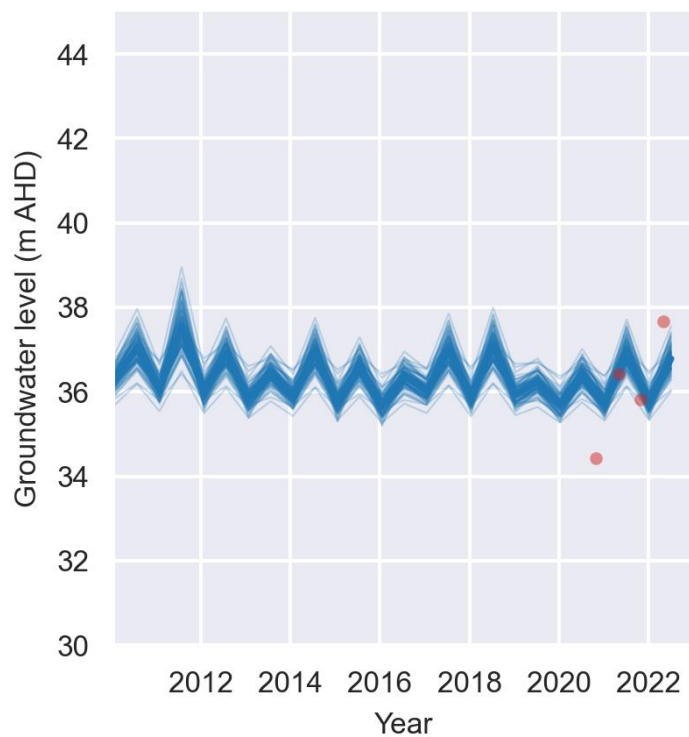




Appendix C Numerical Model Calibration Charts

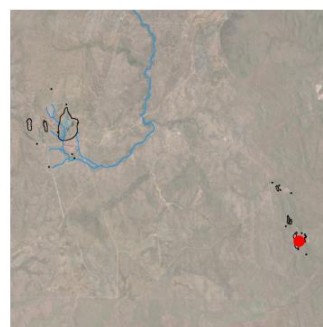
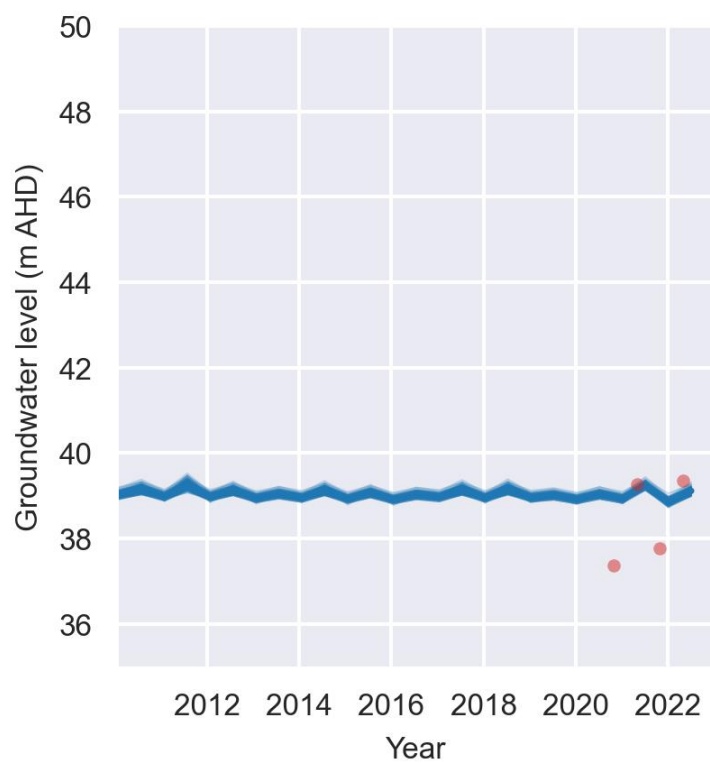
C.1 Modelled to Observed Hydrographs





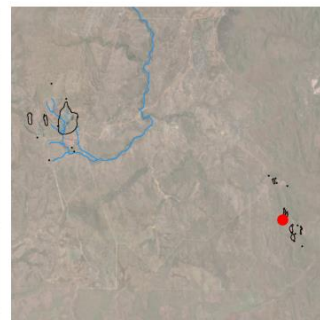
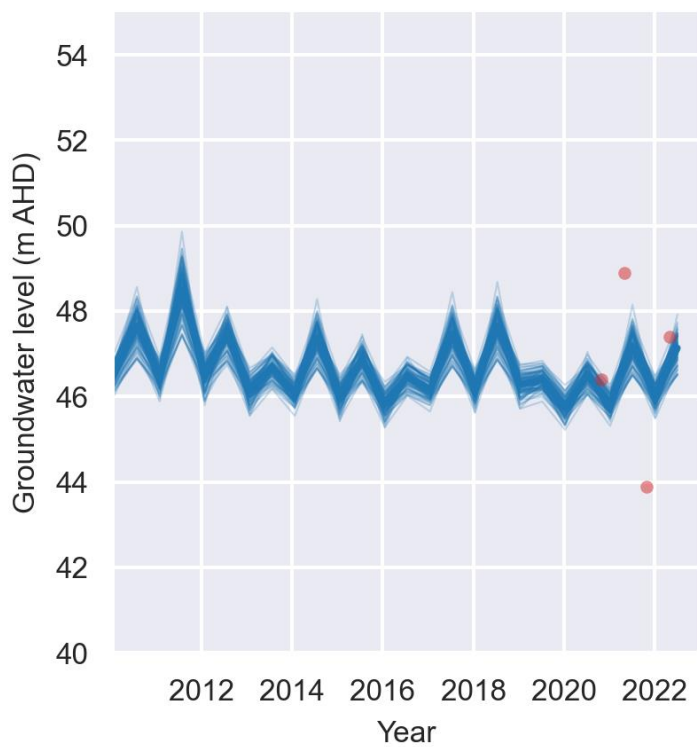
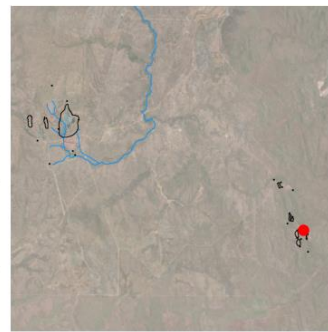
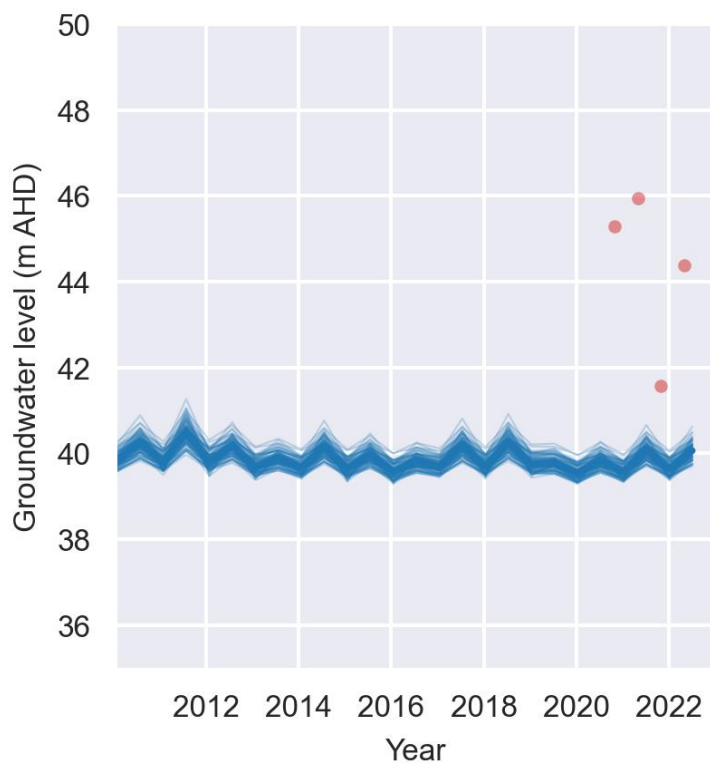
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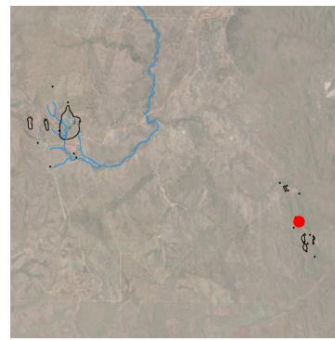
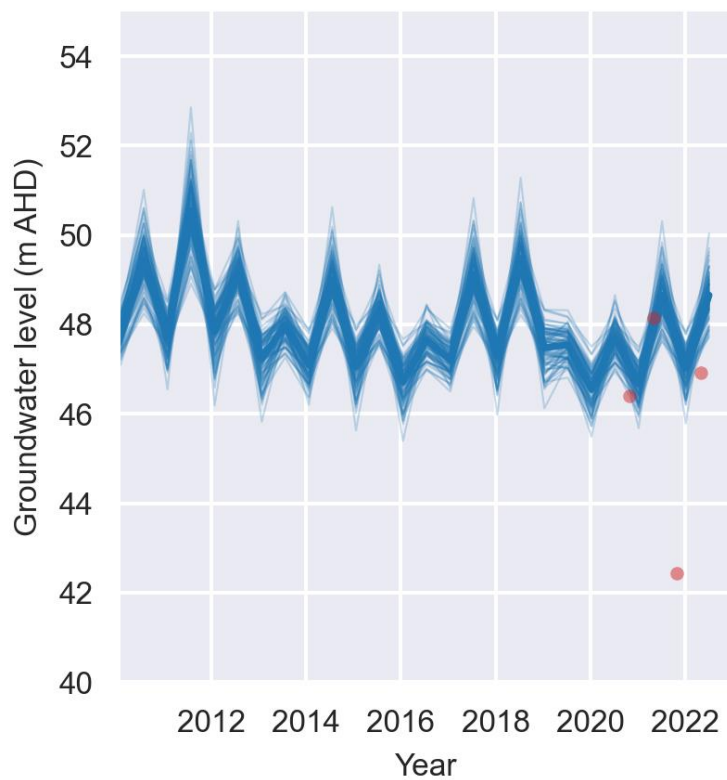
● Observed
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Q29MB04

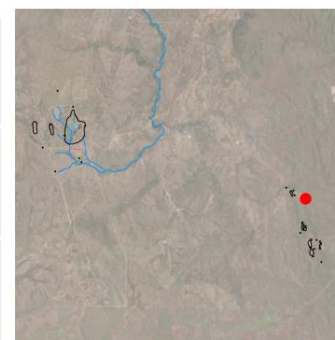
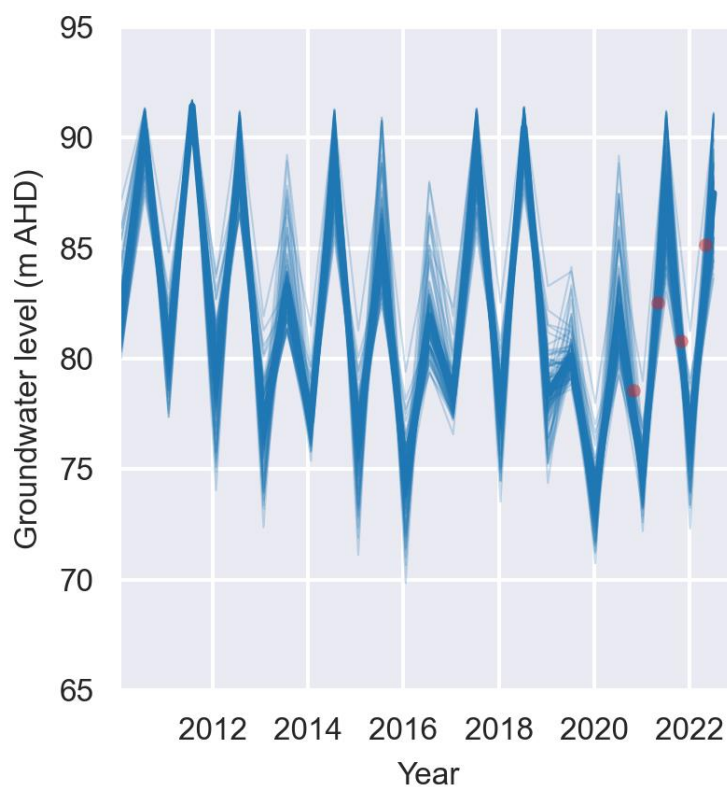
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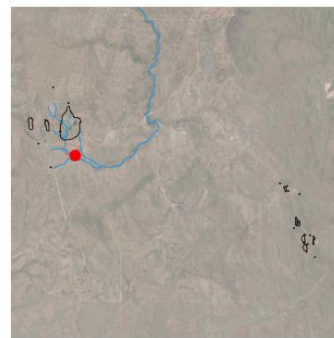
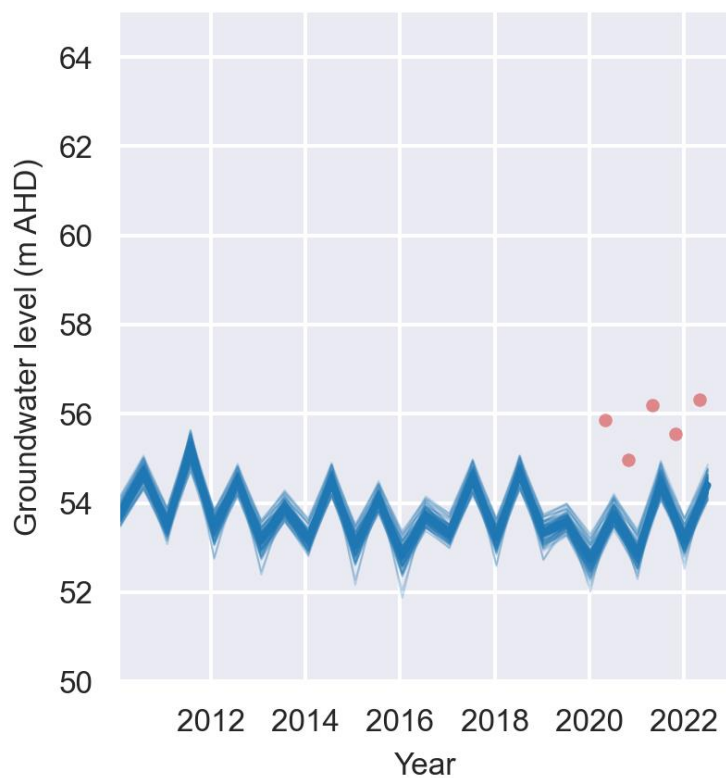
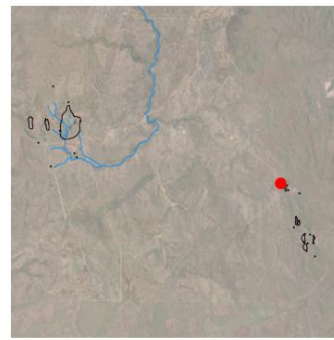
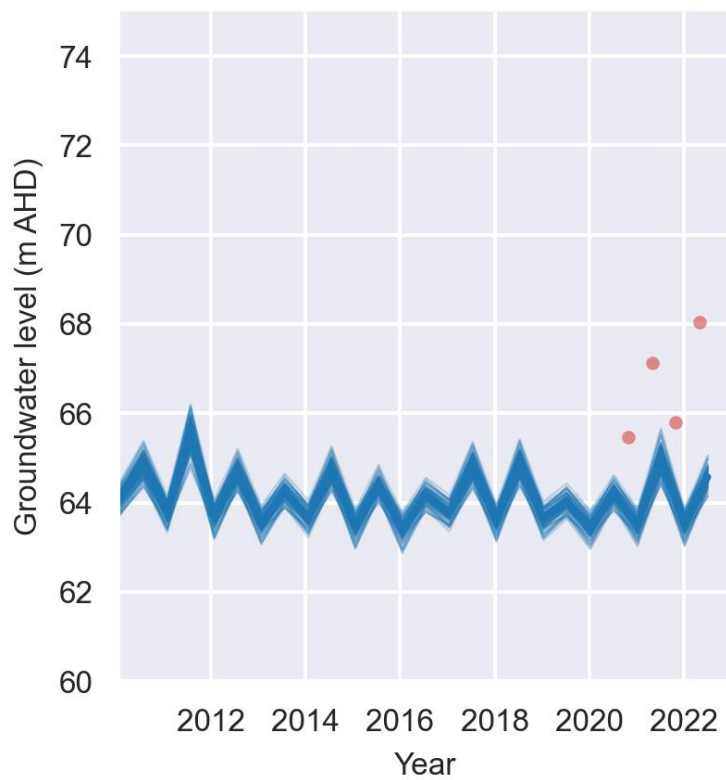
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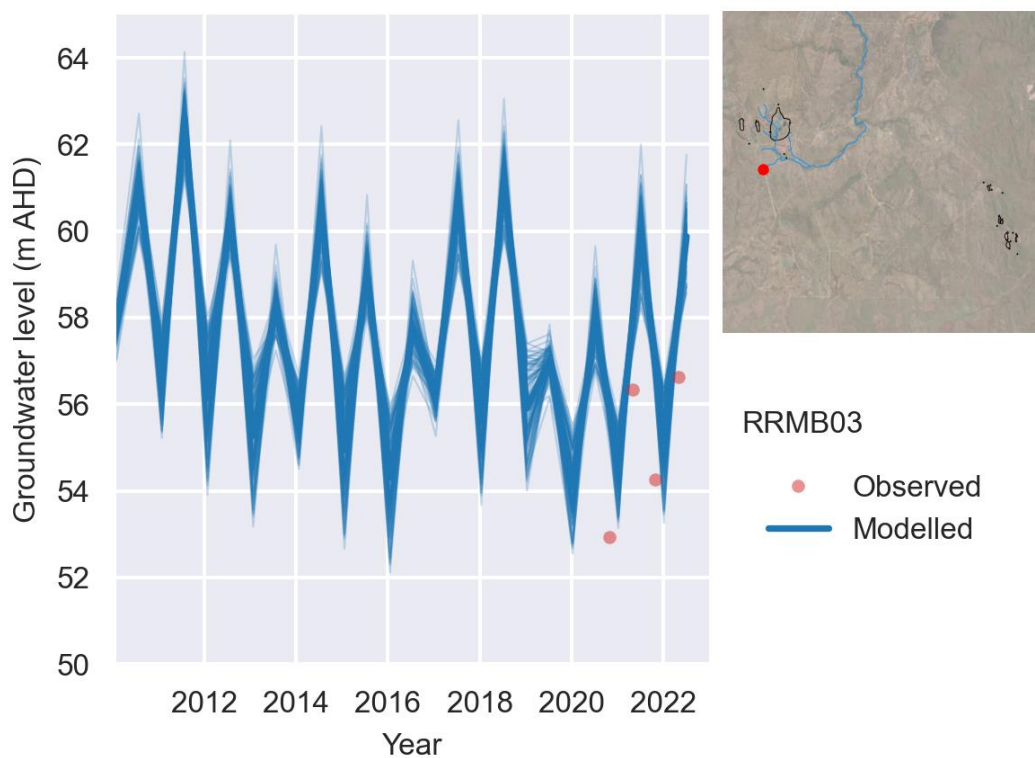
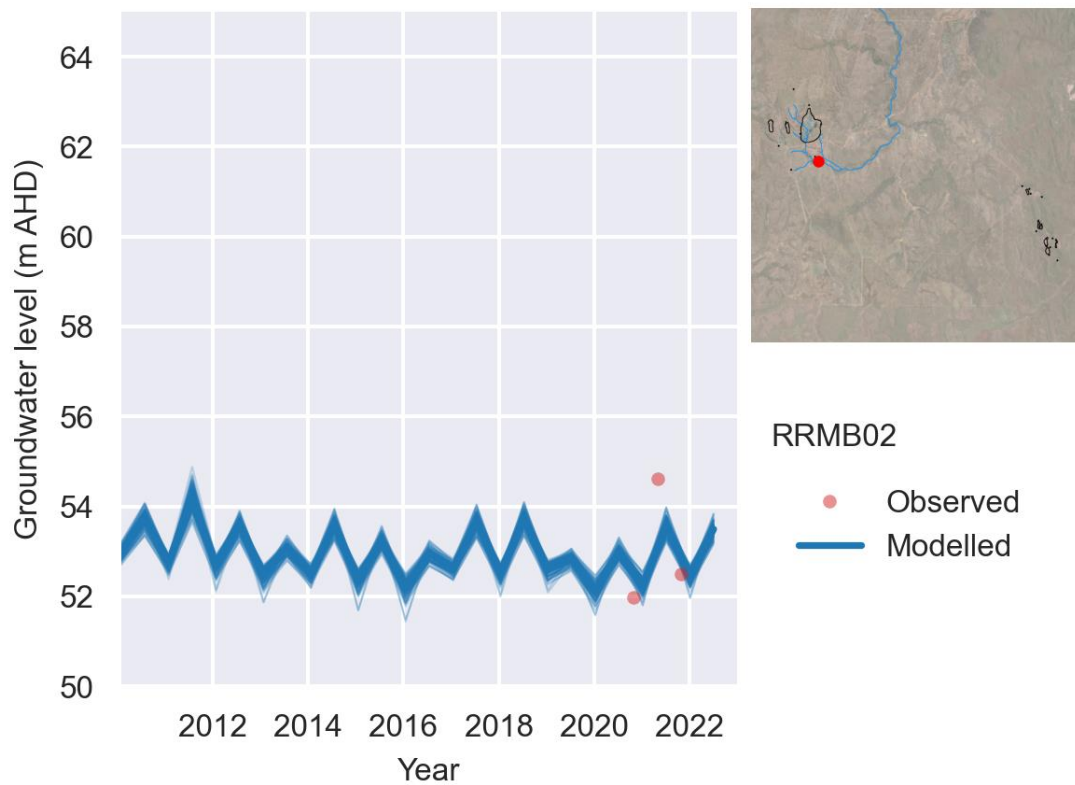
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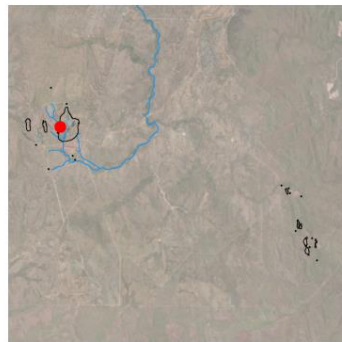
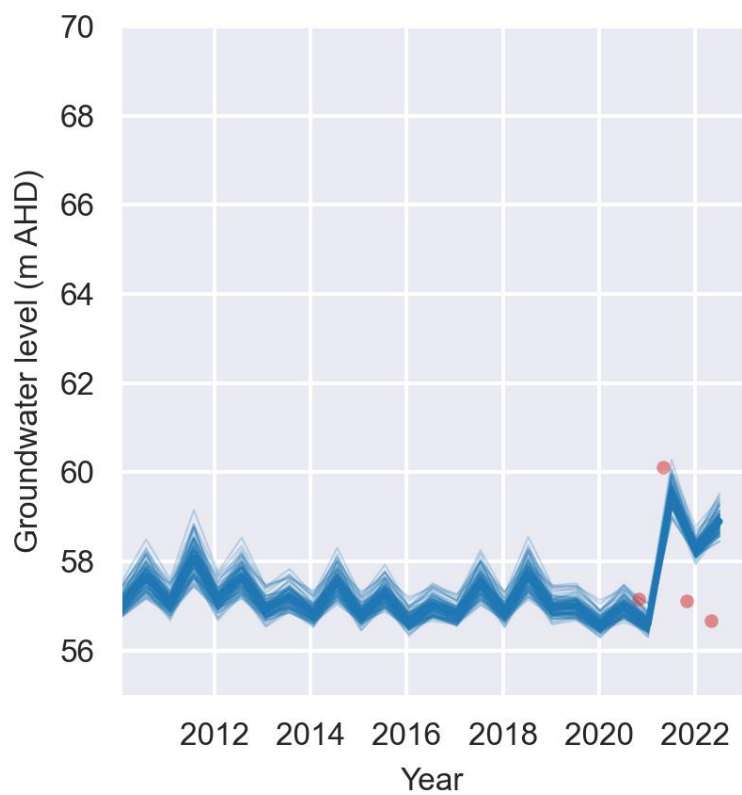
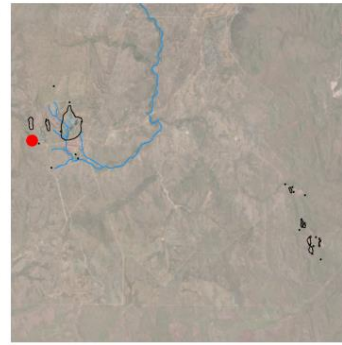
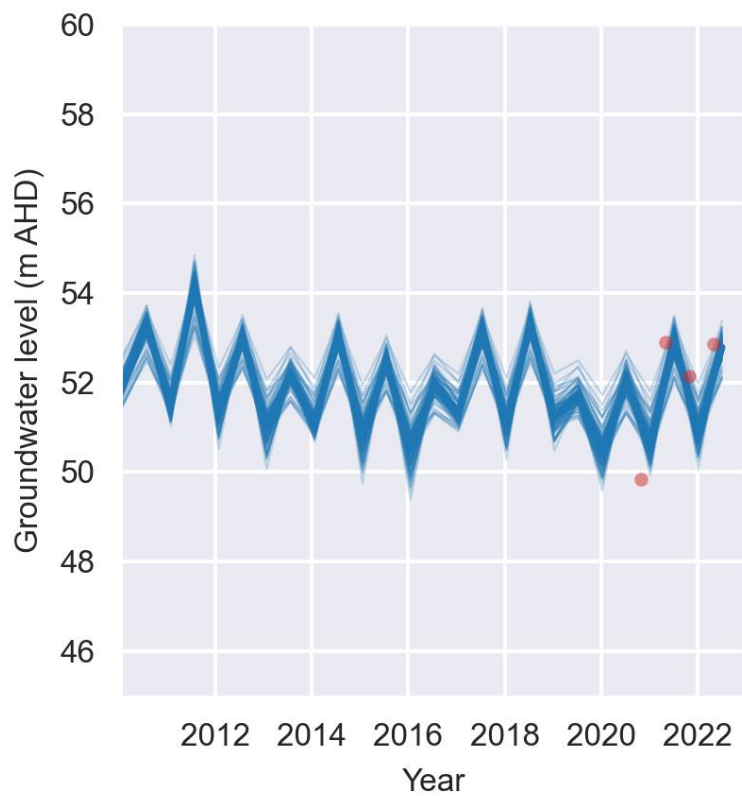


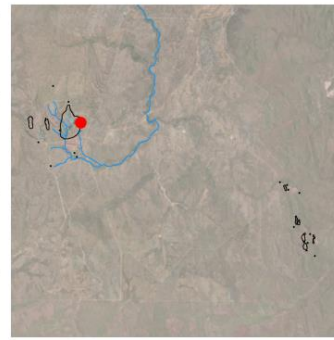
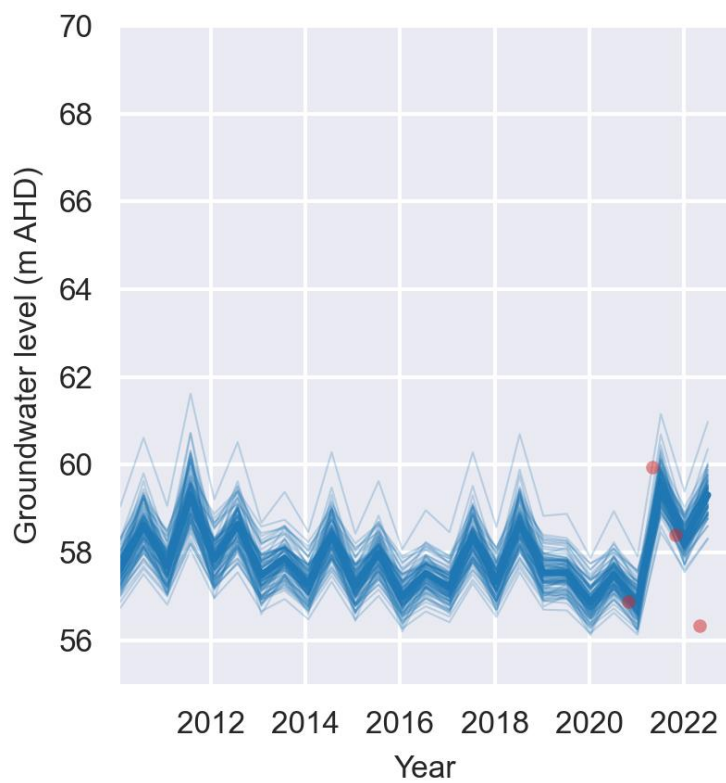
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— Modelled



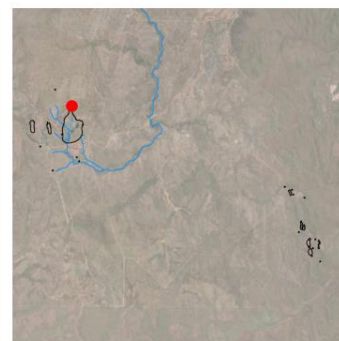
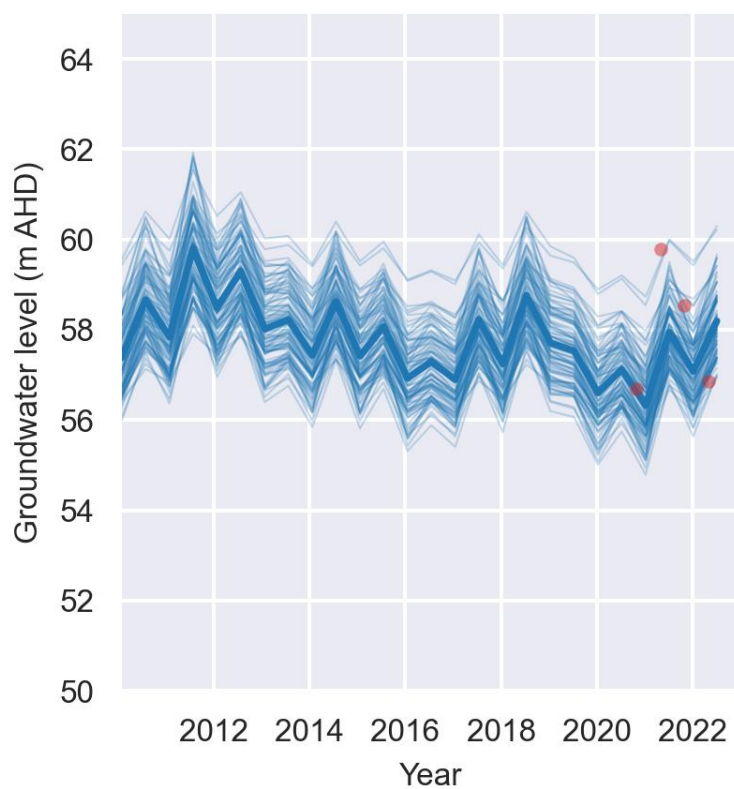






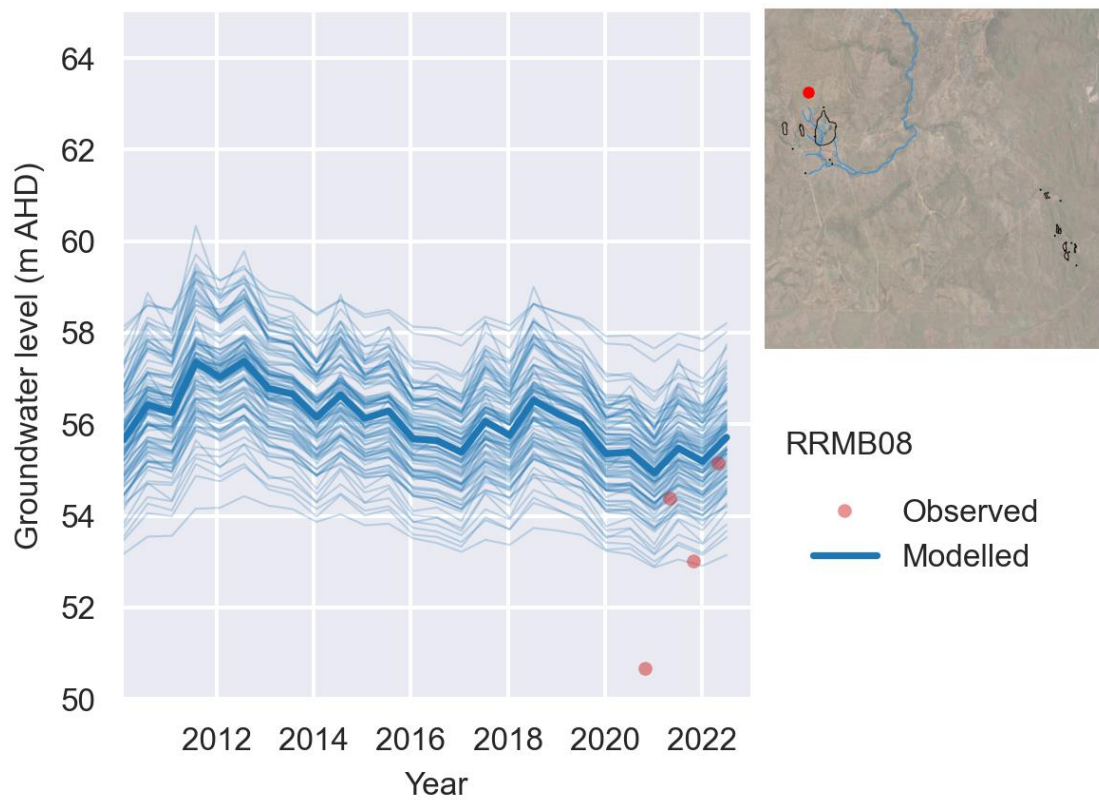
RRMB06

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— Modelled

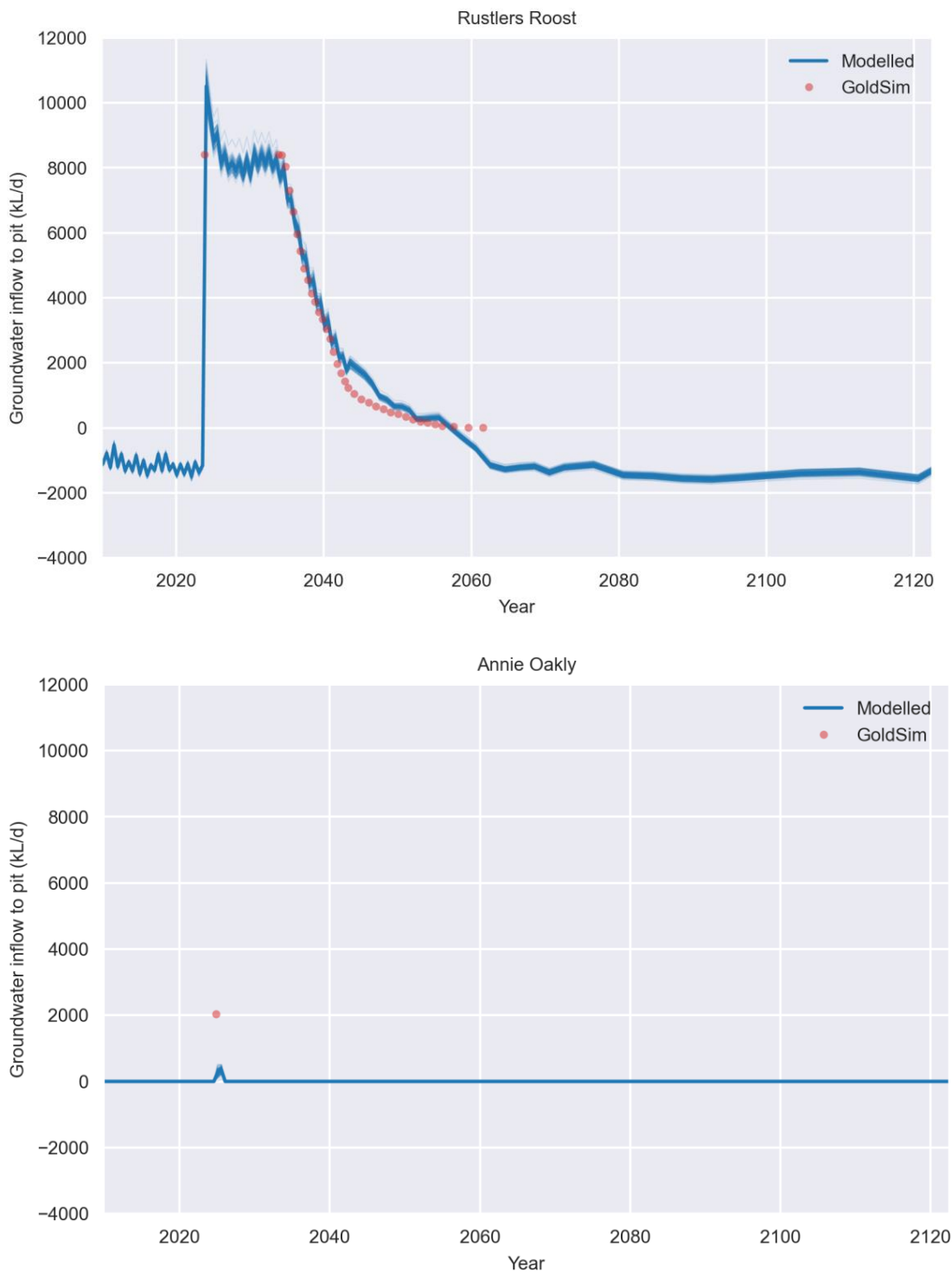


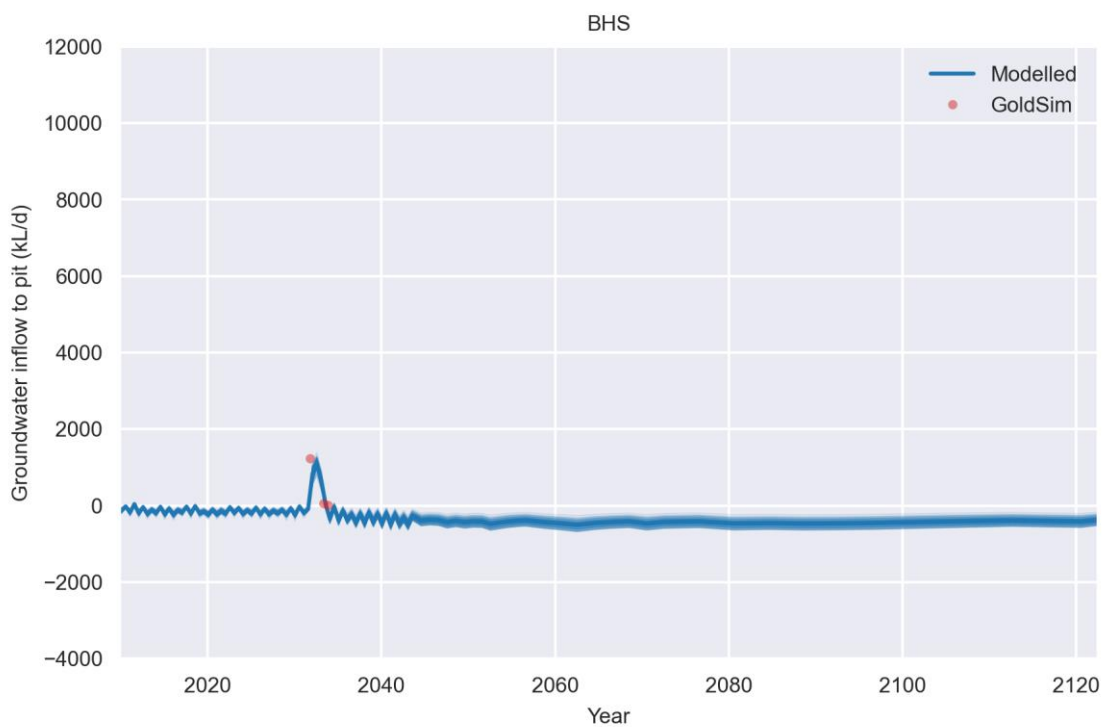
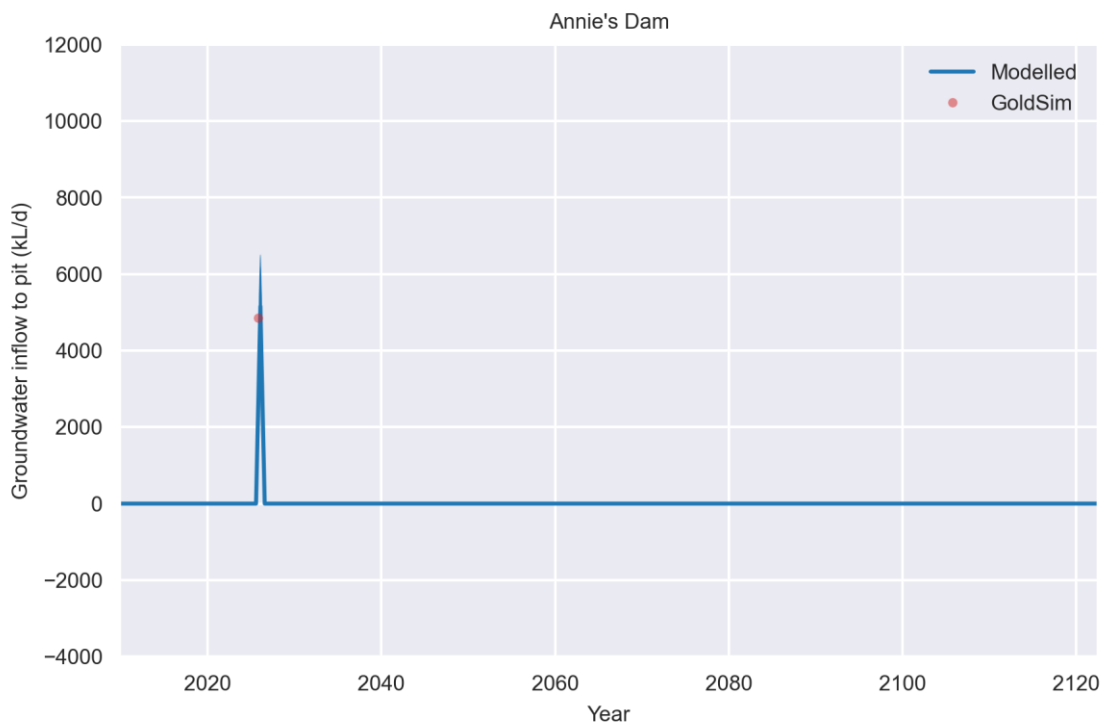
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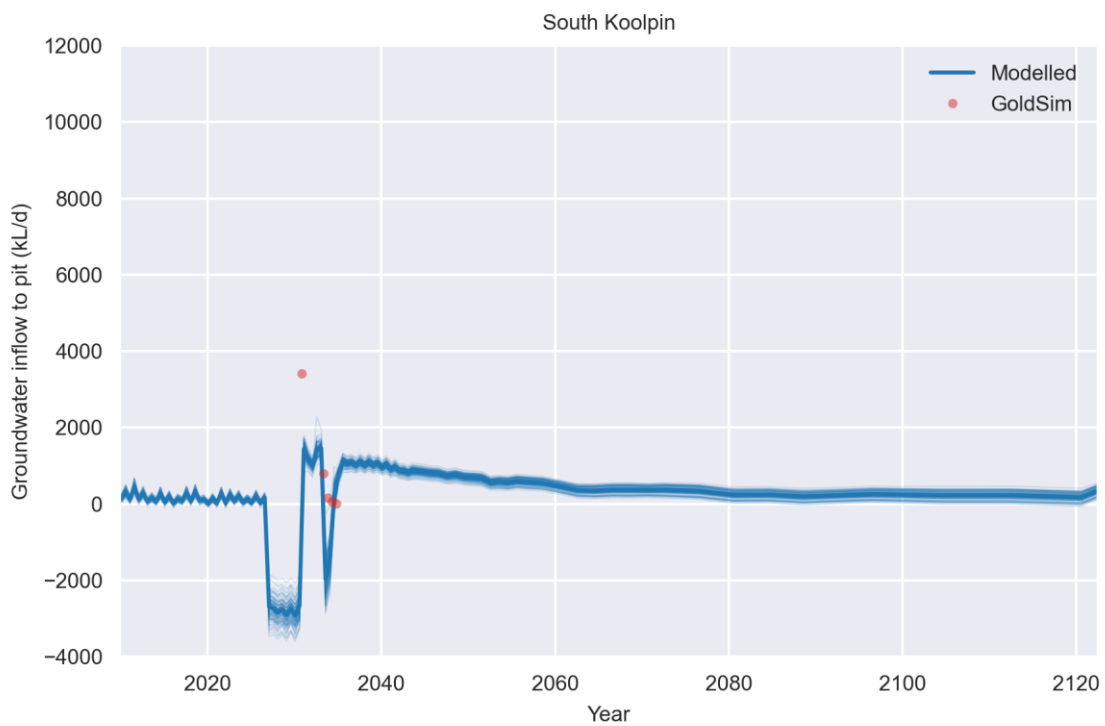
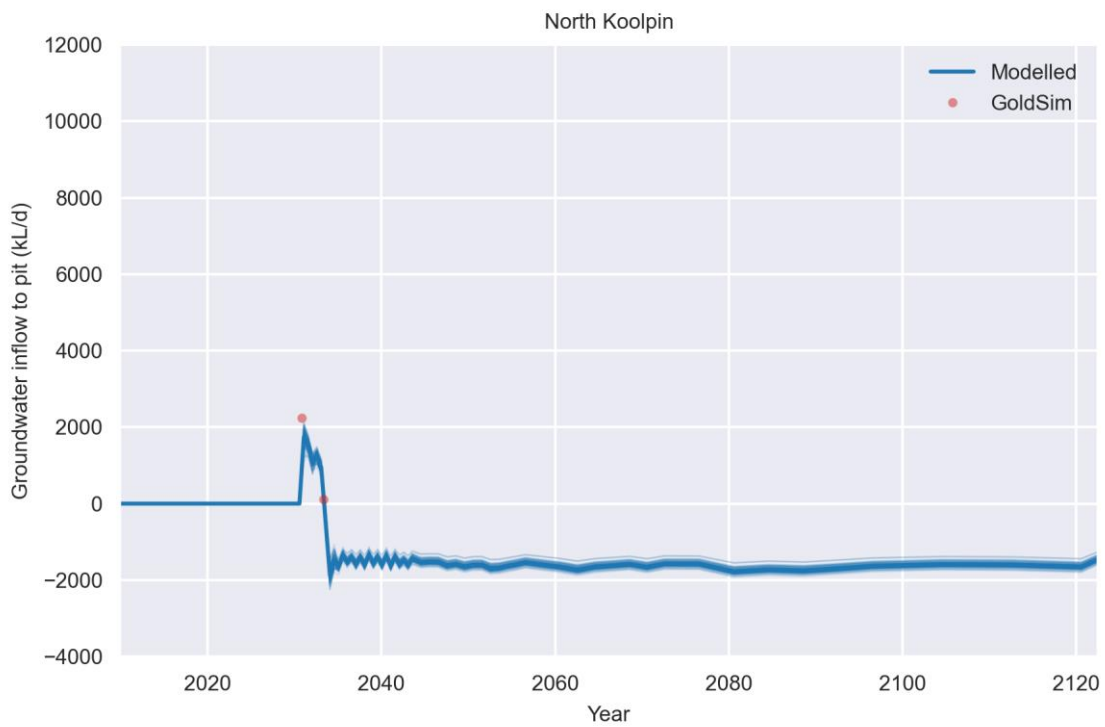
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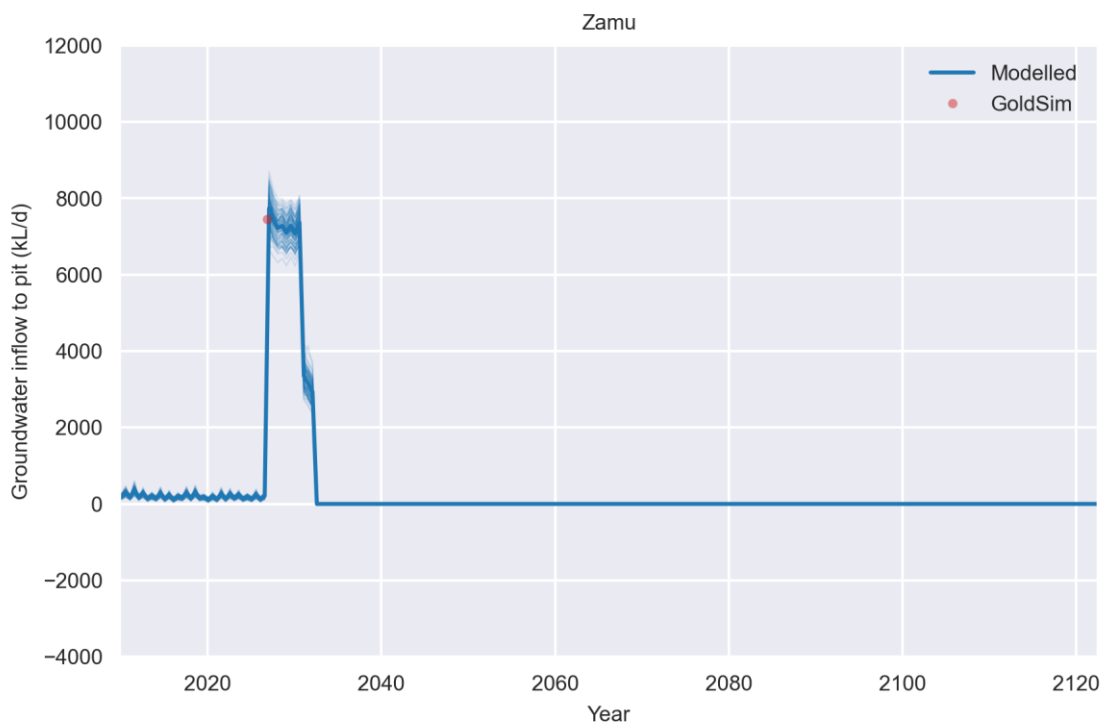
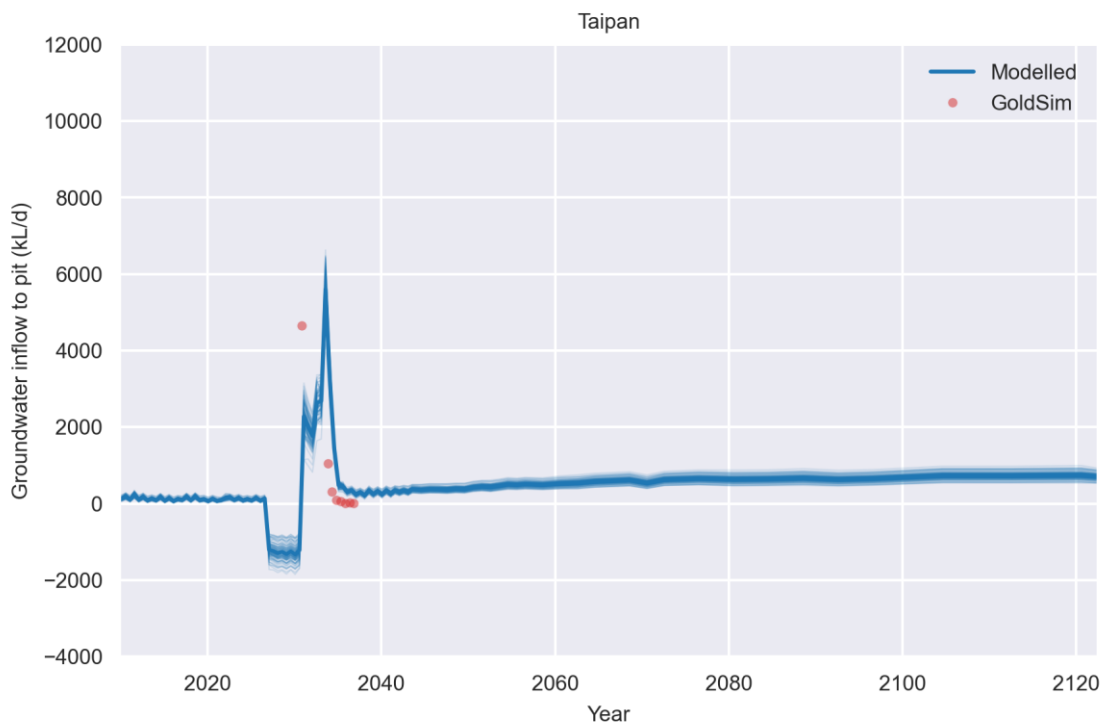


C.2 Modelled to Simulated (Goldsim) mine pit fluxes









Appendix D Rustlers Roost and Quest 29 Groundwater Peer Review

Prepared by Hugh Middlemis from HydroGeoLogic

RUSTLERS ROOST AND QUEST 29 GROUNDWATER PEER REVIEW

Prepared for:

Primary Gold Limited

28 July 2022

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HydroGeoLogic

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Version 1	28 July 2022	Initial draft

THIS REPORT SHOULD BE CITED/ATTRIBUTED AS:

Middlemis H (2022). Rustlers Roost and Quest 29 Groundwater Peer Review. Prepared by HydroGeoLogic for Primary Gold Limited. 28 July 2022.

1. INTRODUCTION

This report presents the findings of an independent peer review of the groundwater modelling for the Rustlers Roost and Quest 29 gold projects (NT), which forms the quantitative basis for the groundwater impact assessments supporting the EIS process.

1.1 Rustlers Roost and Quest 29 Gold Projects

Rustlers Roost ('RR') and Quest 29 ('Q29') are brownfield mining sites on Mineral Leases (ML1083 and ML29783, respectively) in the Mount Bunday region, about 100 km south-east of Darwin in the Northern Territory (Figure 1). The sites are about 11 km apart and south of the Arnhem Highway on Old Mount Bunday Station and McKinlay River Station. Rustlers Roost is on the boundary between the Adelaide River and McKinlay-Mary River regional catchments, draining via the ephemeral tributaries of the Marakai Creek to the west and Mt Bunday Creek to the east and north. Quest 29 drains mainly south and east into the McKinlay-Mary Rivers, but a small part of the northern BHS pit catchment may also contribute some flow north-west into the Mt Bunday Creek system. The regional groundwater flow system shows similar patterns.

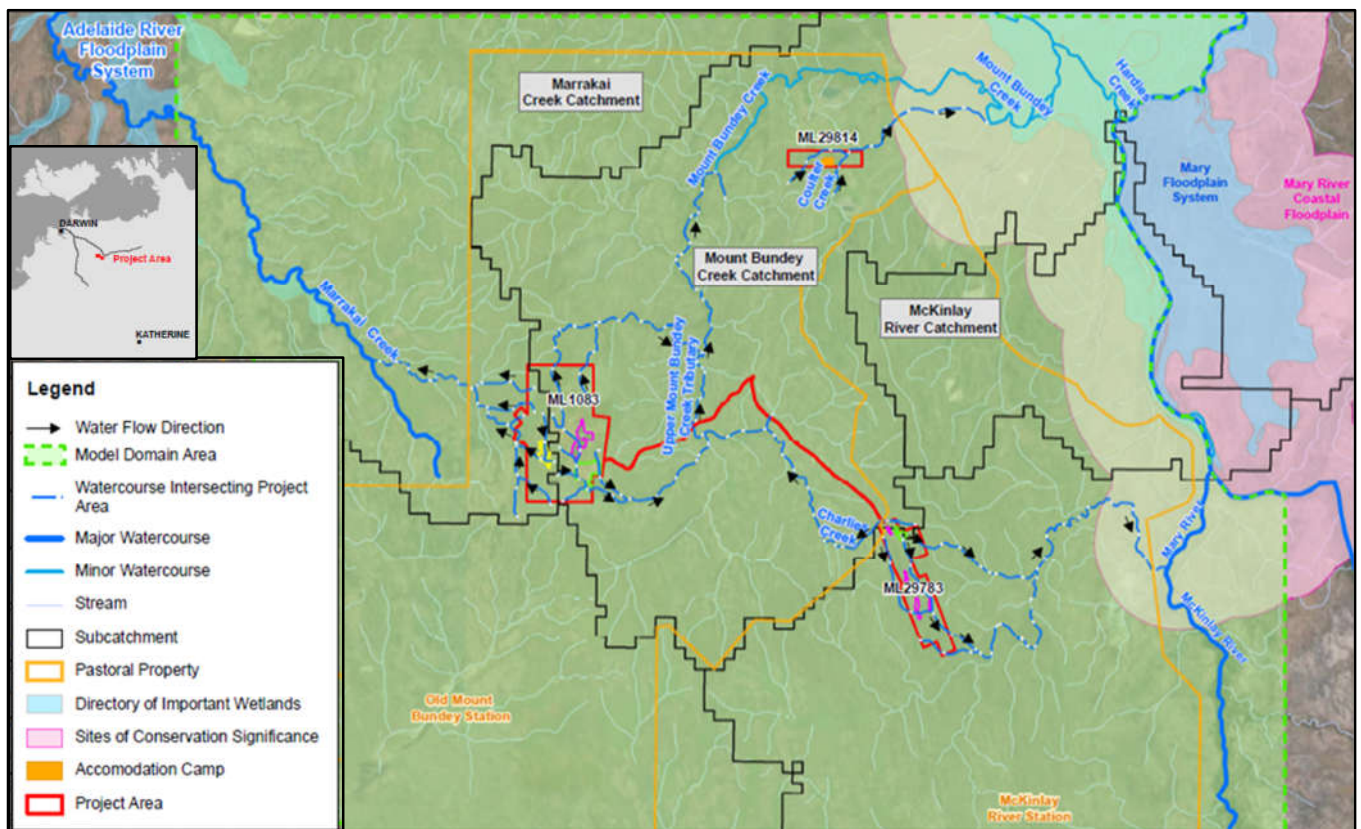


Figure 1 - Rustlers Roost and Quest 29 setting (after CDM Smith 2022, Figure 5-1)

The sites have a long history of gold mining activity after gold was discovered in the 1940s. Mining activities have occurred intermittently since then, most recently ending in 1997 at Rustlers Roost and 2004 at Quest 29. There is an existing RR pit void lake (holding about 3 GL to a level of 56.9 mAHD in Nov. 2020). Site-specific groundwater and surface water investigations have been conducted in 1993-94 and since 2016.

Primary Gold Limited (PGO) is proposing to redevelop the existing mines by expanding the open pit gold mining operations at the two sites, and constructing a process plant and tailings storage facility (TSF) at Rustlers Roost, plus an accommodation camp (on ML29814 near Toms Gully), groundwater bores for water supply and upgrading the roads connecting the sites. The planned rate of production is up to 5 million tonnes per annum (Mtpa) over the 10-year life of mine (LM). The post-mining landform will include a final RR pit void lake and five pit void lakes at the multiple Q29 pit shells.

1.2 Peer Review Methodology

This report summarises the outcomes of a peer review of the groundwater and modelling investigations (CDM Smith 2022) that form the quantitative basis for the groundwater impact assessment elements of the Supplement to the Draft Environmental Impact Statement (SEIS) prepared for the proposed project by Primary Gold Limited (PGO).

The best practice principles and criteria of the Australian Groundwater Modelling Guideline ('AGMG'; Barnett et al. 2012) were applied to this desktop review, as there are no standard procedures for peer reviews of groundwater investigations and impact assessments as such. Consideration was also given to recent guidance on uncertainty analysis (Middlemis and Peeters, 2018; and the 2022 update in preparation).

This independent peer review effectively forms advice on whether the groundwater assessments made have been conducted competently and the conclusions reached are supported by the evidence presented, and/or whether additional information, monitoring, assessment and/or modelling may be required to inform the assessment.

This peer review considered the conceptual hydrogeological model, its implementation in the numerical groundwater model and its fitness for the purpose of groundwater impact assessment via simulations of mine dewatering effects, related water management and mitigation actions, and mine closure scenarios. Conformance with best practice guidelines was assessed in relation to: the conceptual hydrogeological model; the numerical model design, grid and boundaries; layering and parameterisation; model calibration performance; non-uniqueness and sensitivity-uncertainty prediction scenarios and results; and final pit void lake modelling. Related analyses including the GoldSim site water balance and the final void lake hydrogeochemical analysis were considered, but those analyses and models were not audited in detail.

The peer review involved video link and phone discussions and email exchanges with the CDM Smith team, consistent with guideline principles, mainly on documentation issues arising from the initial review. The draft groundwater assessment report was updated accordingly, such that it adequately addressed the issues raised. Some post-mining particle tracking results were presented and discussed prior to inclusion in a final report.

The review outcomes are summarised in the modelling guideline compliance summary checklist presented as Table 1 in Section 2 below, while some elements are discussed further in Section 3.

This peer review of groundwater issues was conducted during June-July 2022 by Hugh Middlemis (HydroGeoLogic), an independent consultant specialising in groundwater modelling. Hugh holds a degree in civil engineering and a masters in hydrology and hydrogeology, with more than 40 years' experience. Hugh was principal author of the first Australian groundwater modelling guidelines (Middlemis et al. 2001) that formed the basis for the latest guidelines (Barnett et al. 2012) and was awarded a Churchill Fellowship in 2004 to benchmark groundwater modelling best practice. He is principal author on two recent guidance reports on modelling uncertainty (Middlemis and Peeters 2018 (2022 update in prep.); Middlemis et al. 2019).

The peer reviewer is familiar with Top End conditions, having lived at Katherine and Darwin, and has suitable skills and experience on NT groundwater projects, for example:

- Independent expert reviews of groundwater assessments and/or water management plans for several NT mining projects; Fountain Head Groundwater Model Update (2022); Ammaroo Phosphate Groundwater Model (2022 and 2017); Jervois Base Metals Groundwater Monitoring and Management Plan (2020); Cambrian Limestone Aquifer and Roper River Model (Daly/Roper Basin model review 2020); Tindall Limestone Aquifer (2020); Chandler Salt Water Management Plan (2017); Ranger Pit 1 (2016).
- Hugh was previously Technical Director on several Aquaterra projects in the NT, which also involved site visits and investigations: Middle Point groundwater model (1999); Elizabeth River waterway groundwater model (NT Dept of Transport, 1999); Woodcutters mine decommissioning (1999); Groote Eylandt mine dewatering and river-aquifer interactions (1998-2002); Angela uranium (2010-11); McArthur River mine dewatering and river-aquifer interactions (2012-13).

We assert no conflict of interest issues in relation to this work. Mr Middlemis has not worked on the Rustlers Roost project, nor for Primary Gold nor Hanking Australia, nor for CDM Smith, other than in a review role.

2. RUSTLERS ROOST & QUEST 29 PEER REVIEW SUMMARY

This desktop peer review considered the CDM Smith (2022) groundwater assessment report that supports the Supplement to the Draft EIS on the project. The modelling report details the understanding of the hydrogeological system and related groundwater-dependent ecosystems (GDEs), along with the conceptual model and design and development of a Modflow numerical groundwater flow model, and a GoldSim water and solute balance model. This work comprises a significant update to the 2021 draft EIS investigation in terms of the more extensive data used for model calibration, the uncertainty analysis methods and the water-solute balance modelling.

The peer review outcomes are summarised in Table 1, based on the modelling guideline compliance summary checklist (Barnett et al. 2012, Table 9-1), with further discussion outlined in Section 3.

Table 1 - Groundwater Model Peer Review: 10-point summary: Rustlers Roost and Quest 29

Question	Y/N	Comments re Rustlers Roost and Quest 29 modelling (2022)
1. Are the model objectives and model confidence level classification clearly stated?	Yes	Overall objectives indicated as modelling investigation to support environmental approvals via predictive scenarios and sensitivity-uncertainty analysis of the effects on groundwater levels and flows due to mining and TSF activities and post-mining recovery. Includes GoldSim site-wide water balance and solute analysis including post-mining pit void lakes and lake water quality geochemical analyses. Class 2 groundwater model confidence level target, assessed as achieved by this review, although the quantitative uncertainty analysis that has been conducted surpasses the need for the qualitative confidence level that is now regarded as outmoded (Middlemis and Peeters 2018); see also section 3.2.
2. Are the objectives satisfied?	Yes	Competent Modflow and GoldSim model design and calibration. Some limitations on some aspects of post-mining assessments (see items 8-10 below and further discussion at section 3). Potential surface and groundwater interactions and GDEs are well represented in Modflow model. Prediction scenarios and uncertainty analysis are fit for purpose stated above. Additional post-1998 data on groundwater and pit lake levels and fluxes used in the history match calibration; eg. 2004 satellite imagery used to estimate pit lake level and thus benchmark GoldSim water balance model 'hindcast' since 1998 mine closure. This expands the data available (previously not used) on levels and fluxes for input to Modflow model, and provides an independent estimate of aquifer Kh (0.2-1.0 m/d). Data and methods upgrade the draft EIS modelling, especially on predictive uncertainty analysis. Well designed and executed to address EPA issues. Conservative/simplifying assumptions adopted where reasonable such that effects are over-estimated by Modflow model (eg. immediate and full pit dewatering from start of mining in 2023). Modflow and GoldSim modelling forms a sound quantitative basis for groundwater impact and water balance assessment purposes. After initial review, post-mining particle tracking was conducted; results showed pit lakes are generally semi-regional recharge sources or thruflow systems, with some local-scale seasonal recharge-discharge dynamics, consistent with existing pit lake character; final model report will include results and discussion.

Question	Y/N	Comments re Rustlers Roost and Quest 29 modelling (2022)
3. Is the conceptual model consistent with objectives and confidence level?	Yes	Quantitative uncertainty analysis surpasses the outmoded qualitative confidence level (Middlemis and Peeters 2018). Modflow Conceptual Hydrogeological Model (CHM) is mature and has been subject to review over several years. Complexities of pit lake dynamics captured in Figure 6-34 to 6-36. CHM consistent with data, objectives and Class 2 confidence level, and suitable for mining project impact assessment. CHM structural uncertainty tested by varying boundary conditions; results showed low sensitivity to regional groundwater thruflow conditions. Pit lake geochemical analysis suggests low risk as potential source for water quality impacts. GoldSim conceptual model well-designed and executed for water-solute balance focus (ie. to not under-estimate water storage needs and spill potential, arguably justifying an assumption of no pit lake outflow to groundwater).
4. Is the conceptual model based on all available data, presented clearly and reviewed by an appropriate reviewer?	Yes	See also items 2 and 3 above. Report summarises previous investigations and Modflow/GoldSim modelling, including: a) regional groundwater data and aquifer parameter properties, including data/properties from Toms Gully (10 km north); b) site-specific testing, sampling, monitoring 1993-94 and 2016-21; c) new bores in 2020 with monthly monitoring and sampling (8 new bores at Rustlers Roost; 9 new bores at Quest 29); d) lake level loggers since 2020 (pit lakes at RR, BHS, Taipan), with spot surveys and LiDAR data for other lakes; e) evapotranspiration based on Middle Point FAO56 estimates; f) recharge benchmarked to CSIRO and BoM estimates; g) GoldSim pit lake water balance effectively captures aquifer-lake recovery since mining ceased in 1998 (new data); applied to Modflow 2010-21 history match as level and flux targets; h) RR pit lake geochemical analysis (Mine Lakes Consulting 2021). All combined to develop sound conceptual models. Good presentations of geology, hydrology, groundwater flow system, GDEs and conceptual model. Competent hydrogeologists and modellers have evaluated the data, conceptualisation, impact pathways, model design, execution, sensitivity/uncertainty assessments and outcomes.
5. Does the model design conform to best practice?	Yes	The groundwater model design and execution is consistent with best practice in terms of software (Modflow-USG, Vistas v8, FloPy, PESTpp-IES); extent (30x27 km); boundaries (no flow, GHB and major river features); 3 layers (80m thick each, fractured rock equivalent porous medium, and hydraulic conductivity decreases with depth; justified); parameters (range applied to uncertainty analysis); and AlgoMesh Voronoi grid. Grid cell sizes are 15-150m near pits and rivers/lakes, increasing to 1500m regionally; totals 183,000 cells; good for fast run times for uncertainty analysis. Low sensitivity to regional groundwater inflow/outflow boundaries. Ephemeral creeks reasonably modelled as Modflow Drains (groundwater discharge only), while major rivers use Modflow Rivers package (recharge-discharge potential). Rainfall Recharge chloride mass balance method OK. TSF is above watertable but lined, so recharge ignored (Geotech estimates). Depth-dependent evapotranspiration (ET) applies reasonable parameters, with max. rate as FAO56 mean, increased to 95%ile for climate change scenarios, and with 2m extinction depth and LiDAR and SRTM topography. GoldSim conceptual model well-designed and executed for water-solute balance and storage capacity and spill assessment focus.

Question	Y/N	Comments re Rustlers Roost and Quest 29 modelling (2022)
6. Is the model calibration satisfactory?	Yes	Modflow post-legacy mining history match period 2010-2022, with min. 6-month stress periods (wet/dry season) and focus on high quality data since 2020. GoldSim pit lake water balance model calibrated to available data on post-1998 legacy mining, with benchmarked parameters. Advanced calibration-optimisation method (PESTpp-IES) with pilot points for Modflow model. Key parameters tested: Kh, Kv, Sy, Ss, conductance (C) for boundary conditions, and recharge (RCH). Sound use of GoldSim water balance model data on pit inflows as PEST targets and lake levels as GHB boundary conditions. Existing pit lakes assumed dewatered instantaneously at 2023, and subsequent pit floor levels as Modflow Drain cells adjusted for ongoing mine dewatering (Tables 5-1, 5-2, 6-7). Applies post-mining pit lake levels from GoldSim for Modflow GHB bdy condition levels, with GoldSim pit fluxes set as PEST targets. Generates 100 IES realisations, calibration-constrained within reasonable parameter ranges, all consistent with best practice probabilistic uncertainty analysis methods. Reasonable statistical performance sRMS=4.2% (3.8-4.6% range), within guideline criterion. Time series matches acceptable, and divergences adequately explained (eg. RRMB05-07).
7. Are the calibrated parameter values and estimated fluxes plausible?	Yes	Model parameter values are consistent with site specific drilling and testing information and regional investigations. Good match to reasonable GoldSim pit inflow fluxes, which are benchmarked to available pit lake level data; minimises model non-uniqueness. Post-mining Modflow fluxes (Table 5-8) show mainly outflow from RR pit lake to aquifer and much lower groundwater inflow volumes to RR pit lake (net recharge source pit lake), consistent with existing character and data showing lake levels higher than bores in dry season and lower in wet season (Figures 4-10, 4-11). Q29 pit lakes are recharge at BHS & North Koolpin, local sinks at South Koolpin & Taipain (Zamu backfilled); Q29 is regional thruflow. Modflow water balance dominated by rainfall recharge inputs and ET outputs, with minor volumes of river leakage input and regional groundwater inflow and outflow. Parameter sensitivity analysis demonstrates effective relative uncertainty reduction attributed to the calibration methodology.
8. Do the model predictions conform to best practice?	Yes	See also items 5-7 above re model setup. Long term average climate assumed for mining and post-mining Modflow predictions. Predicted drawdown at end of mining (maximum spatial extent), and post-mining (10, 20, 30, 40 years), showing near full recovery after 40 years, allowing for pit lakes and backfilled pits. Predictive uncertainty range based on 100 IES realisations, with 5th and 95th percentile results also shown, along with mean (most likely). Climate change scenarios applied to Modflow (increased) rainfall from RCP4.5 to estimate recharge and (increased) ET (95thile FAO56, rather than mean FAO56 used for other scenarios); results show low sensitivity to climate change scenario. GoldSim model is designed to assess mine site water balance and storage capacity, allowing for mining-related water demands and including rainfall-runoff and ET processes. Groundwater inflows ('seepages') to pits estimated by Dupuit-Forchheimer analytical equation benchmarked to post-legacy mining data (OK). Monte-Carlo GoldSim simulations for 100 realisations of reasonable parameter ranges (eg. Kh (0.01-5.0 m/d); ET pan factor (0.6-0.8); runoff coefficient (0.4-0.8); reference water table (+/-2m)). GoldSim allows release to creeks, but no outflow from pit lakes to groundwater; this is OK and conservative for mine water balance and storage capacity/spill assessment, but is not realistic for groundwater impact assessment (Modflow designed for that).

Question	Y/N	Comments re Rustlers Roost and Quest 29 modelling (2022)
9. Is the uncertainty associated with the simulations/predictions reported?	Yes	See also items above re Modflow and GoldSim model methods and setup. Best practice quantitative uncertainty analysis (UA) conducted for Modflow model using PESTpp-IES methods, and with climate change scenarios. GoldSim model applies best practice (Monte Carlo) methods. Wide range of Modflow and GoldSim parameters tested; see items 6 and 8 above (ie. potential bias is low). Modflow results presented as mean and 5th and 95th percentiles. GoldSim presents 5th, 25th, 50th (mean), 75th and 95th percentiles, and highlights infrequent occurrences of spills from storages.
10. Is the model fit for purpose?	Yes	This review finds that the Modflow groundwater modelling for Rustlers Roost and Quest 29 was conducted consistent with best practice in terms of predicted dewatering and drawdown effects and related uncertainty analysis. The GoldSim water and solute balance analysis and uncertainty assessment has been conducted conservatively to evaluate the site water balance and storage capacity issues. Note that the GoldSim assumption of not allowing pit lake outflows to groundwater is a limitation that renders the GoldSim results not realistic for local and regional groundwater impact assessment (but the Modflow model is designed for that purpose).

3. DISCUSSION

The project area is reportedly not within a Water Control District or Water Plan area, but there are Beneficial Use Declarations for catchments downstream of the project area, which have been considered in the groundwater assessment.

The assessment report (CDM Smith 2022) is largely well-written and provides explanations of the geological and hydrogeological setting, conceptual model and the numerical model design and execution, the mining project stresses and simulations, the sensitivity and uncertainty analyses and the predicted impacts.

3.1 Modflow Model Design and Capability

This review finds that the Rustlers Roost (RR) and Quest 29 (Q29) model fundamentals (domain, layer setup, grid design, boundary conditions and parameters) are consistent with the available information and conceptualisation, and that up-to-date software and modelling methods have been applied, including MODFLOW-USG and Vistas, and PESTpp-IES uncertainty analysis.

An equivalent porous medium (EPM) approach has been adopted for the numerical groundwater model, which is consistent with best practice principles in fractured rock aquifer systems (Barnett et al. 2012), and is adequately justified with reference to the hydrogeological investigations, pumping test results, conceptualisation and model calibration. The structural model uncertainty testing of the (distant) regional groundwater throughflow boundary conditions has indicated low sensitivity.

The RR/Q29 Modflow model is assessed as suitable for groundwater impact assessment purposes in relation to the legacy mining and the proposed operations at RR/Q29. The proposed water supply borefield extraction is not included within the RR/Q29 Modflow groundwater model, presumably because the volumes are very much smaller than the mine dewatering, but the borefield extractions have been accounted for in the GoldSim water balance model. The proposed accommodation camp is reportedly sited on ML29814, which is immediately south of the Toms Gully mine (ML1058), and both are within the model domain but the RR/Q29 model does not include any related groundwater extraction. Despite this, the RR/Q29 model results can be considered to provide adequate information for cumulative impacts assessment, in that the drawdown and related effects are dominated by the proposed RR/Q29 mine dewatering, but the drawdown effects do not propagate to the Toms Gully area. Any predicted drawdown effect that may be associated with the water supply borefield and/or Toms Gully activities could simply be added to the predicted RR/Q29 drawdown using the hydrogeological principle of superposition, although it would have been more helpful if the RR/Q29 modelling had included these effects.

3.2 Model Confidence Class

The ‘model confidence level classification’ set out in the Australian Groundwater Modelling Guidelines (‘AGMG’; Barnett et al. 2012) is an outmoded qualitative assessment of the level of data available, especially aquifer responses to hydrological stresses, as well as the conceptualisation and calibration process and performance, and the manner in which the predictions are formulated. The AGMG is being revised and the AGMG qualitative assessment is being discontinued. The guidance on uncertainty analysis methods that were in the early stages of development at that time (a decade ago) are also being revised.

It is a common misconception that the model confidence level assessment is mandatory for every model, noting that the AGMG actually recommends the confidence level method for application to situations when a formal uncertainty analysis has not been conducted. In this case, an uncertainty analysis has been conducted, so the confidence level scheme is not strictly applicable. However, as the NT EPA (2022) requested that the model calibration should conform to ‘Class 2’ criteria, this review has considered the issues and concludes that, as additional data has been used in the 2022 modelling and the model calibration conforms to the AGMG performance criteria, including level and flux constraints, the RR/Q29 model is considered fit for the Class 2 investigative modelling purpose.

Having said that, the uncertainty guidance provided in the 2012 AGMG was augmented and updated in 2018 (Middlemis et al. 2018, 2019), including the important principle that “a model should be able to quantify its own reliability [via a well-executed uncertainty analysis], rather than relying on the AGMG confidence level scheme, which is prone to misinterpretation”. This was warranted in the sense of concerns that the AGMG was being used inappropriately in some cases to justify ‘indiscriminate complexification’ of models, rather than the ‘effective simplification’ that is warranted for application to quantitative uncertainty analysis.

The 2018 guidance update frames uncertainty analysis as an integral part of risk management, in that it informs and complements other aspects such as risk assessment, mitigations/treatments, communicating outcomes and prioritising efforts to reduce uncertainty. It requires a balance to be struck between model simplicity and complexity for the purpose of uncertainty evaluation, commensurate with the risk/consequence profile of the project.

The 2012 AGMG and the 2018 uncertainty guidance are both in the process of being updated. This reviewer is advised that the AGMG revision will involve the rejection of the ‘model confidence level’ scheme and its formal replacement with uncertainty analysis methodologies. The quantitative uncertainty analysis conducted for the 2022 RR/Q29 modelling is consistent with existing guidance and should be consistent with the new guides (expected in late 2022).

3.3 Post-mining Pit Lake Recharge-Discharge Dynamics

The GoldSim model is well-designed to investigate the site water balance and storage capacity, along with the solute balance and pit water quality. However, there is an assumption applied that results in the GoldSim model being only suitable for this purpose, and not for other purposes such as groundwater-related impact assessment, especially for full lake conditions.

The GoldSim model does not include pit lake discharge to groundwater as a process.

While this can be described as conservative, that is only in relation to the site water balance and storage capacity assessment, and to the pit lake concentrations of contaminants of potential concern (CoPC). In other words, the occasional discharge of water and solute from the pit to groundwater is ignored and thus the pit lake volumes and concentrations are not underestimated, which is reasonable for a water and solute balance assessment. The (pumped) disposal to nearby creeks, mainly during the wet season, is accounted for in the GoldSim model (and thus the Modflow model via the use of GoldSim fluxes and lake levels), which is again reasonable.

The RR pit lake hydrogeochemical analysis (Mine Lakes Consulting 2021) can be characterised in terms of CoPC concentrations as generally good for ecosystem and drinking water values, although with slight exceedances for total Fe and NH₄, but moderately poor for aquatic ecosystem habitat, with high nutrients and low oxygen levels. This can be characterised as a relatively low risk in terms of a potential source of water quality impacts, noting that there is little material evidence for poor groundwater quality in the project area, more than 20 years after mining ceased.

It is worth noting that the GoldSim water and solute balance modelling applied sound methods to track the volumes and concentration loads moved between pits for initial dewatering purposes and to account for wet season discharge to creeks, while also accounting for groundwater inflow volumes and concentrations. The GoldSim predictions indicate future water quality will be similar to existing relatively good pit lake quality.

The available data and the Modflow model results show that some pit lakes can act as long term groundwater recharge sources, which means that the long term water quality impacts should be assessed, despite the low risks indicated from the geochemical assessment. For example, the RR pit lake and the Q29 pit lakes at BHS and North Koolpin are mainly groundwater recharge sources, although there may be short periods (mainly during the wet season) when they may act as short term local scale sinks (receiving groundwater inflows). For example, Figures 4-9, 4-10 and 4-11 of the modelling report present level data as time series and contour plans showing that the RR pit lake is currently acting in this manner. The Modflow model results show that this dynamic character is adequately replicated, and thus the Modflow model is suitable for the assessment of impacts in terms of CoPC transport and fate. These processes have been well conceptualised in the modelling report (after CDM Smith 2022, Figures 6-35, 6-36).

Following discussion of these initial review comments, the CDM Smith modelling team conducted some particle tracking analysis of flowpaths around the RR and Q29 pit lakes. The results showed that the RR pit lake acts as a long term recharge source to the regional groundwater flow system under existing and future conditions, and the Q29 pit lake system also acts as a long term regional recharge to throughflow system. The final modelling report version will report on the results and the implications, including the water quality and GDE issues.

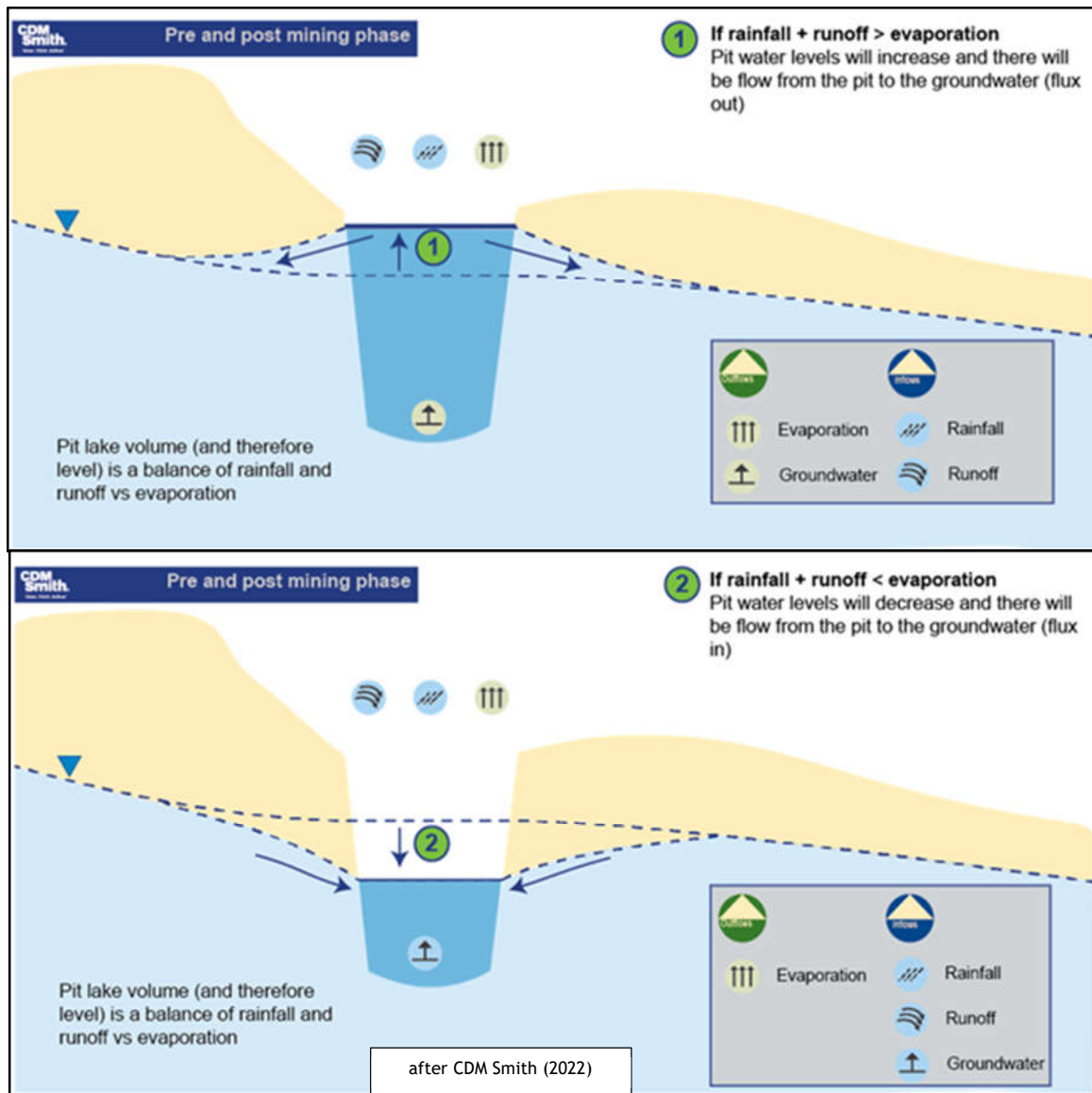


Figure 2 - pit lake conceptualisation (after CDM Smith 2022, Figures 6-35, 6-36)

4. CONCLUSIONS

My professional opinion is that the groundwater modelling and related impact assessment has been competently conducted and documented and it meets best practice criteria for modelling and uncertainty analysis.

The Rustlers Roost and Quest 29 groundwater model is fit for purpose to inform impact assessment, mitigation and management planning, and licensing, and for further development to investigate sensitivities and uncertainties under future work programs.

Ongoing monitoring and other investigations will provide additional data for future model refinements and improvements in performance and uncertainty analysis. Such progressive updates should, in turn, be used to guide future monitoring and management programs.

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