Water Environmental Management Plan

Toms Gully

Project Area

2013 - 2014

Authorisation 0740 01

CONTENTS

Figures

Tables

Appendices

GLOSSARY OF TERMS

Units	Description
µg/L	micrograms per litre
°C	degrees Celsius
Ha	hectares
km	kilometres
km^2	kilometres squared
km/hr	kilometres per hour
L/s	litres per second
mg/L	milligrams per litre
ML	mega litre
m	meters
mm	millimetres
mm/year	millimetres per year
t	tonnes
Chemical Symbols	**Description**
Al	Aluminium
As	Arsenic
Ca	Calcium
Cd	Cadmium
Cl^-	Chloride
Co	Cobalt
Cr	Chromium
Cu	Copper
Fe	Iron
Pb	Lead
Mg	Magnesium
Mn	Manganese
Na	Sodium
Ni	Nickel
Se	Selenium
SO_4^{2-}	Sulfate
U	Uranium
Zn	Zinc
Abbreviations	**Description**
AMD	Acid Mine Drainage
ANZECC	Australian and New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUSRIVAS	Australian River Assessment Scheme
AWBM	Australian Water Balance Model, which is a widely applied hydrological model

	based on partial area saturation overland flow
BOM	Bureau of Meteorology
CGAO	Crocodile Gold Australia Operations Pty Ltd
DO	Dissolved Oxygen
DoR	Department of Resources
EC	Electrical Conductivity
EMP	Environment Management Plans
ERISS	Environmental Research Institute of the Supervising Scientist
ICAM	Integrated Catchment Assessment and Management
MLN	Mining Lease Number
MMP	Mining Management Plan
NATA	National Association of Testing Authorities
NOx	Oxides of Nitrogen
NRETAS	Department of Natural Resources, Environment, the Arts and Sport
NT	Northern Territory
NTU	Nephelometric turbidity units
PG	Primary Gold Limited
RO	Reverse Osmosis
ROM	Run-of-mine
TDS	Total Dissolved Solids
TGM	Tom's Gully Mine
TSS	Total Suspended Solids
WDL	Waste Discharge Licence
WMP	Water Management Plan
WMS	Water Management System
WRD	Waste Rock Dump
Description	**Description**
Active discharge	The release of water from mine site to the environment via controlled structures (gated weirs and spillways). The controlled structures are usually operated under WDL conditions.
AWBM	Australian Water Balance Model, which is a widely applied hydrological model based on partial area saturation overland flow.
Circumneutral	Approximately 1.5 pH units from neutral pH 7.
First flush	The initial water-borne transport of sediment and solutes accumulated in the dry season with the arrival of the wet season.
Passive Discharge	The release of water from mine site to the environment in the absence of controlled structures. Usually passes through wetland systems to improve water quality.
Water balance	Accounting of water movement within a site, process or facility.

1. INTRODUCTION

Primary Gold Limited (PG) has prepared this Water Management Plan (WMP) as the project proponent for the Tom's Gully mine, located approximately 90 km southeast of Darwin and 1.6 km west of the Arnhem Highway on Old Mount Bundey Station (PPL 1163, NT Portion 4973) and McKinlay Station. Figure 1.1 shows the location of the project area.

The Tom's Gully gold deposit was discovered in 1986 by Carpentaria Exploration Company Pty Ltd and subsequently developed in 1988 as an open pit mine with the existing Evaporation Ponds and Old Tailings Dam infrastructures constructed at this time. The site operated open cast mine until 1991 and commenced as a board and pillar underground mine from the east end of the pit at the start of 1990.

Development in the decline was halted in December 1990 when the Crabb Fault Zone was encountered 465 metres from the portal. Despite successfully transecting the fault, delays in scheduling led to the decision to cease operations after the open cut was completed in May 1991.

The mine and associated leases were sold to Esmeralda Exploration Ltd, who allowed the pit to flood and transferred ownership to Kakadu Resources NL (KR) in 1993. KR constructed a new 250,000 tonne per annum Carbon In Leach (CIL) plant in 1995 to re-process sulfide and oxide tailings with the New Tailings Dam and Wetlands Oxbow constructed during the development. Issues with process design and recoveries led to the cessation of operations following 65,000 tonnes of tailings treatment.

During the CIL plant development, dewatering from the open pit commenced with approved waste water discharges during the wet season. During the dewatering process KR was restructured as Sirocco Resources NL (Sirocco) who also began open pit mining activities at the nearby Quest 29 (Q29) in June 1999. A crushing circuit was added to the CIL circuit to process the sulfide/oxide grade ores from Q29, however the inability to segregate high and low grade ore saw all of the ore treated in the Q29 heap leach facility off site.

The open pit was fully dewatered by mid-2001. In 2004 Sirocco, re-named as Renison Consolidated Mines NL, completed extensive drilling programs for the Tom's Gully ore body and production was recommenced in January 2006 and continued until June 2007.

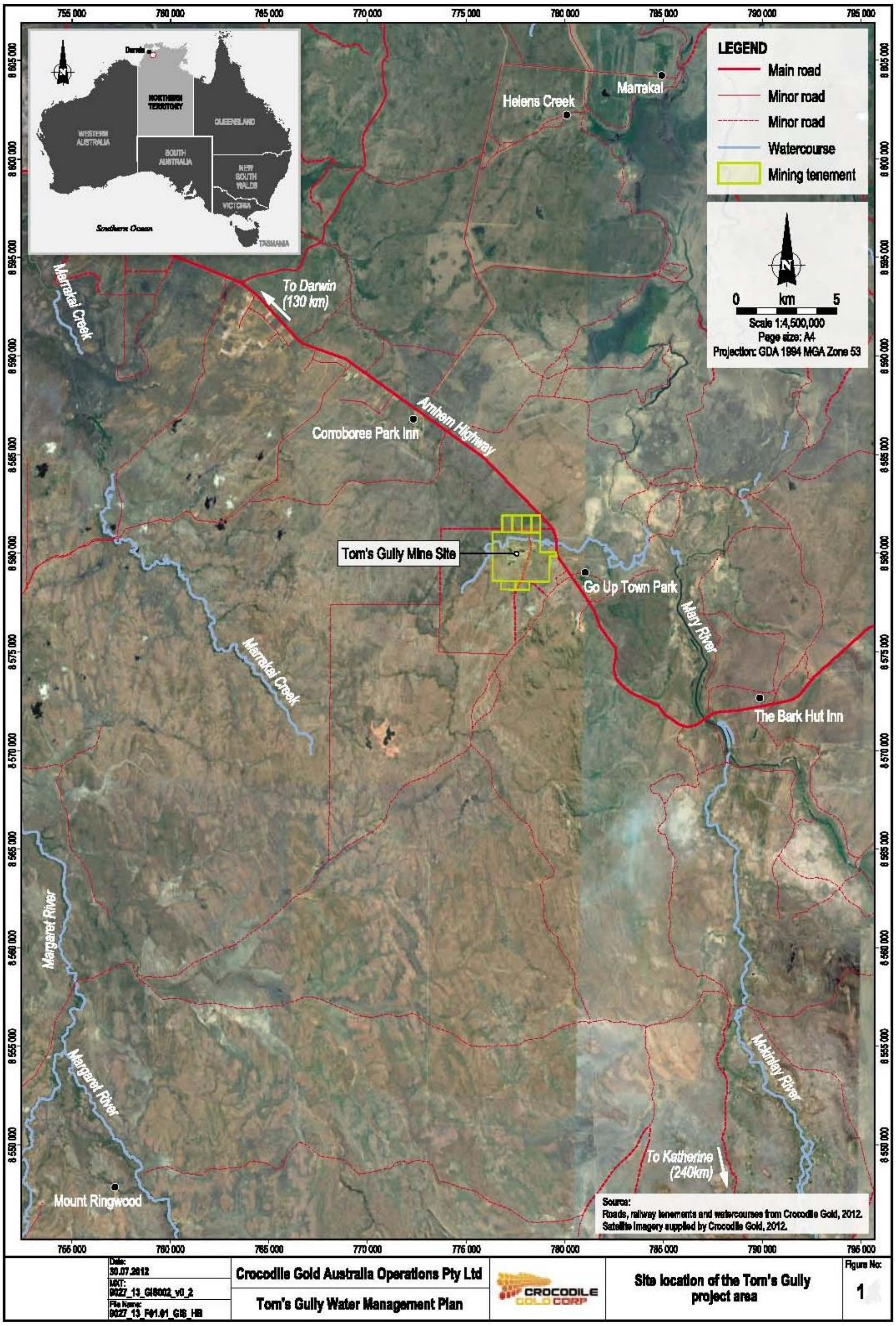
In February 2007, the site suffered flood damage to the underground operations from a monsoonal trough which later developed into a tropical cyclone. The stop in production led to the mine being sold in July 2007 to Burnside Operations Pty. Ltd., a subsidiary of GBS Gold Australia (GBS). The mine was being developed and refurbished with the purpose of recommencing production in August 2008 when GBS was placed into administration and the site placed under care and maintenance from October 2008.

The site was acquired by CGAO in November 2009 with refurbishment and development commencing following authorisation under the *Mining Management Act*. CGAO further developed the underground operations progressing to ore extraction and stockpiling within the decline and on the ROM pad. The onsite processing plant underwent some refurbishment but no ore processing was undertaken. Gold production ceased in November 2010 to allow further geological assessment of the underground mine and the leases in general. Tom's Gully was placed into care and maintenance since the end of 2010.

PG acquired Tom's Gully Project Area as part of the Mount Bundy Gold Project (including Rustler's Roost, Quest 29 and exploration leases in late 2012 with a final hand over early in 2013.

A feasibility study has been undertaken and capital is being raised to take TGPA out of Care and Maintenance back into production.

Figure 1.1 Site location of the Tom's Gully project area



1.1 Purpose of the Water Management Plan

This WMP has been prepared to address the requirements of Mining Management Act for the Tom's Gully Mine site for the 2013/2014 period.

The project site locations are those granted under the *Mining Act* and are defined as follows:

- MCN3333, MCN3334, MCN3335, MCN3336, MCN3337, MCN3338, MCN3339 and MLN1058.

The WMP provides an overview of CGAO's site environmental performance as it relates to water management and has been produced in adherence to the requirements set out in the WMP Advisory Note provided by the Northern Territory Government's Department of Resources (DoR), dated August 2008. CGAO is aware of the newly released Draft Template for the Preparation of a Mining Management Plan (including Attachment A: Water Management Plan Advisory). Future WMPs will adhere to this new template.

The document also outlines CGAO's progress against commitments made in the previous WMP and addresses the DoR comments upon which the previous year's approval was conditional (Appendix A).

1.2 Water Management Plan Objectives and Targets

CGAO's objectives in the management of water at the Tom's Gully Mine site include:

- Managing site waters in accordance with its authorisation to operate under the Mining Management Act. In particular, the Tom's Gully Project Area Authorisation 0740-01.
- To meet the requirements of the *Water Act* where applicable.
- To successfully manage a mine from care and maintenance with substantial pre-existing environmental disturbance back into production.

1.3 Term of this Water Management Plan

The term of the WMP includes the previous twelve month period (1 Feb 2013 to 30 Sept 2013) and an outline of planned activities for the next twelve months (1 Nov 2013 to 31 Oct 2014) of the authorisation period. The initial twelve month period reflects the requirement for the WMP to be delivered three months prior to the authorisation date and encompasses the analytical data received to the date of preparation.

2. CURRENT PROJECT SITE CONDITIONS

2.1 Climate

The climate of the Darwin–Katherine region is broadly classified as tropical monsoonal. Two distinct seasons can be identified, with two transitional periods between them. The dry season occurs from May to September. The hot, 'dry-wet' transition period from October to November has high humidity. The wet season occurs from December to March. The hot, 'wet-dry' transition period of April has variable winds, though dominantly westerly.

Virtually all rainfall occurs in the wet season and rainfall intensities are high, being typical of the wetter portions of the north western regions of Australia.

The Gulf of Carpentaria averages two cyclones a year, while the Arafura and Timor Seas average one a year. Cyclones in the Gulf of Carpentaria move very erratically, whereas those in the Arafura and Timor Seas tend to follow more regular tracks to the southwest. Over half the cyclones generated in the northern region of Australia move either southwest or southeast into adjoining regions. Therefore the Tom's Gully project area is an area where cyclone activity is probable. The Bureau of Meteorology cyclone frequency data for the northern Australian region is presented in Figure 2.1.

As site-specific climatic records (except for rainfall) do not exist, regional data was obtained from the Bureau of Metrology (BoM) Middle Point Rangers monitoring station (BoM station no. 014090) (BoM, 2013) located approximately 33 km north of the project area.

The mean daily maximum temperature in the region (Figure 2.2) ranges from 31.3 °C in the coolest months (June and July) to 35.6 °C in the hottest months (September to November). Mean daily minimum temperatures in the region (Figure 2.2) range from approximately 14.9 °C during the dry season (June and July) to 23.9 °C in the wet season (December to March).

The mean rainfall in the region (Figure 2.3) during the wet season is 1,100 mm while dry season rainfall averages 40 mm. Maximum rainfall (Figure 2.3) occurs in January and based on the last 54 years extreme rainfall events could record up to 866 mm in a month (January, 1997).

Rainfall measurements were recorded at the Tom's Gully Mine site by previous operators between 1990 and 2008 (Figures 2.3 and 2.4). A rain gauge is currently located at the Tom's Gully Mine site (781065E, 8578238N) and was been monitored daily by CGAO from 2009 to 2013 (Figures 2.3 and 2.4), PG has not monitored the rainfall daily but will when the site is in the refurbishment, commissioning and operational phases. Annual average rainfall at the Tom's Gully Mine site has been recorded at 1,517 mm/year as shown in Figure 2.4. There is small discrepancy between these figures and BoM records which may be due to the localised nature of rainfall in the area.

There is a distinctive and predictable seasonal wind pattern in this area. During the dry season strong southeast trade winds dominate and during the wet season, winds can be more variable, predominantly westerly and northwesterly. Wind speed and direction at the Middle Point Rangers weather station are shown in Figure 2.5. Regional 9am wind speed (Figure 2.6) is highest from May to July with monthly averages fluctuating around 7 to 8.4 km/hr. The wind speed is lowest in the months of March and November dropping to 5.1 km/hr.

Annual evaporation in the region is greater than rainfall at an approximate average of 2,000 mm, with the highest evaporation occurring in September and October (Figure 2.7).

Figure 2.1 Northern region cyclone frequency per year from 1963 to 2006

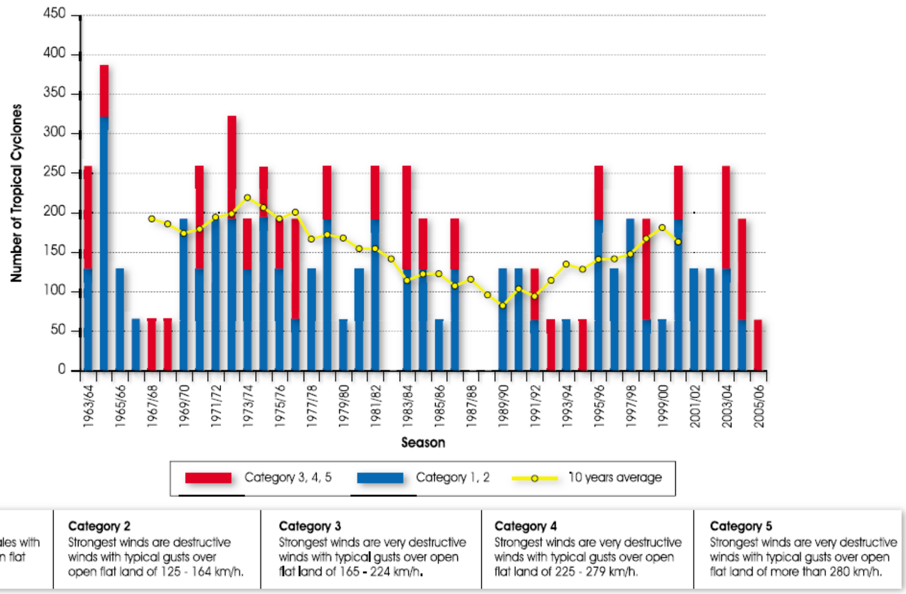


Figure 2.2 Monthly mean maximum and minimum daily temperatures for Middle Point Rangers weather station

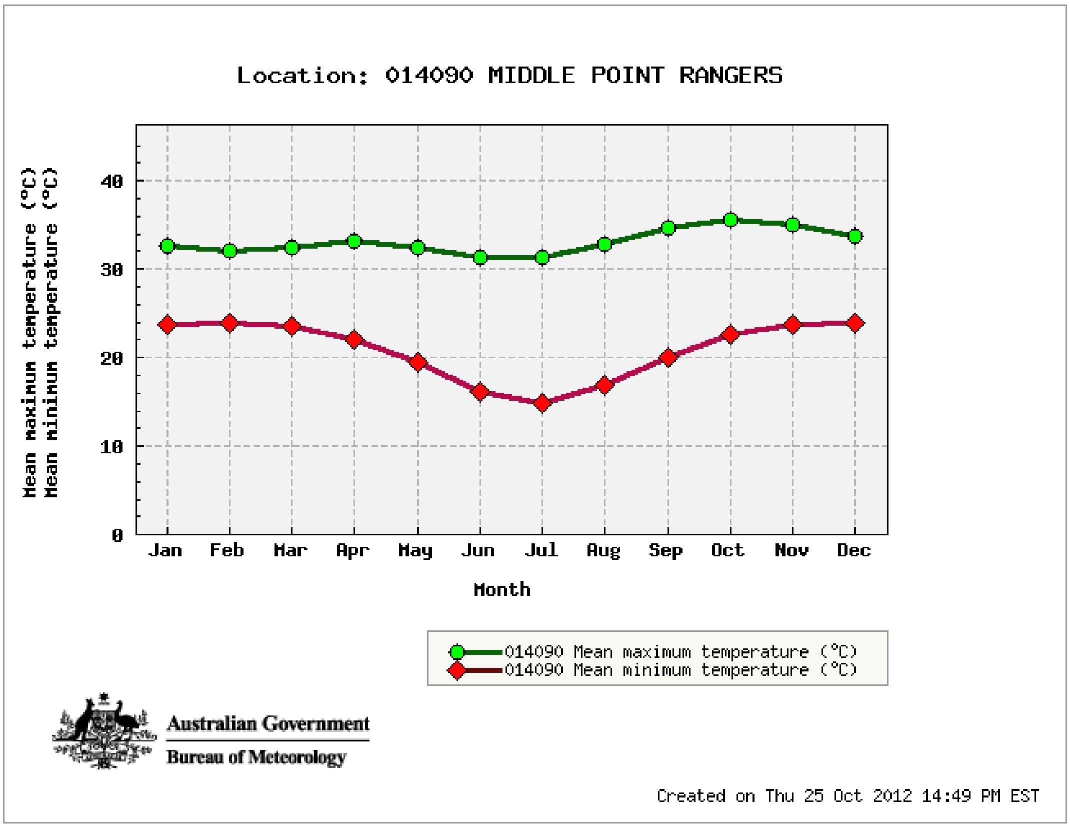
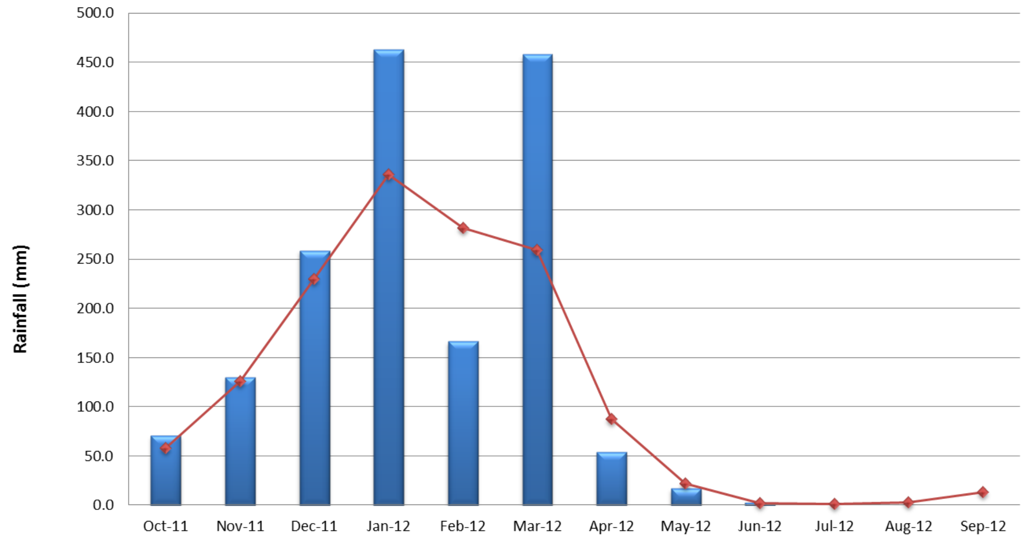
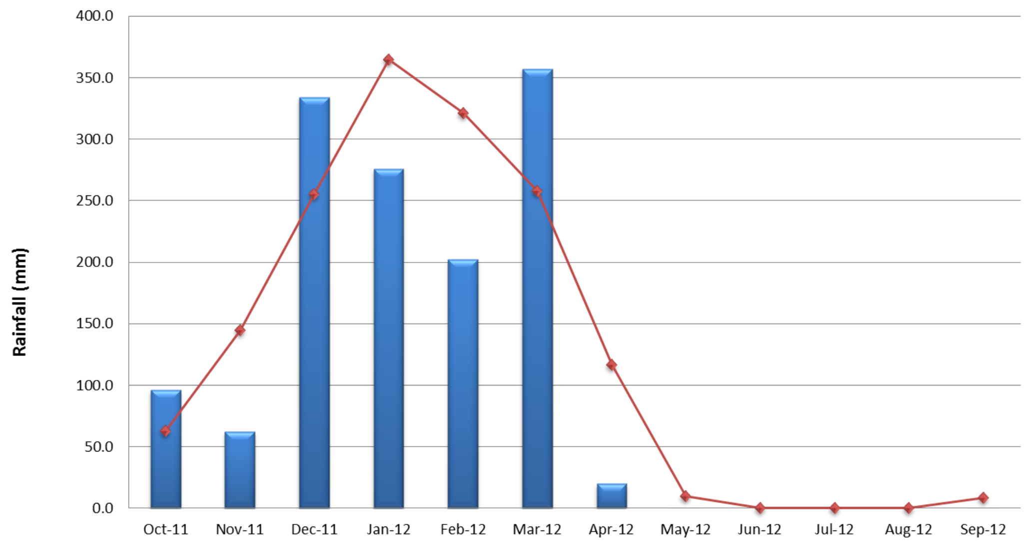


Figure 2.3 Mean monthly rainfall and highest monthly rainfall for Middle Point Rangers weather station and mean monthly rainfall for Tom's Gully Mine site



	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12
Monthly rainfall 2011-2012	70.6	130.0	258.9	463.4	166.4	458.0	54.0	17.0	2.9	0.0	0.0	
monthly ave 1990-2012	57.7	125.9	229.3	335.5	281.3	259.1	87.7	21.9	1.6	0.8	2.3	12.9

Figure 2.4 Mean annual rainfall for Tom's Gully Mine site



	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12
Monthly rainfall 2011-2012	96.0	62.0	334.0	276.0	202.0	357.0	20.0	0.0	0.0	0.0	0.0	0.0
monthly ave 1990-2012	63.1	144.4	255.5	364.7	320.9	257.9	116.5	10.1	0.0	0.1	0.1	8.6

Figure 2.5 Seasonal wind direction and speed for Middle Point Rangers weather station

Rose of Wind direction versus Wind speed in km/h (01 Jan 1965 to 30 Jan 1998)

Custom times selected, refer to attached note for details

MIDDLE POINT RANGERS

Site No: 014090 • Opened Jan 1957 • Still Open • Latitude: -12.5781° • Longitude: 131.3145° • Elevation 10m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

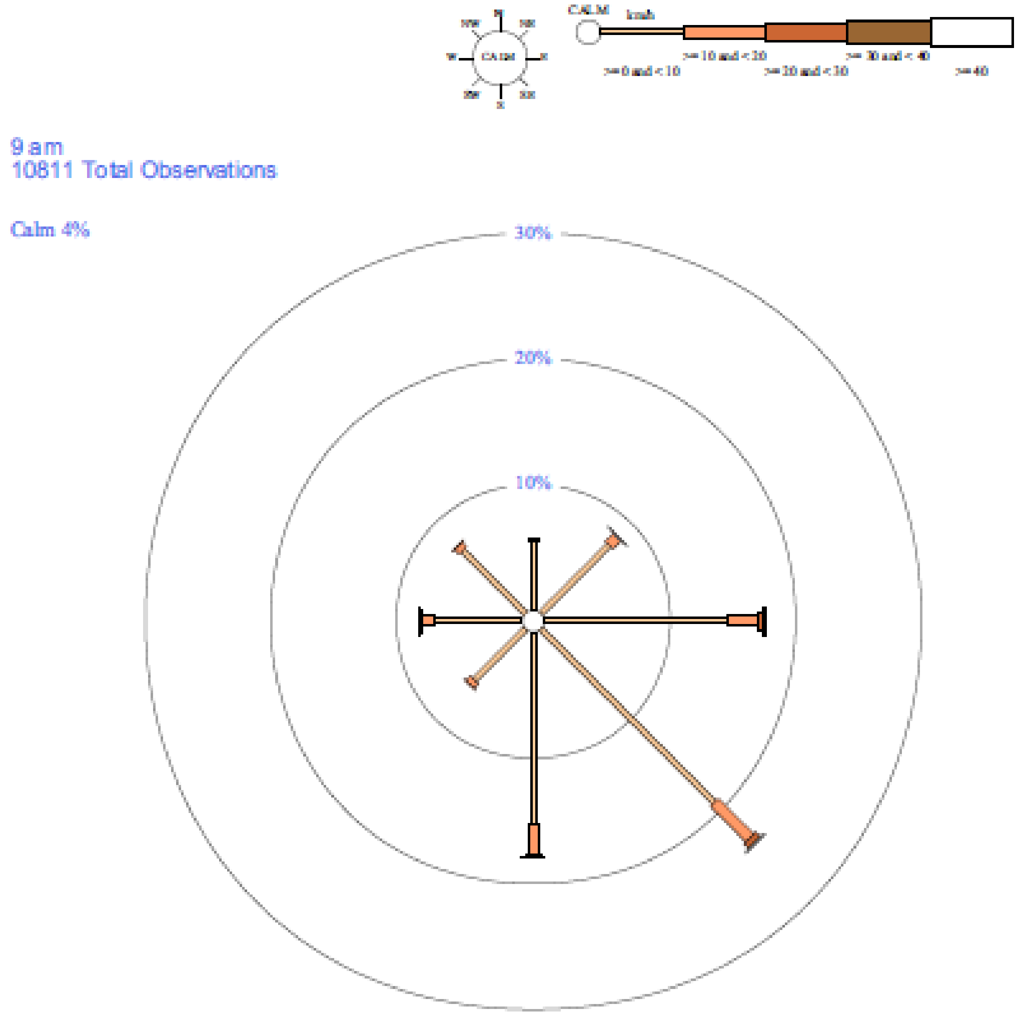


Figure 2.6 Mean 9am wind speed (averaged per month) for Middle Point Rangers weather station

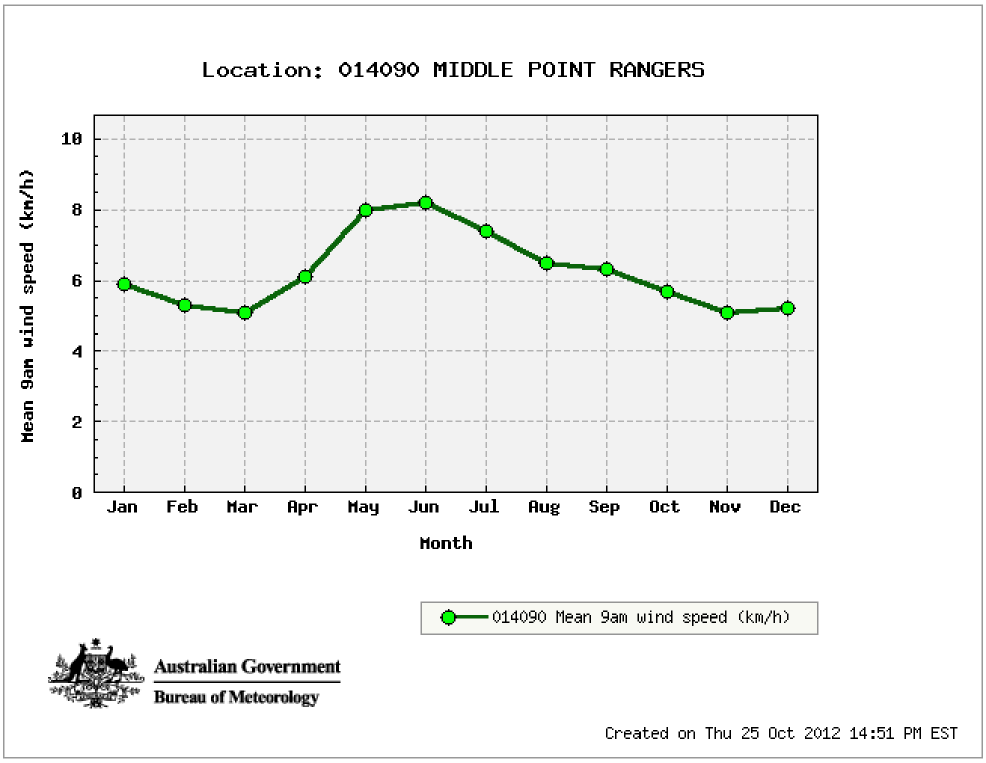
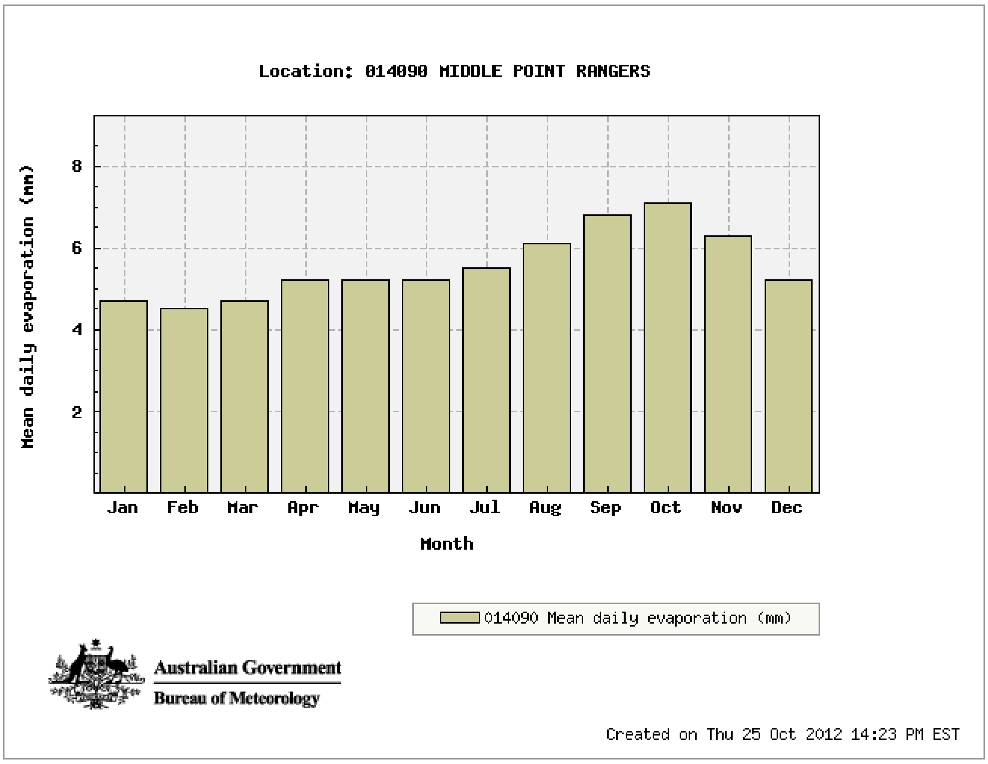


Figure 2.7 Mean daily evaporation (averaged per month) at Middle Point Rangers weather station



2.2 Surface Water Catchments

The Tom's Gully Mine site is within the Mount Bundey Creek catchment, which comprises a series of small ridges and dissected hills that are drained by small, steep rivulets, which converge into Mount Bundey Creek. The majority of the catchment upstream of the project area consists of outcropping rock with thin soil cover and shallow alluvium drainage lines. The total catchment area upstream from the mine is approximately 117 km^2. Figure 2.8 shows the regional hydrology, including river systems and water bodies.

Mount Bundey Creek flows west to east along the northern section of the project area (Figure 2.9). Coulter Creek is a tributary of Mount Bundey Creek and flows southwest to east (to the south of the project area). Coulter Creek flows into Mount Bundey Creek downstream of the project area (see Figure 2.9).

There are several local catchments within the mine site, where runoff into these catchments is contained on site in water storage facilities. Figure 2.9 shows these site catchments, which include:

- Evaporation Pond 1 (EP1).
- Evaporation Pond 2 (EP2).
- Old Tailings Dam (OTD).
- New Tailings Dam (NTD).
- Open Pit.
- Raw Water Dam.
- Stormwater Pond.

Water from Tom's Gully Mine was previously discharged into Mount Bundey Creek via two mechanisms: passive discharge and active discharge. Passive discharge includes runoff that has not been in contact with possible contamination sources, such as runoff from the northern side of EP2 or runoff from the area east of Wetlands Oxbow (Figure 2.9), as well water that flows into Mount Bundey Creek from Wetlands Oxbow during times of back-flushing (i.e., when Mount Bundey Creek flows into and then out of Wetlands Oxbow due to large rain events). Active discharge refers to discharge as a result of opening the EP2 siphons and/or lifting the Wetlands Oxbow weir boards. Discharge from the project area is discussed in further detail in Section 4.4.

The focus of the Tom's Gully water management system is to contain all contaminated waste water on site. The care and maintenance strategy to avoid discharge from the Tom's Gully Mine site is to pump contaminated excess water into the open pit. Water can be pumped from the OTD, EP2, NTD and Stormwater Pond directly to the open pit when required. This strategy will change during the 2013-2014 period capital raising dependent.

Currently, as the open pit is only 61% full (see Figure 3.1 in Section 3.2), there is sufficient capacity to handle high rainfall events over the 2013-2014 wet season. On current increases there is 5-6 years capacity in the TG Pit before water will be released from site.

However, in 2013-2014 PG will be making a concerted effort to dewater the pit and underground workings.

This will be achieved by increasing the storage capacity on site by building a New Process Water Dam (2.6 GL) downstream of the Old Tailings Dam, potentially raising the height of the Evaporation Ponds wall (0.5 GL to 0.9 GL). This will increase the storage capacity by approximately 2.4 GL.

Enhanced evaporation will be utilised with banks of evaporation fans being installed if the site water balance at the time of the pit dewatering requires it. Fans are available in modular banks with the number and configuration adaptable to the specific requirements. It is estimated that evaporation rates of between 10-14 l/s are achievable per fan assuming throughput of 27 l/s with an evaporation rate of up to 50%. Each bank of four fans would therefore be able to evaporate between 40-56 l/s.

A second contingency would be to treat excess water and discharge into the local waterways. For the water treatment and discharge option, a small water treatment plant would be hired or purchased and use either lime or caustic soda for pH control. This facility could be located at either the NPWD or the Evaporation Ponds.

Treated water would be discharged only during creek flow (ie during the wet season) and be in line with the current draft WDL that is currently with the EPA. This WDL will only be activated if active discharge is required in the future. This is likely to only be required during the wet season once operations have begun to significantly reduce the site water balance after dewatering of the pit and underground is complete.

The declared beneficial use for Mount Bundey Creek is ‘aquatic ecosystem protection’ except for a 7.8 km section downstream of, and beginning at, Arnhem Highway where the beneficial use is ‘stock water supply’. The predominant users of surface water downstream of the mine are cattle grazers using the water for stock watering.

Due to these beneficial uses and the legacy of historic mining operations in the area, PG will aim to achieve water quality objectives based on focus, action and upper limit levels of protection. Each of these is based on ANZECC/ARMCANZ 2000 water quality guidelines for 95% protection of aquatic ecosystem species, 80% protection of aquatic ecosystem species and stock water guidelines, respectively (see Section 6.3). While the 80% ecosystem protection and stock water.

Figure 2.8 Regional hydrology including Mount Bundey Creek

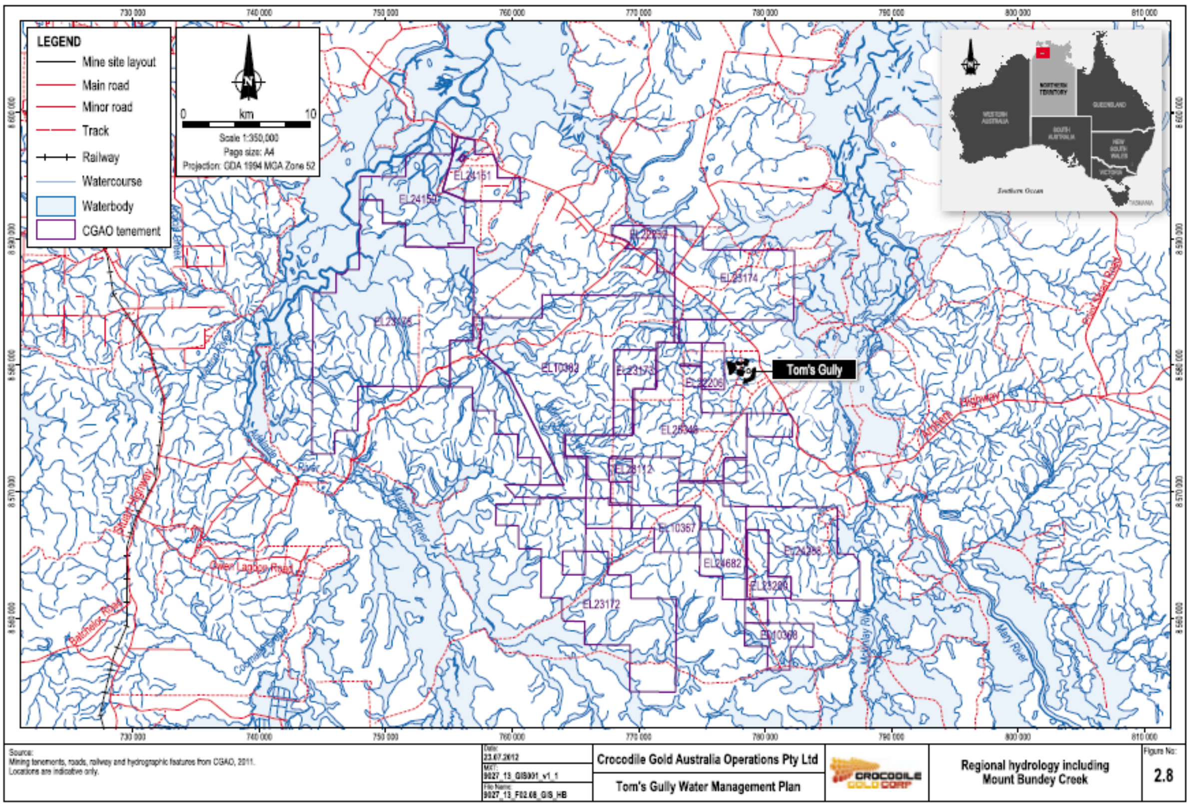
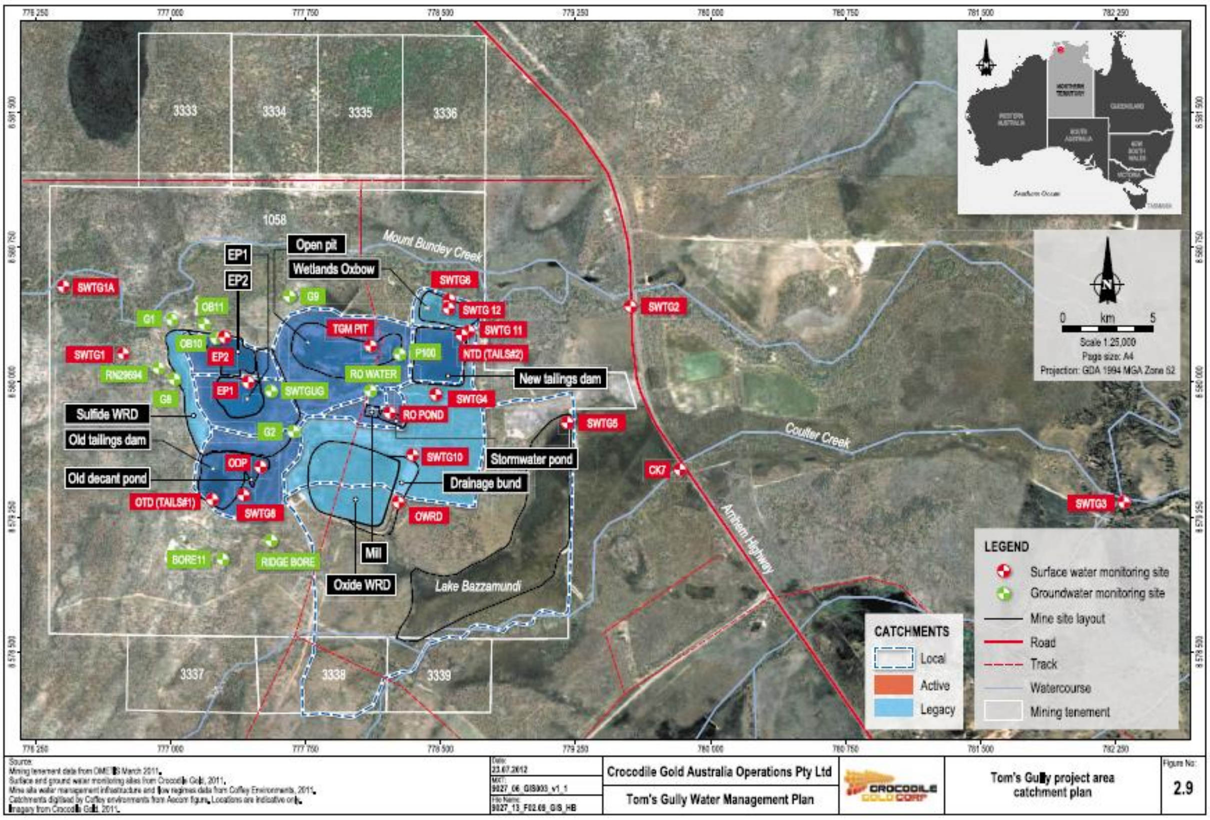


Figure 2.9 Tom's Gully project area catchment plan



guidelines will trigger investigation and possible remedial action as required, the 95% ecosystem protection guideline will continue to be compared to water quality data to identify changing trends.

2.3 Groundwater Resources

2.3.1 Groundwater Occurrence

The regional geology predominantly comprises Proterozoic metasediments of the South Alligator Group. Local aquifers are approximately 5 to 25 m below ground level and typically flow within fractured and weathered rocks. The local aquifer system is recharged by the surface infiltration of rainfall.

The Wildman Siltstone is the mineralised local fractured aquifer of the project area, and is defined by faults and reef features. One such fault is Crabb's Fault Zone, which trends south-southwesterly through the mine site. The reef features associated with the Crabb's fault mostly consist of quartz laminated with black shale and sulfides. The fault is associated with the mineralised Wildman aquifer of high yield, up to 20 L/s.

Groundwater has been intersected and influenced by previous mining activities on the site with groundwater flowing into both the previously dewatered Tom's Gully underground mine and the open pit.

During previous operations groundwater was extracted through several bores (see Section 2.3.3).

Pumps will be re-installed at a number of bores during the re-establishment phase of the mining infrastructure. Groundwater will be used for dust suppression and for processing activities.

2.3.2 Beneficial Uses

The current groundwater use in the vicinity of the Tom's Gully Mine site is for stock watering, with very minor use of water for maintenance of the mill tanks. Other uses of groundwater further from the project area include the bores of surrounding landholders for stock watering purposes.

2.3.3 Previous Groundwater Surveys

Due to previous mining activity at Tom's Gully it is not possible to ascertain to what extent groundwater quality has been affected by mining and to what extent natural background levels contribute to the quality of water monitored. Site groundwater data records were not available from before the development of the mine.

Until March 2010 groundwater was monitored on a biannual basis. Groundwater was being monitored by CGAO quarterly. PG will monitor groundwater quarterly.

Currently, groundwater nearest the pit and waste rock dumps (such as at sites G8, OB10 and OB11; see Figure 2.10) has low pH and elevated dissolved metals (particularly Al, Cd, Co, Cr, Cu, Pb, Mn, Ni and Zn) and high sulfate concentrations – a legacy effect of acid rock drainage from historic mining activities at the site (see Section 7.2). The pH, metals and sulfate concentrations are often outside the ANZECC/ARMCANZ 2000 water quality guidelines for 80% freshwater ecosystem species protection and for stock watering. Some bores do however have good quality water and these include Ridge Bore and Bore 11; a standby water supply bore, P100; and observation bores, G1, G2, G9 and RN29694 (see Section 7.2 and Figure 2.10).

Figure 2.10 Tom's Gully surface and groundwater monitoring locations

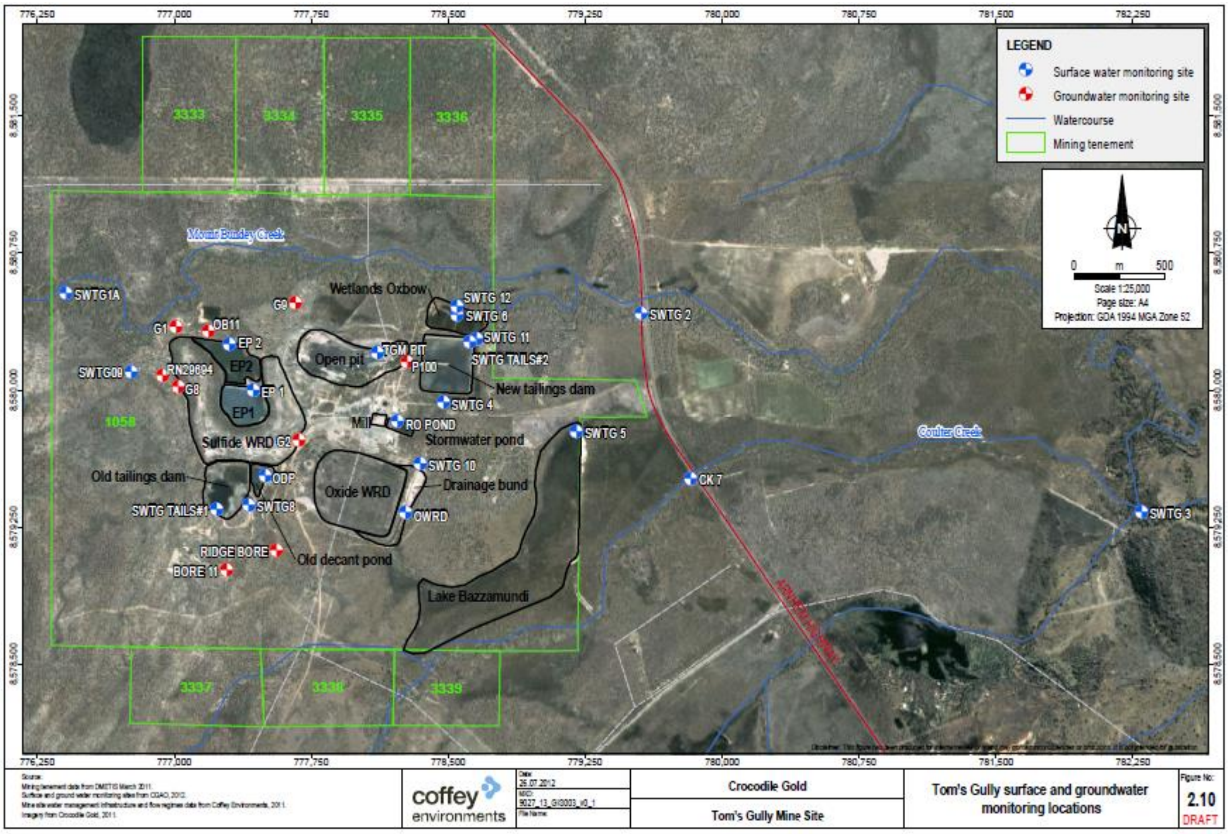


Table 2.1 displays historic (prior to CGAO acquiring the mine site in 2009) water quality data for the following bores (the locations of which are shown in Figure 2.10):

- P100 – this bore was previously used for raw water supply for ablutions and washing on site. This bore remains on standby should it be required, for example, in emergency situations such as wildfire and controlled burn-offs. The bore is also currently used to flush tanks in the mill to avoid rusting.
- Ridge Bore and Bore 11 – these bores were previously used for dewatering through to stock irrigation but are non-operational during care and maintenance.
- G8, G9, OB10 and OB11 – these are water quality observation bores, which are monitored during care and maintenance (except OB10 which was decommissioned in January 2011 due to the casing being destroyed by machinery).

From the pre-2009 data, P100, G9, Ridge Bore and Bore 11 have circumneutral pH and relatively low metal concentrations, which is consistent with more recent (2010 to 2011) data for these sites. The observation bores G8, OB10 and OB11 had variable pH and higher metal concentrations, which also is consistent with the recent (2011) data for these sites.

PG will commission a hydrogeological study to be undertaken in the 2014 dry season, which will assess the need for additional monitoring bores (and their potential locations) and assess water quality within existing bores. A review of all the current bores' structural integrity and fitness for purpose will be carried out and information will feed into the hydrogeological assessment. The outcomes of this study will identify potential improvements in the current groundwater monitoring program and will recommend the most suitable locations for bores taking into account utilising existing bores.

PG will investigate decommissioned and damaged historical bores (G6 – south of Old Tailings Dam; Bore 6 – north of Oxide Waste Rock Dump and Bore 7 – between the Old Decant Pond and Oxide Waste Rock Dump). PG will assess the integrity of these bores and their potential for inclusion in the monitoring program before commissioning new bores. PG does not intend to reinstate the use of bore OB10 as there are three other bores in the area north of EP2 which are considered to give representative water quality information.

Groundwater quality data monitored during the CGAO ownership of the mine site in 2009 are presented and discussed in Section 7.2.

Table 2.1 Historic (pre-2009) groundwater quality data

					Total Metals												**Major Ions**				
Bore	**Date**	**pH**	**EC**	**TSS**	**Al**	**As**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Ni**	**Se**	**Zn**	**Ca**	**K**	**Na**	**Mg**	**SO_4^{2-}**
			µS/cm	**mg/L**	**µg/L**												**mg/L**				
Ridge Bore	14/12/05	6.5	166		21.9	8.1	0.24			5.31						106					
Ridge Bore	19/09/06	6.9	179		1.1	8.75				0.41	2,120		1.97			1,710					
Ridge Bore	02/01/07	7.7	464		5.3	74.5	<0.2			<0.1	2,360		831			90.9					
Ridge Bore	08/04/08	6.7	136		1.9	5.55	0.12			0.97	2,600		669			155					
Ridge Bore	06/10/08	6.78	1,458		5	4.25	<0.2			0.59	19,000		5,430	119		33					
Bore 11	19/09/06	7.7	724		21.2	11	<0.2			3.37	2,600		622			1,790					
Bore 11	04/09/07	7	391		20	7.55	<0.02			0.74	17,000		1,220			53.5					
Bore 11	08/04/08	7.9	3,950		58.5	1.85	<0.2			2.15	1,760		204			46.1					
Bore 11	06/10/08	6.84	1,454		5.4	3.95	<0.2			1.22	21,200		5,430			51.5					
P100	06/10/08	6.47	1,495		5.3	12	1.46			22.1	1,100		1,740			669					
OB10	04/09/07	6.6	5,780	7,160	1,130	26.5	1.18			9.94	9,840		1,110			109					
OB10	08/04/08	8.3	172			8.14	1.24			41.6	42,200					228					
OB10	06/10/08	6.57	4,100		628	26	0.54			6.43	8,640		1,190			114					
OB10	02/11/09	5.74	3,330	190	6,810	64.5	68.8	934	2.9	65.9	144	20.3	26.7	1,790	14.8	11,100	537	15.2	26.9	502	3,260
OB11	08/04/08	7.5	5,150	N.A.	236		<0.2			4.13	1,220		217			18.2					
OB11	06/10/08	6.93	3,600	4,710	212	11	0.22			4.97	780		512			25.7					
G8	04/09/07	8.3	244	100	5.6	0.35	<0.02			800	2,000		195			0.6					
G8	08/04/08	8.5	221		3		<0.02			1,280	620		90.5			1.1					
G8	06/10/08	4.26	1,017	910	14,500	<2	74.2			4,100	1,340		17,900			3,410					
G9	04/09/07	6.5	64	30	87.5	1.75	1.3			2.79	80		33.4			99.1					
G9	08/04/08	7.7	325		94		0.04			0.73	160		168			5.1					
G9	06/10/08	6.68	82.6	70	42.3	4.4	1.78			4.86	100		59.1			45					
G9	02/11/09	6.9	344	<10	50.7	6.55	0.56	7.94	0.2	6.53	240	23.6	208	10.2	<0.2	42.5	54.3	3.1	4.2	10	4.7

3. WATER MANAGEMENT SYSTEMS

3.1 Water Use in Operations

Water will be required during all stages of the PG TG project. In the initial stages water will be required for dust suppression and will be sourced from one of the water supply bores (to be determined when the bores have been inspected).

As the plant moves into commissioning and then production process makeup water will be required.

During commissioning all areas of the plant will be commissioned on water. This water will be sourced initially from water supply bores and then primarily from return water from the New Tailings Dam.

Return water from the dam will be stored in the Process Water Pond next to the Processing Plant.

Bore water will be treated via a Reverse Osmosis plant for the processing plant elution circuit.

The underground will require small volumes of water from the bores for underground services as these are progressively installed.

3.2 Water Management Infrastructure

Water management infrastructure in the project area is listed in Table 3.1.

Table 3.1 Tom's Gully Mine site water storage and infrastructure

Infrastructure	Surface Area (ha)	Total Capacity (ML)	Current Volume (ML)	Remaining Capacity (ML)
Tom's Gully Pit	9.00	4,674.74	2,468.86	2,205.88
Evaporation Pond 1	4.67	140.00	35.00	105.00
Evaporation Pond 2	4.79	143.63	35.91	107.72
Stormwater Pond	0.55	11.04	0	11.04
Wetlands Oxbow	2.99	29.90	1.50	28.40
Old Tailings Dam	5.93	88.95	17.79	71.16
Old Decant Pond	1.16	46.22	23.11	23.11
New Tailings Dam	7.53	75.30	0	75.30
Raw Water Pond	0.05	1.43	0	1.43
Lake Bazzamundi	16.75	50.25	10.05	40.20
TOTAL	**53.41**	**5,261.46**	**2,599.37**	**2,661.33.**

PG Plans to increase the volume of the Evaporation Ponds by raising the final dam wall by 3m to increase total storage to 900ML, from 280ML. This will give the Evaporation Ponds capacity to manage operational water and a surge capacity for excess water accumulated during the wet season, see Figure 3.2 and Figure 3.3.

Excess water will then be subsequently evaporated during the peak evaporation periods of Sept – Jan of each year or as required, or treated and discharged as per the current Draft WDL.

3.3 Dewatering Tom's Gully Pit Methodology

Primary Gold requires the Toms Gully pit and underground to be dewatered to enable the mine to be rehabilitated prior to site moving into production. The main method of dewatering will be to pump the Pit water to the new process water dam and upgraded evaporation ponds. At these points, the water balance can be managed as required with the assistance of a combination of assisted evaporation and treatment & discharge. The degree of reliance on the above will depend on the relative timing of dewatering activities in relation to the prevailing season.

As discussed in previous sections, Primary is planning to establish a combination of temporary and whole mine life infrastructure that will be installed prior to and during the dewatering.

Temporary infrastructure includes:

- Pumps in the pit and underground depending on the stage of dewatering
- Generators for the pumps
- HDPE water lines

Pumping will utilise pontoon mounted, diesel/electric pumps of up to 1,000 litres per second capacity. Pumped water will be reticulated to the evaporation ponds and new process water dam using 450mm PN16 HDPE pipeline.

Permanent infrastructure includes:

- New Process Water Dam
- Wall raise on Evaporation Ponds (if required) (see Figure 3.1 and 3.2)

Primary will construct the New Process Water Dam (NPWD) prior to starting the dewatering from the mine. While the NPWD is being constructed temporary infrastructure will be installed to enable pumping to the evaporation ponds and to the NPWD once construction is finalised.

When the portal has been fully exposed the underground workings will be progressively dewatered using portable pump stations that be regularly moved to follow the water down the decline. The water will be pumped to the surface up the decline and then pumped to the NPWD or Evaporation Ponds.

It is expected that the pit and underground workings can be dewatered within 2 months. This assumes the following:

- 2.64 Gl water to be pumped
- up to 1000 l/s
- Pumping 24 hrs/day
- Pumping 25 days/mnth

The major assumption for this scenario is that the dewatering occurs in the dry season and that evaporation is greater than precipitation.

Primary also intends to use enhanced evaporation using fans and/or water discharge via a water treatment plant if the site water balance at the time of the mine workings dewatering project requires. Both supplementary methods will require additional infrastructure.

Evaporation fans are available from a variety of vendors and are a well proven mechanical technique to simulate favourable evaporation conditions and accelerates the evaporation process.

The equipment enables large volumes of water to be transferred from a liquid to vapour, transferring water back to the atmosphere.

Evaporation fans have been used extensively in Africa, North & South America and significantly, in areas similar terrains and climate in Australia, including:

- Newlands (Glencore Xstrata),
- Isaac Plains (Vale Australia),
- Mt Morgan (Qld Gov.),
- Gove (RIO)
- Claremont (RIO)
- Palmer Nickel (QNI)

The factors that allow evaporation are described below:

Parameters associated with evaporation of aqueous drops in air are ambient air temperature and relative humidity, as well as aspects related to the droplet itself: its size and relative velocity. A water droplet falling through air, or floating in air, is subject to evaporation and will decrease in size. During a relatively short transient time, the droplet cools down due to evaporation, until it reaches its wet-bulb temperature. At the same time, a thin layer of saturated vapour forms around the droplet, and since the temperature of the droplet is lower than that of the ambient air, heat flows towards the droplet and accelerates the evaporation process.

The potential for droplet evaporation or growth is typically assessed through a consideration of cloud microphysics theory. More specifically, a Kohler curve representing two competing factors: the curvature effect which raises the saturation vapour pressure as the droplet gets smaller, and the solute factor which lowers the saturation vapour pressure as the droplet gets smaller (Figure 3.4). Each Kohler curve represents the variation of equilibrium relative humidity (super saturation) with droplet radius for a fixed mass of solution in water.

For example, consider a droplet with an initial size and mass of solution. An increase in relative humidity would cause the droplet to increase in size, first at sub saturation levels (<100% relative humidity) and then at super saturation levels (conversely, a decrease in relative humidity will result in the droplet shrinking). As the droplet increases in size, the solution becomes weaker and the Kelvin curvature effect becomes the dominant influence (at the high point on the curve – the activation point). Beyond the activation point, lower relative humidity will allow the drop to grow further.

Fans are available in modular banks (Figures 3.4 and 3.5) with the number and configuration adaptable to the specific requirements. It is estimated that evaporation rates of between 10-14 l/s are achievable per fan assuming throughput of 27 l/s with an evaporation rate of up to 50%. Each bank of four fans would therefore be able to evaporate between 40-56 l/s.

Fans will be aligned to optimise the prevailing wind directions of the season ensuring the mist is carried back over the ponds. They will also be installed with automated operating system and weather station to monitor humidity, wind direction and wind speed etc to ensure that evaporation is optimised, but also so that the system can be automatically shut-down when conditions unsuitable e.g. when the wind direction is not in the preferred direction (back over the water body).

For the water treatment and discharge option, a small water treatment plant would be hired or purchased and use either lime or caustic soda for pH control. This facility could be located at either the NPWD or the Evaporation Ponds.

Treated water would be discharged only during creek flow (ie during the wet season) and be in line with the current draft WDL that is currently with the EPA. This WDL will only be activated if active discharge is required in the future. This is likely to only be required during the wet season once operations have begun to significantly reduce the site water balance after dewatering of the pit and underground is complete.

3.4 Water Balance

A water balance model has been prepared (Coffey Environment 2014) to reflect the Toms Gully Mine site during dewatering and operations. This predictive model is based on average rainfall conditions.

The new water balance model takes into account rainfall and pan evaporation, seepage, individual catchment area and the topography of the eleven storages on site (Open Cut Pit, Evaporation Pond 1, Evaporation Pond 2, Old Tailings Dam, New Tailings Dam, Old Decant Pond, Stormwater Pond, New Process Water Dam, Process Water Pond (Old Raw Water Pond), Wetlands Oxbow and Lake Bazzamundi), catchment-specific catchment runoff ratios (and cumulative excess rainfall conditions), and model changes in volume based on a 0.1 m water level volume and surface area relationships. It also takes into account the increased capacities of the Evaporation Ponds and the New Tailings Dam.

The water balance model allows the prediction of the amount and timing of surface water runoff as well as assisting in the management of water at the Toms Gully Mine site through the estimation of volumes to be managed. The water balance is capable of predicting storage levels over a 1-year period, based on existing system conditions such as storage volume levels. The water balance model will ensure that the capacity never reaches a volume where there may be a possibility of overtopping, unless it is a planned management strategy (ie Lake Bazamundi weir boards removed).

Monthly mean (average), wettest year on record (above average), and actual daily (where available) precipitation and pan evaporation data for the water balance model will be sourced from the Australian Bureau of Meteorology (BOM) Station 014090 (Middle Point Rangers monitoring station, period of record 1957 – 2012). Evaporation rates used in the water balance calculations are based on detailed storage versus surface area relationships for individual storages. An evaporation co-efficient of 0.75 will be applied to all pan evaporation data.

The model incorporates surface area to volume data for the storages, and catchment areas. Runoff ratios for the catchment areas will be modelled based on catchment slope and recent rainfall conditions.

The model will include an extreme rain event function, simulating a 72-hour, 1 in 100 year rainfall event. A 72-hour, 1 in 100 year rainfall intensity of 6.31 mm/hour will be assumed for the model. The model will also calculate the required capacity of each storage to accommodate the simulated 72-hour, 1 in 100 year, and average recurrence interval (ARI) rainfall events.

The water balance model will then be reviewed prior to entering into production to ensure that all the parameters are correct. This will allow the site to understand if and for how long the evaporation fans will be required in the future. This will also allow PG to determine if other method may be more appropriate for smaller volumes (ie treat and release).

The current water balance model is showing a positive annual water balance of 800ML.

Figure 3.1 Evaporation ponds (looking south)

Figure 3.2 Evaporation ponds plan

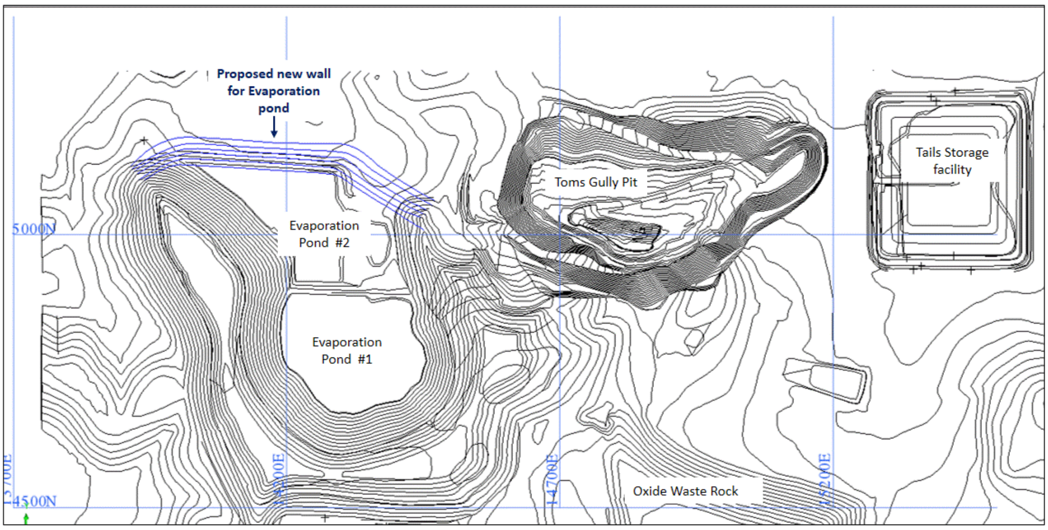


Figure 3.3 Kohler Curves for evaporation

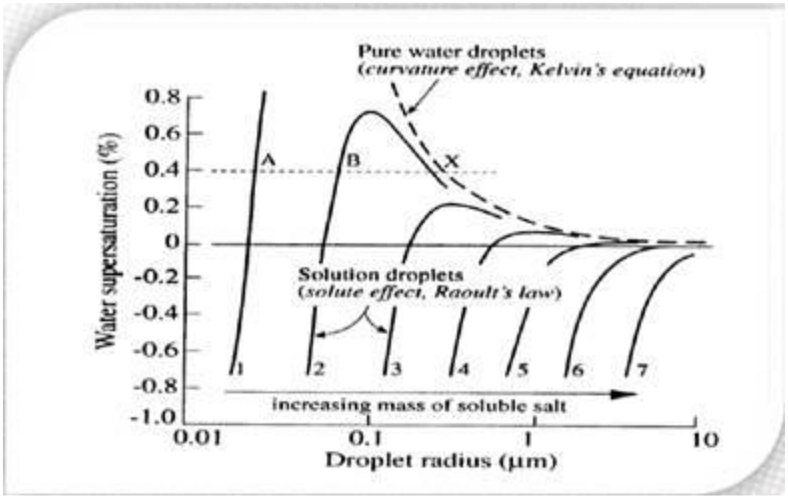


Figure 3.4 Schematic of proposed evaporation fan installation

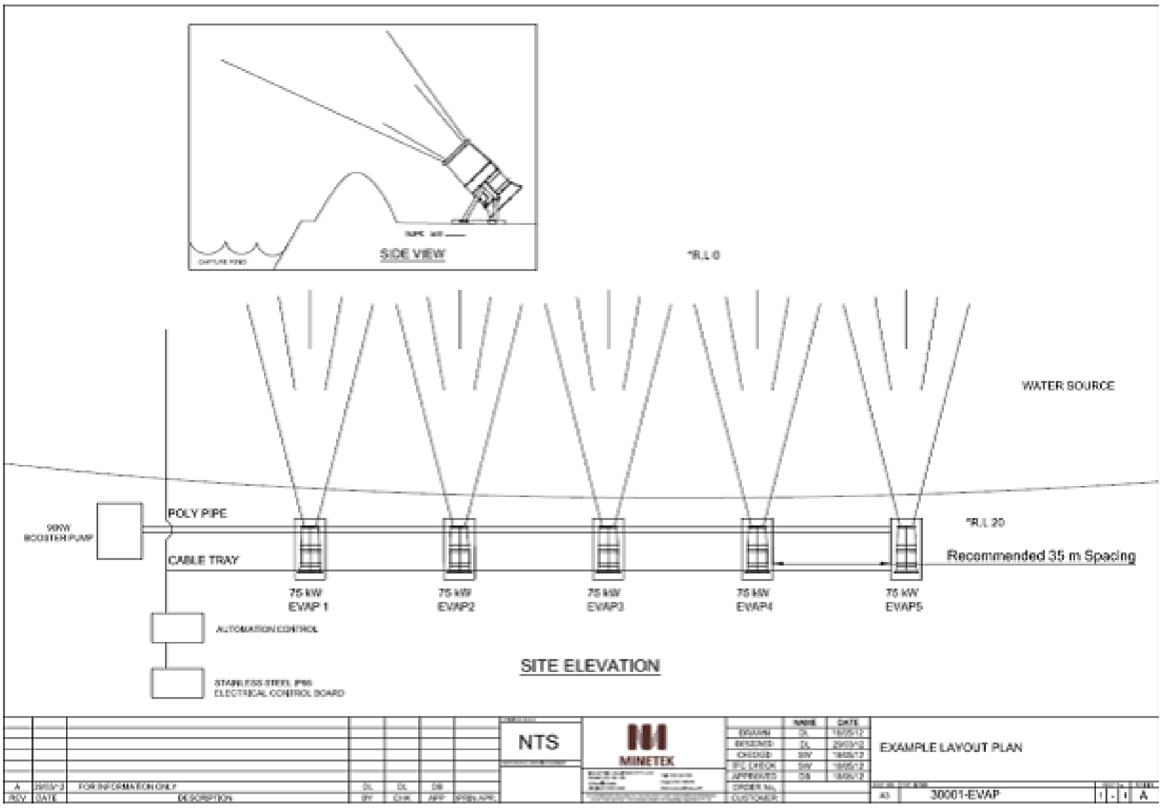


Figure 3.5 Example of evaporation fan installation

4. SURFACE WATER MANAGEMENT

4.1 Potential Contaminants

A large portion of the Tom's Gully Mine site has been subjected to intense open cut and underground mining and mineral processing, leaving the site with significant sources that have the potential to contribute to reduced water quality, particularly in the generation of acid and metalliferous drainage (AMD). The term 'metalliferous drainage' is used in this document to encompass both acid rock drainage and neutral mine drainage.

Metalliferous drainage is a significant issue at the mine site, particularly from the waste rock dumps created in the late 1980s. Metals of particular interest include aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese and zinc. An increase in electrical conductivity and decrease in pH is a common feature resulting from the oxidation of pyritic minerals into sulfuric acid.

4.2 Potential Impacts

The key potential impact is the reduction in water quality of local surface water resources and the subsequent decline in ecosystem health due to the sources identified in Section 4.1. Specific potential impacts include:

- Adverse effects on downstream ecosystems due to the passive release of poor quality water.
- Adverse effects on downstream ecosystems due to the release of fugitive sediments.
- Adverse effects on fauna and riparian vegetation and groundwater users due to reduced surface water quality.
- Adverse impacts on the receiving waters that may negatively impact the aquatic ecology of and or affect the beneficial values of the water resource.

The main source of impact would be the potential overflow from storage facilities listed in Table 3.1. CGAO assessed that the open pit has sufficient capacity to store contingency runoff over the life of this WMP, and until at least 2020 under normal rainfall conditions (see Table 3.1 and the findings of the water balance modelling in Appendix B). However with the planned fan evaporation to dewater the pit there is even a lower potential for overflow in the future.

4.3 Surface Water Management Infrastructure

The inputs and outputs for the water infrastructure on the project areas identified are provided quantitatively in the water balance tables and a description of the mechanisms are outlined below.

4.3.1 Evaporation Ponds

The evaporation ponds (EP1 and EP2) currently have a combined volume of more than 280 ML and are currently less than 25% full. EP1 and EP2 are bound by the SWRD, except on the northern side, and receive seepage and runoff from the SWRD.

Active discharge from EP2 into Mount Bundey Creek was previously regulated through a system of 15 siphons located on the northern bank of EP2. These siphons are no longer used; instead water from both evaporation ponds is currently pumped via EP2 to the open pit. This reduces the risk of overtopping of the evaporation ponds and subsequent impact on the surrounding environment.

PG plans to raise the final dam wall by 5m to just under 10m (see Figure 3.1 and Figure 3.2) to increase the capacity of the evaporation ponds to almost 900ML. This increase in capacity it to ensure that all site water can be pumped to this area during high rainfall events and any excess water from production and retain a surge capacity in the event of a high rainfall event.

This increased capacity with the option of enhanced evaporation will allow PG to ensure that the site water balance in appropriately managed.

4.3.2 New Process Water Dam

Note: The following section outlines in-house, preliminary design which have followed the "Guidelines for the Construction of Earth-Fill Dams, Water Resources Policy, Policy #2008/1, November 2008, Department of Primary Industries and Water, Tasmania". However, final design will be completed and construction overseen by independent, qualified and experienced dam engineers following all necessary guidelines for large dams.

Construction of a new Process Water Dam is proposed to the south of the existing waste dump. The location is selected due to its proximity to the Toms Gully Pit and favourable topography. It will also allow containment of the tailings from the Old TSF, where significant erosion of the containment walls has been observed.

Preliminary designs have the lowest point of the new dam at approx. 1,030 mRL, in a creek at approx. coordinates 13,940E and 4,100N and maximum wall height of 17 meters i.e. top of the wall at 1,047 mRL.

The wall will be approximately 525m long, 85m wide at the base and 6m wide on top (to permit light vehicles and service vehicles access along the crest of the dam wall and require approx. 140,000m^3 for construction. Oxide material required for construction will be sourced from the oxide waste dump which has a volume of approximately 3.1 million cubic meters.

A small wall, shown in red below, will be required on the North East corner of the new dam. The corner wall needs to be raised to 1,047mRL. This wall will be 125m long, approx. 7m high at the deepest point, 6m wide at the top, and requires approx. 4,300 m^3 of material for construction.

The maximum water level will be at approx. 1,046.5 mRL which requires construction of a new spillway on the south east side of the reservoir, approximate location at 13,910mE and 3,720mN. The spillway will be constructed at 0.5m below the western wall height to ensure the maximum dam capacity can be safely maintained. The spillway wall requires 590m^3 of material for construction. The wall length of 52m, height up to 1.5m and width on top of 5 - 6m will allow travel on the crest both during and after construction.

The proposed new dam will have storage capacity of approximately 2.8Gl to 1046.5m allowing for 0.5m free board. Freeboard is the vertical distance from the top of the embankment to the level of the spillway and needs to take into account potential wave action. As a rule of thumb the wave height can be calculated by Hawksley's formula [H = 0.0138(F)0.5], where H is the wave height in metres and F is the fetch distance over the longest exposed water surface expressed in metres. For the new Process Water Dam, the fetch distance is 500m and the wave height is approx. 0.3m.

Figure 4.1 Layout of the Proposed New Process Water Dam

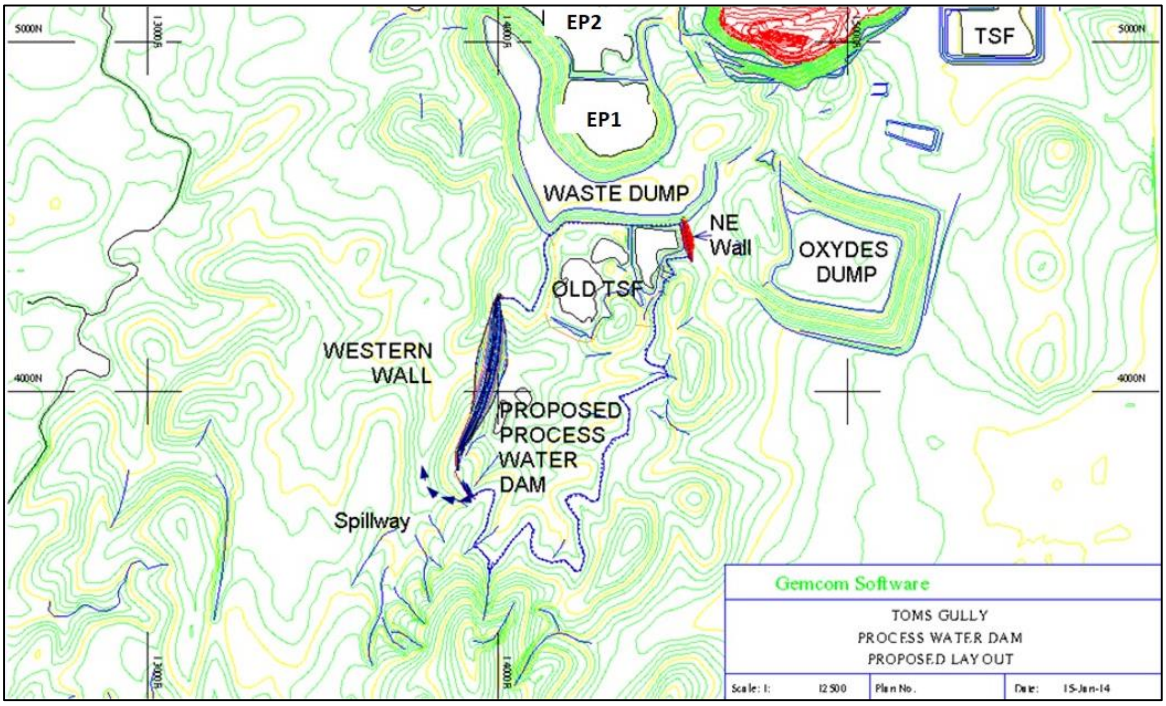
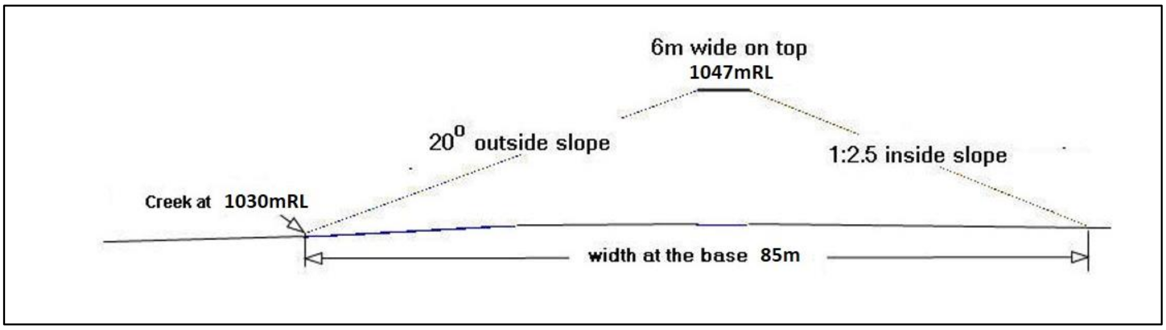


Figure 4.2 Indicative Vertical Section through the Dam Wall



4.3.3 Waste Rock Dumps

The waste rock dumps were separated into oxide and sulfide dumps when Carpentaria Gold developed the open pit between 1989 and 1992. Rehabilitation activities were undertaken on both waste rock dumps before CGAO acquired the lease and the techniques used at the time for the rehabilitation of the waste rock dumps are not currently known. Currently acidic and metal-laden water seeps from the SWRD to the ODP and evaporation ponds; and from the OWRD to the Wetlands Oxbow via a drainage bund.

Oxide Waste Rock Dump (OWRD)

The OWRD is vegetated and runoff flows via the drainage bund along the eastern and northern boundaries of the OWRD into the Wetlands Oxbow. There are some acidic and metal-laden water seeps from the OWRD to Lake Bazzamundi, however the extent of these seeps have not been confirmed through detailed investigations.

Sulfide Waste Rock Dump (SWRD)

The western edge of the SWRD has been capped and revegetated. Surface runoff to the west passively discharges to the environment towards Mount Bundey Creek. Runoff to the southern and eastern sides of the SWRD is collected and held in the ODP, EP1, EP2 and minimal surface water flows into the open cut pit. Improved drainage lines from the SWRD to the ODP have been constructed to prevent runoff flowing into the OTD.

4.3.4 Tailings Dams

The Old Tailings Dam (OTD) will be sampled and assayed for Au to determine if there is an economic resource in the dam. If it is proven that there is an economic resource the tailings will be retreated as part of the commissioning of the processing plant. When the dam is empty it will be assessed to determine if the dam can be used for future tailings storage.

If the OTD cannot be used for future tailings storage the OTD will be rehabilitated once suitable oxide cover material is sourced. Initial, small scale sampling has been undertaken on the western side of the OWRD in early June 2012, to gain an understanding of the material characteristics. These initial results determined that all samples had a pH above 4.5 (with an average of 6.73), sulfur is less than 0.2% (with an average of 0.06%), were all Net Acid Producing Potential (NAPP) test negative, with analysis determining that all samples were Non Acid Forming (NAF) material. This initial sampling will be followed by larger scale investigations (including test drilling) to determine the suitability of bulk of the material from the OWRD and small hill east of OTD for capping purposes during the 2014 dry season.

Old Tailings Dam

The Old Tailings Dam (OTD) currently contains approximately 17.79 ML with remaining capacity of approximately 26.69 ML. About 15% of the tailings material in this dam is sulfidic (containing arsenopyrite and pyrite).

In the initial stages of the site refurbishment the OTD will be used to evaporate water from the TG Pit. This dam will have a series of evaporation fans installed that will pump water from the dam. The dam level will be monitored to ensure that there is adequate capacity for high rainfall events.

During the wet season water levels will be monitored on a daily basis and excess water pumped to the evaporation ponds to ensure that the poor quality water is maintained on site.

New Tailings Dam

The New Tailings Dam (NTD) has a total capacity of approximately 75.3 ML and is currently dry. During the wet season, excess water can currently be pumped to the open cut pit to ensure that poor quality water is maintained on site. In the future this water will be redirected to the Evaporation Ponds. This dam was designed with a 1.0 m freeboard above maximum flood waters of the Mount Bundey Creek.

PG plans to raise the height of the NTD to increase tailings capacity for future production. The 1.0m freeboard will be maintained.

Production is planned during the life of this WMP, however the amount of production will be determined when the sampling of the OTD is undertaken and the dewatering timing of the TG Pit and underground is finalised. Forecasted production details are included in the TG MMP Part B.

PG plans to use the NTD for evaporation of the TG Pit water with evaporation fans as per the evaporation ponds and OTD. The freeboard will be maintained during this process and excess water due to high rainfall events will be pumped either to the evaporation ponds or the TG Pit.

4.3.5 Old Decant Pond

The ODP is situated on the eastern side of the OTD and has a total volume of approximately 46 ML with 50% capacity remaining (23.0 ML). During heavy rainfall periods, water from the ODP overflows into an intermediate pond (directly south of the ODP) and can then flow to Mount Bundey Creek.

4.3.6 Open Pit

The open cut pit has a total volume of 4,675 ML and is 88 m deep at the full supply level (FSL). The pit has a decline leading to underground operations extending to a vertical depth of approximately 200 m, with the portal located on the northern wall of the pit (currently submerged). Since the start of care and maintenance, the pit has been used to store excess poor quality water and groundwater ingress as the groundwater table rises during the wet season and the cone of depression around the pit subsides. Currently the pit is estimated to be 61% full with a remaining capacity of 2,205 ML. Currently, during high rainfall periods, excess water from EP2, OTD, NTD and the Stormwater Pond can be pumped into the pit to prevent overflow at these storages.

PG plans to dewater the TG Pit have been discussed in Section 3.3.

4.3.7 Stormwater Pond

The Stormwater Pond or process runoff pond (PROP) has a storage capacity of 11 ML and is only used to store runoff from the surrounding Mill area during the wet season. Runoff is funnelled into the Stormwater Pond where it is currently pumped into the open cut pit. In the future it will be pumped back into the process water pond or the evaporation ponds.

4.3.8 Wetlands Oxbow

Wetlands Oxbow receives runoff collected in the OWRD diversion bund and runoff from around the NTD. The Wetlands Oxbow acts to improve water quality through adsorption and precipitation of metals by wetland filtration (as evidenced by the decrease in metal concentration between samples collected from the source OWRD within the bund and within the wetland (SWTG6) and samples collected downstream (SWTG12) prior passive discharge; refer to Section 7).

The wetland has a relatively large catchment size and is designed to passively overflow into Mount Bundey Creek through a weir. Mount Bundey Creek also often backflushes into the Wetlands Oxbow during peak flows.

4.3.9 Lake Bazzamundi

Lake Bazzamundi is also an artificial wetland that was previously used to store mine water and bore water compliant with stock water quality guidelines and continues to be used for stock watering purposes. No water has been actively pumped to Lake Bazzamundi since the cessation of underground dewatering towards the end of 2010. The lake has a relatively large catchment size and passively overflows from the south into Coulter Creek, which also receives some surface water runoff from the southern side of the OWRD.

4.4 Discharge

Apart from the scenario described in section 3.3, PG will not be actively discharging to surface water during the life of this WMP. There is, however, likely to be passive discharge during high flow periods from the following:

- Surface runoff from the western side of the SWRD.
- Overflow from the ODP.

- Overflow from the Oxbow Wetlands into Mount Bundey Creek.
- Overflow from Lake Bazzamundi into Coulter Creek.

PG will contact EPA and DME if the quality of the water for passive discharge deteriorates and trends indicate that it has the potential to breach water quality guidelines at the downstream site SWGT2. During the 2011-2012 wet season, ODP overflowed into the mixing zone runoff pond and measurements at SWGT2 remained compliant with guidelines. PG has a siphon system in place to pump the water from the ODP to the OTD facility which was pumped to the open cut pit during the 2012-2013 wet season to ensure that downstream surface water values are not adversely affected. In the 2013-2014 wet season the OTD will be pumped to the evaporation ponds to ensure that downstream surface water values are not adversely affected.

4.5 Abstraction

PG did not abstract surface water during the previous WMP and will not be abstracting surface water during this current authorisation period.

4.6 Contingency Planning and Mitigation Measures

In the event of a localised spill or release, the following emergency response procedures will be enacted to avoid affecting the quality of adjacent surface waters:

- Take all possible safe action to contain the spill and prevent further release.
- Report the incident in accordance with procedures (see Section 6.3.4).
- Assess the environmental impact.
- Notify appropriate authorities, EPA and DME; and PG management if significant environmental harm is likely.
- Undertake remedial action.

General water management practices will continue to be employed, including:

- Monitoring all dam levels and pumping contained water when and where appropriate. The Toms Gully Mine site caretaker carries out daily checks of all water holding facilities during the wet season. When significant rainfall events are forecast, the pumps are turned on to increase water storage capacity and reduce the risk of overflow.
- Redirecting drainage of excess water from the OWRD and Mill area to the Wetlands Oxbow.
- Redirecting poor quality water to the open pit, which acts as contingency storage the containment of poor quality water and open cut pit groundwater ingress.
- Continued monitoring of surface water quality as outlined in Chapter 6.

5. GROUNDWATER MANAGEMENT

5.1 Potential Contaminants

Areas with an increased potential to adversely affect groundwater include the oxide waste rock dump, sulfide waste rock dump, evaporation ponds and the open pit, through seepage.

Seepage of water through the waste rock and tailings piles can result in the development of acidic conditions from the dissolution of pyritic sulphide minerals such as pyrite. This acidic drainage can liberate metals from the waste rock and tailings which can then enter the groundwater including metals and metalloids such as aluminium, arsenic, cadmium, copper, cobalt, chromium, iron, lead, manganese, nickel, selenium and zinc.

5.2 Potential Impacts

Metalliferous seepage from the sources identified in Chapter 4 have the potential for adverse effects on the quality of local groundwater resources impact on the beneficial uses outlined in Section 2.3.2 including stock watering and potentially in health of groundwater dependent ecosystems.

Monitoring results for the groundwater observation bores indicate some poor quality groundwater immediately to the west and north of the sulfide waste rock dump and evaporation ponds. High metal concentrations and acidic pH recorded at bore G8 indicate acid mine drainage to the west of the SWRD (see Section 7.2). The monitoring results from Bore OB10, on the north wall of EP2 are inconclusive and are likely to have been affected by realised water entering the top of the casing during active discharge approved under the Water Act in previous authorisation periods

These bores are in relatively close proximity to Mount Bundey Creek and indicate that there is potential for poor quality water to contribute to Mount Bundey Creek resulting in a reduction in water quality. However, at this stage it must be noted that since 2010 there has been an improvement in the water quality of all metal concentrations measured in G8, except copper, indicating a possible amelioration of the source terms and/or a reduction in groundwater contribution to the creek.

5.3 Groundwater Management Infrastructure

The bores currently monitored at the mine site include Ridge Bore, Bore 11, G1, G2, G8, G9, OB11, RN29694 (WB4) and P100, and are discussed in Chapters 6 and 7 and shown in Figure 6.1.

A production bore will be established to supply the Tom's Gully processing plant with relatively clean raw water. The bores will be inspected to determine the most suitable bore as part of the site refurbishment, the water from the bore will be used both untreated in the plant and as feed for a Reverse Osmosis plant. The RO water will be used in the elution circuit within the processing plant.

P100 currently remains on standby for extraction of small volumes of water for maintaining fill to the mill tanks during the current care and maintenance phase.

As committed in the previous WMP, CGAO investigated the decommissioned and damaged historical bores (G6 – south of Old Tailings Dam; Bore 6 – north of Oxide Waste Rock Dump and

Bore 7 – between the Old Decant Pond and Oxide Waste Rock Dump). Bore 7 was located unserviceable pump was removed. The remaining bores are yet to be located.

An historical bore RN29678 (WB3), located northwest of the NTD, has also recently been discovered. Following an assessment of the bore's structural integrity and placement planned for the 2014 dry season, it will be considered for inclusion in the monitoring program.

The SWRD has been capped by previous operators to mitigate potential impact on groundwater quality as a result of infiltration of surface water through the pile. The results at bore G8 suggest a gradual improvement in water quality (in terms of metal concentrations) since 2010 potentially indicating that the capping may be contributing positively to reducing seepage through the waste rock (see Section 7.2). This change will be will be included in the hydrogeological and surface water assessments to be commissioned at the beginning of July 2014. The study will also aim to improve the understanding of the quality of surface water flowing from the SWRD towards Mount Bundey Creek.

5.4 Abstraction

A production bore will be established to supply the Tom's Gully processing plant with relatively clean raw water. The bores will be inspected to determine the most suitable bore as part of the site refurbishment, Water from the bore will be used both untreated in the plant and as feed for a Reverse Osmosis plant. The RO water will be used in the elution circuit within the processing plant. Projected volumes are uncertain at this stage of the project and will depend on when the TG Pit is dewatered and the plant refurbished.

Currently small volumes from bore P100 are used to regularly flush the tanks in the mill to minimise the potential for corrosion.

5.5 Contingency Planning and Mitigation Measures

Continued monitoring will identify and determine the movement of affected groundwater on site. PG recognises that mitigation of the potential impacts on groundwater quality in this area is complex and requires the commissioning of hydrogeological studies including input from AMD specialists augmented by the ongoing monitoring and interpretation of water quality.

The contingency and mitigation measures outlined in Section 4.6 for surface water will also apply to for groundwater. However, in addition to these mitigation measures, PG will:

- Rehabilitate both the OTD and the NTD once suitable oxide cover material is sourced, with the OTD to be rehabilitated as a priority. PG will commission investigations (including test drilling) in the 2014 dry season to determine the availability of suitability material from the oxide waste rock dump or from a small hill to the east of the OTD.
- Commission a hydrogeological study at the beginning of July 2014 to assess whether new monitoring bores are needed and if so, where they should be located.
- If a groundwater incident (see Section 6.3.4 for definition of incident types) is detected during monitoring, PG will increase the frequency of monitoring, notify the regulator and assess and undertake groundwater remediation works appropriate to the type of impact (in conjunction with hydrogeological and geochemical advice).

Report any incidents in accordance with appropriate procedures (see Section 6.3.4).

6. MONITORING

6.1 Statutory and Non-Statutory Monitoring Programs

Surface water and groundwater are monitored regularly at a number of locations within and around the mine site (see Figure 2.10) since 2012 when PG took ownership of the site (and prior to that by previous operators and DME (at time DoR) as a part of their environmental compliance check monitoring program).

The monitoring programs detailed below will apply for the 2013-2014 authorisation period. Table 6.1 outlines the monitoring frequency adopted for the surface and groundwater monitoring programs, while Table 6.2 shows the parameters for analysis. The sampling program has been developed based on those parameters identified historically as being of concern in the area, as well as through discussions with DME and EPA.

Table 6.1 Monitoring frequency for surface water and groundwater

Frequency	Description
D	Daily (when discharging)
W	Weekly (during flow/discharge and for 2 months after cessation of discharge)
F	Fortnightly (samples during flow only - streams)
M	Monthly (samples during flow only - streams)
Q	Quarterly
B	Biannual (first flow: Oct/Nov, and recessional flow: Apr/May)

Table 6.2 Surface water and groundwater quality parameters

Type	Analytes
Type 0	Water height level reading (particularly for wet season and during wet season discharge, also to gauge evaporation levels in dry season).
Type 1	Field parameters (pH, EC, temperature, flow / water level)
Type 2	Filtered metals (Al, As, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Zn and U); Total metals for new sites or when changes are noticed.
Type 3	Major Cations (Ca, K, Na & Mg) Anions (Cl and SO_4) – Filtered)
Type 4	Titratable Acidity, Alkalinity, Hardness ($CaCO_3$) & Total Suspended Solids (TSS) & Turbidity
Type 5	Cyanide (weak-acid dissociable CN, Total CN, Free CN)
Type 6	Total phosphorus, total nitrogen, ammonia, nitrogen oxides and filterable reactive phosphorus.

6.1.1 Surface Water

The surface water monitoring program is detailed in Table 6.3. The monitoring program is designed to assist in determining the success of the surface water management measures discussed in Chapter 3. Surface water monitoring locations for the project area are shown in Figure 3.10.

6.1.2 Groundwater

The current groundwater monitoring program is provided in Table 6.4. Groundwater monitoring locations are shown in Figure 3.10. Nine groundwater bores will be monitored as part of the 2013-2014 monitoring program.

6.1.3 Biological

Ecotoxicology

Previous owners CGAO employed the services of the Australian Government's Department of Sustainability, Environment, Water, Population and Communities' Supervising Scientist Division's environmental research arm, ERISS, to conduct ecotoxicological studies during the end of the 2009-2010 wet season. These results are described in previous WMPs. No ecotoxicological monitoring was undertaken during the 2010-2011 or 2011-2012 wet seasons as there were no active discharges during these years. It is not envisaged that there will be active discharge in the 2013-2014 wet season. However if water treatment is used and water is actively discharged ecotoxicological studies will be undertaken,

Macroinvertebrate Sampling

Macroinvertebrate sampling will be undertaken at the end of the 2013-2014 wet season. These results will be compared to previous macroinvertebrate studies to assist in the overall assessment of the health of the Mount Bundy Creek system.

Table 6.3 Surface water monitoring program for 2013-2014

Site Code	Sample Location / Description	POSITION			Analysis Type*					
		GRID: UTM / DATUM: WGS84			0	1	2	3	4	5
		Zone	Easting	Northing	Frequency#					
SWTG1A	Mount Bundey Creek, upstream of the mine site – control site.	52L	776407	8580531	F	F	F	F	F	-
SWTG2	Mount Bundey Creek, at Arnhem Hwy bridge, downstream of the mine site.	52L	779558	8580421	F	F	F	F	F	-
SWTG3	Mount Bundey Creek, further downstream of SWTG 2.	52L	782298	8579333	F	F	F	F	F	-
SWTG4	Wetlands area on mine site access road. Downstream of plant runoff pond (spillway).	52L	778473	8579934	-	M	M	M	M	-
SWTG5	Artificial wetlands contiguous to the pastoral property (Lake Bazzamundi).	52L	779203	8579773	-	M	M	M	M	-
SWTG6	Wetlands Oxbow – middle of wetland area	52L	778547	8580411	M	M	M	M	M	-
SWTG8	Overflow of runoff from ODP, to be sampled when overflowing.	52L	777408	8579371	-	F	F	F	F	-
SWTG9	Runoff from Sulfide Waste Rock Dump, prior to joining creek	52L	776764	8580100	F	F	F	F	F	
SWTG10	Seepage/runoff collected in diversion drain from Oxide Waste Rock Dump, water diversion flow to Wetlands Oxbow.	52L	778348	8579597	-	M	M	M	M	-
SWTG11	Entrance to Wetlands Oxbow.	52L	778657	8580282	-	M	M	M	M	-
SWTG12	Weir gate at wetland-discharge point. Monitored when discharge occurs.	52L	778547	8580458	F	F	F	F	F	-
CK7	Spillway at Arnhem Hwy (receives runoff from Lake Bazzamundi)	52L	779828	8579516	M	M	M	M	M	-
OWRD	Seepage/runoff collected in diversion drain around Oxide Waste Rock Dump	52L	778266	8579330	-	Q	Q	Q	Q	-
RO POND	Stormwater Pond down gradient of mill, ROM pad and workshop.	52L	778222	8579831	F	M	M	M	M	-
SWTG TAILS 1	Old Tailings Dam	52L	777232	8579348	F	Q	Q	Q	Q	Q
SWTG TAILS 2	New Tailings Dam	52L	778617	8580264	F	Q	Q	Q	Q	Q
EP1	Evaporation Pond 1	52L	777432	8580000	F	Q	Q	Q	Q	Q
EP2	Evaporation Pond 2	52L	777301	8580251	F	Q	Q	Q	Q	Q
ODP	Old Decant Pond, next to Old Tailings storage facility #1	52L	777498	8579531	F	Q	Q	Q	Q	Q
TGM PIT	Tom's Gully Open Pit	52L	778111	8580205	M	Q	Q	Q	Q	-

* Refer to Table 6.2 for analysis type description.

Refer to Table 6.1 for frequency description.

Table 6.4 Groundwater monitoring program for 2013-2014

Site Code	Sample Location / Description	POSITION			Analysis Type*				
		GRID: UTM DATUM: WGS84			0	1	2	3	4
		Zone	Easting	Northing	Frequency#				
RIDGE BORE	Monitoring bore south of Old Tailings Dam	52L	777559	8579124	Q	Q	Q	Q	Q
BORE 11	Monitoring bore south of Old Tailings Dam	52L	777288	8579016	Q	Q	Q	Q	Q
OB11	Observation bore north of EP 2	52L	777186	8580322	Q	Q	Q	Q	Q
G1	Northwest corner of EP 2	52L	777009	8580348	Q	Q	Q	Q	Q
G2	West of OWRD alongside road	52L	777683	8579727	Q	Q	Q	Q	Q
G8	Monitoring bore west of EP 1 over SWRD on road side	52L	777021	8580019	Q	Q	Q	Q	Q
G9	Observation bore north of the open pit	52L	777663	8580478	Q	Q	Q	Q	Q
RN29694 (WB4)	Down-gradient of G8, between SWRD and Mount Bundey Creek	52L	776935	8580080	Q	Q	Q	Q	Q
P100	Bore P100 – standby bore for emergency water supply and maintenance of mill tanks	52L	778275	8580155	Q	Q	Q	Q	Q

* Refer to Table 6.2 for analysis type description.

Refer to Table 6.1 for frequency description.

6.2 Quality Control

PG will use CGAO's environmental sampling methods that are documented in an environmental sampling manual detailing procedures for quality control and sampling methodology (available upon request). A summary of the quality control regime and methodology is provided in this section. All sampling and environmental field testing has been undertaken in accordance with these procedures.

6.2.1 Sample Collection and Dispatch

The following procedures are in place to ensure quality control in the field:

- Rinse the sample bottle (and any other vessel used to collect sample) at least three times before collecting the sample (except for bottles containing preservative, which are not rinsed). Use a different vessel for the 'clean' water sites and the 'dirty' water sites. Also rinse filters and syringes with sample water before use.
- Wear powder-free gloves at all times when sampling and handling sample bottles.
- Close the lid of the sample vessel immediately after sampling and store in a cool container, free of contamination sources.
- Place the water quality meter downstream of where the samples are collected to avoid contamination of samples.
- Do not disturb bed sediment when sampling.
- For each sampling campaign collect a duplicate of a sample and a blank sample (a bottle filled with deionised water) for analysis with the samples. These field QC samples should not be identifiable by the laboratory.
- Keep all samples chilled until they are received by the laboratory.
- Dispatch samples to the laboratory as soon as possible after sample collection ensuring that holding times will be met.

6.2.2 Calibration of Field Instruments

The water quality meter is calibrated as per the instrument manual specifications. This includes regular calibration of temperature, pH and conductivity with standard solutions provided by the manufacturer. The instrument should be calibrated immediately before each use.

Before and after each use, the instrument is visually checked for any damage or contamination and when not in use the probes are stored with caps on and in line with the instrument manufacturer's specifications.

6.2.3 Sample Analysis

PG uses a NATA-certified laboratory, EnviroLab Services (NATA accreditation number 2901), for all sample analyses.

For accuracy, each analyte must be analysed within a certain time period after the sample is collected. Samples have been analysed within the recommended sample holding times for each parameter.

The laboratory implements a stringent quality control program, which includes analysis of method blanks, duplicates and matrix spikes. These results are reported with the data reports to demonstrate the quality of the data.

6.2.4 Standards Preparation – Field QC Standards

Duplicates

Separate samples collected from the same site at the same time are used to determine the reproducibility of the sampling and analysis process.

To sample the duplicate, do one sample twice, but label the second sample with a different sample name, and record the name of it in your field notes. Do not tell the laboratory which sample is the duplicate. Duplicate samples should return results within a determined acceptable relative percentage difference. This acceptable difference between results can be determined using the detection limits of the analytical procedure employed by the testing laboratory.

Blanks

Water known to not contain analytes (i.e., deionised water) is used as a 'blank' sample to detect whether sample contamination is occurring during the sampling process.

Field blanks are required for every sampling campaign. Field blanks should not be identifiable by the laboratory. Blanks that return greater than anticipated values for analytes may indicate exposure to contamination during collection and treatment of the sample.

6.2.5 Data Storage and Verification

Data is stored on a network that is maintained and regularly backed up. In the case of unusual results, possible causes are investigated to verify its accuracy.

Data is compared to previous results for the site as well as guideline values.

6.3 Water Quality Trigger Values

6.3.1 Level of Protection

Beneficial uses for receiving waters downstream of the mine site were declared in February 1994, and amended in May 1997. The beneficial use for Mount Bundey Creek is 'aquatic ecosystem protection' except for a 7.8 km section immediately downstream of the Arnhem Highway where the beneficial use is 'stock water supply'.

Due to the long-term human influence and impacts of Tom's Gully Mine and surrounding areas, the ecosystem in the immediate vicinity of the project area (i.e., surface water within and around the mine site) can be classified as being 'condition 3: highly disturbed' of which according to ANZECC/ARMCANZ (2000), are ecosystems in which 'are measurably degraded ecosystems of lower ecological value'. Upstream and downstream of the mine, the ecosystem is condition 2: slightly, to moderately disturbed, which according to ANZECC/ARMCANZ (2000) is an ecosystem where 'aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity'.

Due to these beneficial uses and the legacy of historic mining operations in the area, PG aims to use water quality value comparisons based on ANZECC/ARMCANZ (2000) water quality guidelines for 80% protection of aquatic ecosystem species, with the stock water guidelines as the upper limit, with exceedance triggering investigation, comparison with upstream sites to determine potential exogenous influences and remedial action where appropriate. The 95%

ecosystem protection guideline will continue to be compared to water quality data to assist in identifying data trends.

6.3.2 Surface Water

Surface water environmental values in the region are based on those recommended for lowland river and stream systems of the tropics by ANZECC/ARMCANZ (2000). Surface water on the mine site includes the two tailings dams and evaporation ponds, the two main artificial wetland systems (Lake Bazzamundi and Wetlands Oxbow), the open pit, Mount Bundey Creek and Coulter Creek, and any drainage lines and channels within the mining lease. The main indicators of ecosystem health that are used to monitor surface waters and are derived from ANZECC/ ARMCANZ (2000) and include:

- Physical and chemical stressors.
- Toxicants.
- Biological indicators.
- Sediments.

Table 6.5 and Table 6.6 show the water quality objectives and the ANZECC (2000) 95%, 90%, 80% and stock water guidelines (SWG) species protection values.

Table 6.5 Physical and chemical water quality objectives

Indicator	Unit	Surface Water	
		Focus	Upper Limit (SWG)
pH		6.0 to 8.0	4.0 to 9.0
Electrical Conductivity	µS cm^{-1}	20 to 250	<5,900
Turbidity	NTU	2 to 15	NA
Total Phosphorous	µg P L^{-1}	10	NA
Filterable reactive phosphate (FRP)	µg P L^{-1}	4	NA
Total Nitrogen	µg N L^{-1}	200 to 300	NA
Oxides of nitrogen (NOx)	µg N L^{-1}	10	30
Dissolved oxygen (DO)	% saturation	85 to 120	NA

Table 6.6 Recommended Water Quality Trigger Values (ANZECC, 2000)

	Trigger Value for Fresh Water (µg/L)(% species protection)			
	95%	90%	80%	Stock Water Guidelines (SWG)
Metals and Metalloids				
Aluminium (pH >6)	55	80	150	5,000
Aluminium (pH <6)	ID	ID	ID	5,000
Arsenic	24	94	360	500
Beryllium	ID	ID	ID	5,000
Boron	370	680	1,300	5,000
Cadmium	0.2	0.4	0.8	10
Chromium	ID	ID	ID	1,000
Cobalt	ID	ID	ID	1,000
Copper	1.4	1.8	2.5	400 for sheep; 1,000 for cattle; 5,000 for pigs/poultry

	Trigger Value for Fresh Water (µg/L)(% species protection)			
	95%	90%	80%	Stock Water Guidelines (SWG)
Fluoride	ID	ID	ID	2,000
Iron	ID	ID	ID	Not sufficiently toxic
Lead	3.4	5.6	9.4	100
Manganese	1,900	2,500	3,600	Not sufficiently toxic
Mercury	ID	ID	ID	2
Molybdenum	ID	ID	ID	150
Nickel	11	13	17	1,000
Selenium	11	18	34	20
Uranium	ID	ID	ID	200
Zinc	8	15	31	20,000
Non-Metallic Inorganics				
Ammonia	900	1,430	2,300	-
Cyanide	7	11	18	-
Nitrate	700	3,400	17,000	-
Hydrogen Sulfide	1	1.5	2.6	-

ID = Insufficient Data to determine a trigger value

6.3.3 Groundwater

While ANZECC/ARMCANZ (2000) guidelines do not provide trigger values for groundwater ecosystem protection, they do provide values for stock drinking and agricultural irrigation (long-term trigger value [LTV], short-term trigger value [STV]); both of which have been identified as beneficial uses of groundwater. It is also appropriate to consider the connectivity between groundwater and surface water ecosystems and thus groundwater data is compared to the ANZECC (2000) Water Quality Guidelines for freshwater aquatic ecosystem 80% species protection.

Groundwater quality trigger values for the Tom's Gully Mine site are provided in Table 6.7. It should however be kept in mind that groundwater quality often reflects the mineralisation existing subsurface and background levels may be naturally elevated due to this. In this instance values are also compared over time to identify change.

Table 6.7 Groundwater trigger values

Parameter	Unit	80% Aquatic Ecosystem	Agricultural irrigation LTV	Agricultural irrigation STV	Stock Drinking Water
pH	-	6 to 8	NA	NA	4 to 9
EC	µS/cm	250	NA	NA	5,970
Aluminium	µg/L	150	5,000	20,000	5,000
Arsenic	µg/L	140	100	200	500
Cadmium	µg/L	0.8	10	50	10
Cobalt	µg/L	1,000	50	100	1,000
Chromium	µg/L	40	100	1,000	1,000
Copper	µg/L	2.5	200	5,000	1,000
Iron	µg/L	ID	200	1,000	ID

Parameter	Unit	80% Aquatic Ecosystem	Agricultural irrigation LTV	Agricultural irrigation STV	Stock Drinking Water
Lead	µg/L	9.4	2,000	5,000	100
Manganese	µg/L	3,600	200	10,000	10,000
Nickel	µg/L	17	200	2000	1,000
Selenium	µg/L	34	20	50	34
Zinc	µg/L	31	2,000	5,000	20,000
Calcium	mg/L	NA	NA	NA	1,000
Magnesium	mg/L	NA	NA	NA	1,000
Sulfate	mg/L	NA	NA	NA	1,000
Chloride	mg/L	33	NA	NA	NA
Cyanide – WAD	mg/L	18	NA	NA	NA
Cyanide – Total	mg/L	18	NA	NA	NA
Cyanide – Free	mg/L	18	NA	NA	NA

6.3.4 Application of Trigger Values and Incident Reporting

Comparison values for surface water provide the basis for corrective actions and reporting procedures in this WMP. These are summarised in Table 6.8.

Table 6.8 Surface water quality management

Trigger Level	Corrective Action	Reporting Requirements
Focus (80% Aquatic Water Guidelines)	Manage by routine procedures Manage at team level	No action required
Action Level (50% - outside of agreed compliance)	Investigation Manage through routine procedures	CGAO Event/Hazard/Incident/Injury Report to be completed
Upper-Limit Level (Outside of Stock Water Guidelines)	Consider ceasing all affected activities i.e. waste water discharge; consider ICAM	CGAO Event/Hazard/Incident/Injury Report to be completed

PG will immediately report all incidents that include the following:

- Onsite incident: an event that occurs on site that has the potential to cause environmental harm through release off site.
- Offsite incident: exceedance of Upper Limit trigger levels (ANZECC/ARMCANZ, 2000 guidelines for stock water) at downstream monitoring sites, where parameters are currently not in exceedance of these guidelines.
- Critical incident or serious accident: as defined in the Mining Management Act. A critical incident is defined as an event on a mining site that has the potential to cause a significant adverse effect on the environment. A serious accident is defined as an event on a mining site that causes material environmental harm.

PG will immediately notify DME if there is the potential for offsite release and will notify DME and the EPA if an incident is detected off site. Notification to DME and the EPA will occur within 24 hours and reporting of the incident will be within 48 hours.

PG will immediately report any critical incident or serious accident to DME in accordance with Section 29 of the Mining Management Act procedure for Notification of a Serious Accident or Critical Incident (DoR, 2011).

All environmental incidents will also be reported internally by PG initially via email, then via a digital system when purchased.

All incidents will be investigated and isolated and contained (if possible and safe to do so). All internal reporting must be completed with 12 hours of the incident occurring. It is the responsibility of any company personnel to also contact the PG Environmental Manager or PG Director immediately if there is any discharge greater than 20 L into a waterway.

7. REPORTING

This section summarises the results from the 2011-2012 water monitoring programs and interprets these results. Data is presented for the period April 2011 to April 2012. The raw water quality data is provided in Appendix A.

PG will provide raw data for the results of water quality monitoring to the DME on a quarterly basis, or as agreed with the DME Mining Performance team.

To interpret the shading in the tables provided in this chapter, the following information is provided:

- No shading indicates compliance with all guidelines.
- Blue shading indicates non-compliance with stock watering guidelines.
- Yellow shading indicates compliance with stock watering guidelines, but non-compliance with ANZECC 80% freshwater ecosystem protection guidelines.
- Peach shading indicates compliance ANZECC 80% freshwater ecosystem protection guidelines but non-compliance with ANZECC 95% freshwater ecosystem protection guidelines.

Where data analytical results are presented below detection levels, one half of the detection level is used and presented in the data for statistical calculations of mean and standard deviation.

7.1 Key Interpretations

pH

The surface water pH values for all samples from the sites outside the main mine area (SWTG1, SWTG2, SWTG3, CK7 and SWTG9) recorded pH values within the stock watering guideline range (4 to 9). Values showed seasonal fluctuations but no significant change since CGAO monitoring began at the end of 2010.

All surface water sites within the main mine recorded median pH values outside the stock watering guideline range (lower pH level of 4), except for the site located within Lake Bazzamundi (SWTG5), which was 4.56. However during the higher rainfall period (January and February 2012) pH values were mostly below 4. Since the end of 2010, pH values have decreased in the evaporation ponds, ODP, SWTG10, SWTG11 and SWTG12. The pH values at SWTG11 and SWTG12 have decreased by as much as 3 pH units over this period. The pH values at the tailings dams, the open cut pit and Oxbow Wetlands (SWTG6) have been below the stock watering guideline since the end of 2010.

Groundwater pH values were all within the stock watering guideline range, however G8 (on the western side of the SWRD) recorded pH values below the 80% protection guideline in all samples.

If low pH waters from the evaporation ponds are impacting the groundwater on the western side of the SWRD, this impact is very localised as bore RN29694 (immediately to the northwest of G8) has recorded circumneutral pH values.

Electrical Conductivity (EC)

The evaporation ponds (EP1 and EP2) recorded the highest surface water EC concentration. At EP2 the stock watering guideline (5,970 µS/cm) was exceeded on two occasions (10,110 µS/cm in November 2011 and 6,020 µS/cm in April 2010). Bore G11 (directly north of EP2) recorded the highest groundwater EC (up to 4,755 µS/cm), indicating a direct link between the evaporation ponds and the groundwater to the north.

Metals and Metalloids

As would be expected given their function, the evaporation ponds (EP1 and EP2) recorded median aluminium, cadmium, cobalt, copper, manganese, nickel and zinc in excess of the relevant stock watering guideline values. All measured metal concentrations have also increased since CGAO monitoring began in late 2010 reflecting that the ponds are functioning appropriately as evaporative basins concentrating and retaining the solutes in the runoff and toe seepage from the SWRD.

The elevated metals in bore G8 likely also indicate the SWRD as a source term. Solute concentrations at bore RN26964 (to the west of G8) show lower metal concentrations by comparison, potentially indicating that the impacts are remaining quite localised.

The surface waters at OWRD show elevated aluminium, cadmium, cobalt, copper, lead, manganese, nickel and zinc, often in excess of the relevant stock watering guideline values. Temporal trends indicate a worsening water quality since late 2010. These metals at OWRD are likely to have leached from the oxide waste rock dump. The immediate downstream site (SWTG10) does not show such high concentrations, indicating a dilution of metals further from the oxide waste rock dump. The open cut pit (TGMPIT) is also elevated in the same metals, however, its water quality appears to be improving since late 2010.

Metal concentrations in the OTD (SWTG TAILS#1), as expected, exceeded the stock watering guidelines for aluminium, arsenic and cadmium. Concentrations of all measured metals, except iron, show an improving trend since the end of 2010. The nearby ODP exceeded the cadmium stock watering guideline in all samples collected during the current monitoring period and the aluminium stock watering guideline in one sample. Concentrations of all metals, except arsenic, have shown an increasing trend at the ODP since the end of 2010.

Metal concentrations in the NTD (SWTG TAILS#2) again, as expected, exceeded the stock watering guidelines for aluminium and cadmium, and occasionally for copper. All measured metal concentrations have decreased since the end of 2010. All measured metal concentrations at the immediate downstream site (SWTG11) were lower than at SWTG TAILS#2.

Aluminium and cadmium are the only metals to exceed the stock watering guidelines in the surface waters of the Wetlands Oxbow site (SWTG6) and immediately downstream (SWTG12), and these guidelines were only occasionally exceeded. Metal concentrations are generally lower at SWTG12 than at SWTG6, indicating the Wetlands Oxbow may be improving water quality through the adsorption and precipitation of the metals.

Metal concentrations at the surface water sites outside the main mine area (SWTG1A, SWTG2, SWTG3, CK7 and SWTG9) do not exceed the stock watering guideline in any sample collected during this monitoring period. Variability in metal concentrations since monitoring began at the end of 2010 can be reasonably attributed to seasonal variations. There were no increasing or decreasing trends in the metal concentrations of any of the surface water sites outside the main mine area. It is evident from the surface water data that mine derived metal contamination has not extended to the sites outside the main mine area in the sites monitored.

7.2 Surface Water Monitoring

The maximum, minimum and median values were compared to the ANZECC (2000) guidelines for freshwater aquatic ecosystem 95% and 80% species protection and the ANZECC (2000) water quality guidelines for stock watering (Tables 7.1 to 7.19). The guidelines are presented in Tables 6.5 and 6.6. Note that where the data exceed a guideline value, the cell is shaded to correspond to the guideline value cell. Where two guidelines are exceeded, the value is shaded to correspond with the greater guideline value.

Dissolved results are presented below for each site as they are representative of bio-available components and have applicable guidelines. The Tom's Gully project area surface water monitoring locations are shown in Figure 3.10.

SWTG1A

SWTG1A is the site's upstream site and water quality is generally within guideline limits with circumneutral pH and relatively low salinity (electrical conductivity or EC) complying with stock watering guidelines on all occasions. Metals and metalloids (dissolved) were mostly below ANZECC 95% ecosystem protection guidelines and all metals were compliant with the stock watering guidelines at all times. Some metals (Al, Cd, Cu and Zn) were occasionally elevated but were well within stock watering guidelines. Aluminium, copper and zinc exceeded the 80% aquatic ecosystem protection guidelines on some occasions. Exceedances of the 80% aquatic ecosystem protection guidelines did not correspond for each metal and there were no notable trends over the course of the monitoring period.

In the reporting period, pH values have shown an increasing trend (from around 5.3 in 2012 to 6.17 currently), with a slight improvement in all dissolved metals. A potential cause of this could be a higher dilution from previously noted potential exogenous influence on the upstream surface water site.

SWTG2

At SWTG2 the salinity were found to comply with ANZECC stock watering guidelines on all occasions. There has been a degradation of the pH and one sample was below the ANZECC 95% ecosystem guideline. Some dissolved metals (Al, Cd, Cu, and Zn) were elevated but all were below ANZECC stock water guidelines. Since the end of 2010, pH values have decreased slightly (less the 1 pH unit) and dissolved aluminium, copper and zinc are showing a slight increasing trend.

SWTG3

SWTG3 is the most downstream site from the mining area. The pH at this site during the last monitoring period was circumneutral and complied with ANZECC 95% aquatic ecosystem guideline. Salinity was relatively low, complying with 95% aquatic ecosystem guideline on all occasions. Dissolved metals were all in compliance with stock water guidelines. Aluminium, cadmium exceeded the ANZECC 95% aquatic ecosystem and copper and zinc exceeded the 80% aquatic ecosystem protection guidelines on numerous occasions (in both the wet and the dry seasons).

The pH values have decreased slightly (less than 1 pH unit) since the end of 2010, and some dissolved metals (copper, iron and zinc) have shown slight increases during the same period.

SWTG4

Only one sample was taken during the period for SWTG4.

At SWTG4 to the south of the NTD and further downstream of the OWRD drainage line, the pH exceeded the guidelines for stock water for the sample (where pH was less than 4). Electrical conductivity level complied with ANZECC aquatic ecosystem 95% protection guideline. Dissolved metals (As, Co, Mn) exceeded the 95% aquatic ecosystem protection guidelines, (Cu, Pb, Ni and Zn) exceed the 80% aquatic ecosystem protection guidelines and (Al, Cd) exceeded Stock Water Guidelines.

SWTG4 has shown decreased water quality in 2013.

SWTG5

At SWTG5, Lake Bazzamundi the pH exceeded the guidelines for stock water in February and March 2013 (where pH was less than 4) and on numerous occasions exceeded the ANZECC aquatic ecosystem 80% protection guidelines. Electrical conductivity exceeded the 80% aquatic ecosystem protection guideline on three occasions but was in compliance with the stock water guideline. Dissolved metals (Al, Cd, Co, Cu, Ni and Zn) exceeded 80% aquatic ecosystem protection guideline on numerous occasions but all complied with guidelines for stock watering.

Water quality at SWTG5 is very seasonal with increased metal concentrations during the wet season. The pH values have shown a decreasing trend since the end of 2010.

SWTG6

SWTG6 within the Wetlands Oxbow exhibited pH around 4 or lower for the reporting period (pH of lower than 4 exceeds the stock watering guideline) with the exception of one sample. Electrical conductivity exceeded the 80% protection of aquatic ecosystems guideline on all occasions but was in compliance with the stock watering guideline. Many dissolved metals (Al, Cd, Cu, Mn, Ni and Zn) exceeded the 80% protection of aquatic ecosystems guidelines but were mostly compliant with the guidelines for stock watering. The exception was cadmium, which exceeded stock watering guidelines for one sample.

Since the end of 2010, pH values have remained relatively constant while most dissolved metal concentrations have decreased.

CK7

At CK7 downstream of Lake Bazzamundi the pH was circumneutral and complied with the ANZECC 95% aquatic ecosystem guideline on all occasions, with the exception of one sample that was slightly below the ANZECC 95% ecosystem protection guideline (pH 5.94). Salinity was relatively low, complying with 95% aquatic ecosystem guideline on all occasions. Metals (dissolved) were mostly below ANZECC 95% ecosystem protection guidelines and all metals were compliant with the stock watering guidelines at all times. Some metals (Cd, Cu, Ni and Zn) were occasionally relatively elevated but were well within stock watering guidelines.

The pH values at CK7 have decreased slightly (approximately 1 pH unit) since the end of 2010 while dissolved metals have remained relatively constant.

OWRD

Only one sample was taken during the reporting period.

To the east of the oxide waste rock dump, the pH value measured was outside the stock water guideline, being less than 4. Many dissolved metal concentrations (Al, Cd, Cu, Pb, Mn, Ni and Zn) were high and exceeded the 80% protection of aquatic ecosystems, with (Al, Cd, Mn and Ni) exceeding Stock Water Guidelines.

All dissolved metal concentrations at OWRD, except arsenic, have increased significantly since the end of 2010.

SWTG8

At SWTG8 east of the OTD the pH exceeded the 80% protection of aquatic ecosystems guidelines of pH 6 on all occasions but was within Stock Water Guidelines. EC was within 95% protection of aquatic ecosystems guidelines at all times. Dissolved concentrations of many metals (Al, Cd, Cu, Ni and Zn) were elevated, exceeding the 80% protection of aquatic ecosystems but were in compliance with the stock watering guideline.

In this reporting period indications are that there has been an improvement in the water quality at this monitoring point.

SWTG10

At SWTG10 to the north east of the Oxide Waste Rock Dump the pH was below 4 (outside the stock water guideline range) one occasion and lower than the 80% protection guideline of pH 6 on all the other occasion. Electrical conductivity levels exceeded aquatic ecosystem 80% protection guidelines when the pH was below 4 but complied with stock drinking watering guidelines. Many dissolved metals (Al, Cd, Cu, Mn, Ni, Pb and Zn) exceeded the 80% protection of aquatic ecosystems guidelines but were mostly compliant with the stock watering guidelines. The exceptions were aluminium and cadmium, which exceeded the stock watering guidelines in the low pH sample mentioned above.

Since the end of 2010 pH values have decreased significantly (from 5.4 to 3.17), while dissolved metals initially increased (in early 2011), but have generally decreased since.

SWTG11

SWTG11, at the entrance to the Wetlands Oxbow exhibited pH values below 4 (outside the stock water guideline range) on both occasions. Electrical conductivity levels exceeded aquatic ecosystem 80% protection guidelines on one occasion but complied with guideline for stock watering guidelines. Many dissolved metals (Al, Cd, Cu, Mn, Ni and Zn) exceeded the 80% protection of aquatic ecosystems guidelines and (Co, Pb) exceeded the 95% protection of aquatic ecosystems guidelines but were mostly compliant with the guidelines for stock water. The exceptions were aluminium and cadmium, which exceeded the stock water guidelines in the periods mentioned above where pH was very low.

Since the end of 2010 pH values have decreased significantly (from 7.8 to 3.6), while most dissolved metal concentrations increased in early 2011, but have since fallen.

SWTG12

SWTG12 at the Wetlands Oxbow discharge point exhibited pH values below 4 (outside the stock water guideline) on most occasions between January and April 2012. Electrical conductivity levels exceeded aquatic ecosystem 80% protection guidelines on most occasions but complied with guideline for stock drinking water on all occasions. Many dissolved metals (Al, Cd, Cu, Ni and Zn) exceeded the 80% protection of aquatic ecosystems guidelines, (Co, Pb, Mn) exceeded the 95% protection of aquatic ecosystems guidelines and all were compliant with the guidelines for stock water.

The pH values at SWTG12 have decreased by approximately 3 pH units since the end of 2010, and most dissolved metal concentrations have shown an increase.

OTD (SWTG TAILS 1)

Only one sample was taken during the period and as expected, the pH measured within the Old Tailings Dam pond was very low (less than 3) and exceeded the stock watering guidelines. Concentrations of aluminium, arsenic and cadmium were above the guideline for stock water. Levels of chromium, lead, copper, nickel and zinc exceeded ANZECC aquatic ecosystem 80% protection guideline on all occasions but complied with the guidelines for stock drinking water. Cobalt was above 95% protection guidelines.

The pH values have remained constant since the end of 2010 while most dissolved metal concentrations have decreased slightly.

NTD (SWTG TAILS 2)

As expected the pH measured at New Tailings Dam was low (less than 4) and outside the stock watering guidelines range. EC was outside the 80% protection guideline. Most metal concentrations (Al, Cd, Cu, Mn and Ni) were above the guideline for stock watering on for at least one of the samples. Levels of manganese and nickel exceeded ANZECC aquatic ecosystem 80% protection guideline but complied with the guidelines for stock drinking water. The sulphate levels complied with the 95% protection guideline on one occasion and were outside Stock Water Guideline on the other occasion.

The pH values have remained constant since the end of 2010 while dissolved metal concentrations have increased in the last reporting period.

EP1

As expected given the function of Evaporation Pond 1, the pH measured was low (less than 4) and outside the stock watering guidelines. EC was outside the 80% protection guideline. Concentrations of most metals (Al, Cd, Co, Cu, Mn, Ni and Zn) were above the guidelines for stock watering on all occasions. Levels of sulfate were high, exceeding the guideline for stock watering on all occasions.

The pH values have decreased slightly (4.3 to 3.3) since the end of 2010, while all dissolved metal concentrations have shown a significant increase.

EP2

Evaporation Pond 2 was of very similar water quality to that of EP1, the pH measured was low (less than 4) and outside the stock water guidelines. Concentrations of most metals (Al, Cd, Cu, Co, Mn, Ni and Zn) were significantly above the guideline for stock water. Chromium levels exceeded 80% aquatic ecosystem protection guidelines on most occasions but were all compliant with the stock drinking water guideline. Levels of sulphate exceeded the guideline for stock drinking water.

The pH values have decreased slightly (3.5 to 3.08) since the end of 2010, while dissolved metal concentrations showed a large increase in 2013. Dissolved metal concentrations are higher than at the end of 2010.

ODP

The pH at decant pond site was below 4 and shows a declining trend, the electrical conductivity level exceeded aquatic ecosystem 80% protection guidelines but complied with guideline for stock drinking water. Concentrations of many metals (Al, Cd, Cu, Ni and Zn) exceeded the ANZECC aquatic ecosystem 80% protection guideline consistently but generally complied with the guideline for stock drinking water on all occasions. The exception was cadmium which exceeded stock water guidelines.

The pH values have decreased significantly (6.4 to 3.6) since the end of 2010 while dissolved metal concentrations increased significantly to the end of 2011 and have then decreased.

SWTG9

There were no samples taken for this site during the reporting period.

TGMPIT

The pH in the pit was acidic (pH below 4) and electrical conductivity was high (but in compliance with stock watering guidelines). Concentrations of many metals (Al, Cd, Mn and Ni) were above the guidelines for stock watering and many more although compliant with stock watering guidelines (Cu, Pb and Zn) were above the ANZECC aquatic ecosystem 80% protection guideline. Levels of sulfate exceeded the guideline for stock watering.

The pH values have remained relatively constant since the end of 2010, while dissolved metal concentrations have decreased from the very large concentration recorded in November 2010.

Table 7.1 Summary of monitoring data recorded at SWTG1A

SWTG1A	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	5.69	33.2	42	0.5	0.05	0.5	0.5	0.5	280	0.5	10	0.5	13	0.5
Maximum	6.32	39.1	220	1	0.2	0.5	0.5	2	320	0.5	19	0.5	26	1
Median	6.17	34.7	180	0.5	0.05	0.5	0.5	1	300	0.5	14	0.5	21	0.5
Standard Deviation	0.32	2.9	89	0.5	0.1	0.0	0.0	1.0	20	0.0	4.5	0.0	6.5	0.5
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.2 Summary of monitoring data recorded at SWTG2

SWTG2	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	5.9	34.9	38	0.5	0.1	0.5	0.5	2	260	0.5	45	2	14	3
Maximum	6.48	60.6	400	0.5	0.4	3	0.5	3	350	0.5	110	5	37	9
Median	6.08	43.0	160	0.5	0.3	2.0	0.5	2	300	0.5	60	4.0	28	8
Standard Deviation	0.20	13.4	197.0	0.0	0.15	1.0	0.0	0.5	35.6	0.0	35	1.5	10.3	3.3
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.3 Summary of monitoring data recorded at SWTG3

SWTG3	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	6.22	31.2	36	0.5	0.05	0.5	0.5	1	260	0.5	26	2.0	33.0	2
Maximum	6.52	62.5	130	1.0	0.4	1	0.5	4	420	0.5	99	4.0	60.0	9
Median	6.28	57.7	88	1.0	0.1	0.5	0.5	3.0	280	0.5	55	3.0	35.0	7
Standard Deviation	0.11	10.6	45.3	0.0	0.1	0.0	0.0	1.0	93	0.0	30	1.0	9.0	2.3
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.4 Summary of monitoring data recorded at SWTG4

SWTG4	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Sample	3.3	31.6	11,000	23	21	210	0.5	460	1,400	15	3,500	560	2,600	280
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

*one sample taken, dry other monitoring periods

Table 7.5 Summary of monitoring data recorded at SWTG5

SWTG5	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.85	49.8	130	2	0.3	4	0.5	7	14	0.5	96	14	51	10
Maximum	6.06	253.7	1,700	4	4.9	64	0.5	34	330	0.5	1,100	150	590	100
Median	5.25	216.8	300	3	1.6	32	0.5	13	99	0.5	450	83	300	88
Standard Deviation	0.67	57.1	501	0.75	0.75	15.3	0.0	6.8	109	0.0	119.8	29.8	119.8	24.1
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.6 Summary of monitoring data recorded at SWTG6

SWTG6	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.57	61.2	140	1	0.6	6	0.5	7	130	0.5	140	16	82	12
Maximum	4.90	476	1,200	5	15	88	0.5	70	310	2	1,900	220	1,500	200
Median	3.66	300	730	3.0	6.7	54	0.5	34	200	1	1,100	120	680	120
Standard Deviation	0.31	92.3	298	1.6	3.6	20	0.0	16.8	60.2	0.6	412	50.8	441.6	37.6
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.7 Summary of monitoring data recorded at CK7

CK7	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	5.94	48.1	5	0.5	0.05	0.5	0.5	0.5	95	0.5	5	0.5	13	6
Maximum	7.00	196.7	100	1	0.6	13	0.5	4	250	0.5	270	32	120	66
Median	6.42	90.8	42	0.5	0.05	0.5	0.5	1	150	0.5	28	1.0	26	32
Standard Deviation	0.32	44.1	38.3	0.5	0.15	4.2	0.0	1	61.2	0.0	69.8	8.7	27.5	14
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.8 Summary of monitoring data recorded at OWRD

OWRD	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Sample	3.20	904	23,000	7	37	380	2	920	250	57	5,400	1,200	5,000	470
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.9 Monitoring data recorded at SWTG8

SWTG8	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	5.1	36.6	39	0.5	0.3	1	0.5	2	69	0.5	56	6	31	7
Maximum	5.52	96.1	650	1	1.0	8	0.5	5	290	0.5	200	23	77	12
Median	5.17	54.7	51	0.5	0.5	2	0.5	2	130	0.5	130	9	45	10
Standard Deviation	0.15	13.1	140	0.2	0.22	1.4	0.0	0.6	54.2	0.0	39.6	4.6	11.6	1.1
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.10 Summary of monitoring data recorded at SWTG10

SWTG10	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.17	236.3	1,300	5	5.5	52	0.5	56	250	2	970	170	940	87
Maximum	4.01	796	19,000	9	33	310	2	810	720	32	4,500	970	3,900	370
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.11 Summary of monitoring data recorded at SWTG11

SWTG11	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.4	55	3,000	4	16	150	0.5	160	850	5	2,600	440	1,700	220
Maximum	3.4	730	8,400	6	49	230	0.5	290	870	9	4,100	540	4,100	350
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.12 Summary of monitoring data recorded at SWTG12

SWTG12	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.46	55.2	130	2	0.9	8	0.5	9	92	0.5	190	23	100	14
Maximum	4.6	438	4,200	4	9.7	120	0.5	140	270	4	2,200	310	1,200	200
Median	3.52	395	3,000	3.0	6.0	96	0.5	70	170	3	1,800	240	890	150
Standard Deviation	0.29	105.5	1,067	0.75	2.5	31.5	0.0	42.7	67	1.2	522	84.2	352	56.5
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.13 Summary of monitoring data recorded at SWTGTAILS#1

SWTGTAILS#1	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Sample	2.5	1,417	31,000	2,200	110	50	52	880	79,000	21	430	190	1,500	560
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.14 Summary of monitoring data recorded at SWTGTAILS#2

SWTGTAILS#2	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	2.9	970	12,000	40	21	210	17	1,200	1,100	0.5	3,500	380	1,400	470
Maximum	3.23	2,360	46,000	88	67	650	67	3,400	4,400	0.5	11,000	1,100	5,500	1,500
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.15 Summary of monitoring data recorded at EP1

EP1	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.3	2,455	130,000	18	160	930	12	1,600	1,000	3	12,000	4,300	12,000	1,900
Maximum	3.37	4,380	470,000	24	380	2,200	30	3,300	4,400	5	37,000	29,000	37,000	5,100
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.16 Summary of monitoring data recorded at EP2

EP2	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.08	2,226	130,000	14	148	810	18	2,200	2,100	0.5	9,200	3,900	10,000	1,700
Maximum	3.2	10,450	1,140,000	48	880	5,000	150	16,000	22,000	2	66,000	28,000	57,000	15,000
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.17 Summary of monitoring data recorded at ODP

ODP	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Minimum	3.6	125.7	1,600	14	8.8	16	0.5	140	100	0.5	680	37	210	57
Maximum	4.4	446	4,400	35	22	31	1	250	840	5	1,200	73	460	130
Median	3.84	409.5	3,600	16	19	30	0.5	200	150	4	740	72	450	120
Standard Deviation	0.26	124.1	733	7	4.4	5	0.3	36.6	246	1.6	216.1	12	83	24.3
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

Table 7.18 Summary of monitoring data recorded at TGMPIT

TGMPIT	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	SO_4 (mg/L)
Sample	2.95	3,061	36,000	6	120	350	3	510	4,000	15	13,000	1,800	12,000	1,700
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000

7.3 Groundwater Monitoring

Groundwater quality monitoring data for the 2011-2012 authorisation period for the Tom's Gully Mine site are provided in Appendix D. The groundwater monitoring data presented are from April 2011 to April 2012, inclusive.

The maximum, minimum and mean average values were compared to the ANZECC (2000) water quality guidelines for stock drinking and agricultural irrigation water (long-term trigger values [LTV] and short-term trigger values [STV]). Data were also compared to the ANZECC (2000) guidelines for freshwater aquatic ecosystem 80% species protection. The guidelines are presented in Tables 6.6 and 6.7. Note that where datum exceeds a guideline value, its cell is shaded to correspond to the guideline value cell. Where two guidelines are exceeded, the value is shaded to correspond with the greater guideline value.

Ridge Bore

At the Ridge Bore to the south of the site, the pH was circumneutral and complied with all guidelines on all occasions. The electrical conductivity exceeded the 80% protection guideline on one occasion but was compliant with the stock water guidelines. All dissolved metal concentrations were under the 80% protection guideline except zinc, which complied with the stock water guideline. Major ions and total suspended solids were low throughout the monitoring period. Chloride levels all exceeded 95% ANZECC aquatic ecosystem guidelines but complied with the 80% guidelines.

Bore 11

The pH at this southern most bore on site south west of Ridge Bore was above ANZECC aquatic ecosystem guidelines on one occasion (8.03). Electrical conductivity complied with 95% aquatic protection guidelines. All dissolved metals were within 95% ANZECC aquatic ecosystem guidelines. Chloride levels exceeded 95% ANZECC aquatic ecosystem guidelines but complied with the 80% guidelines. Concentrations of total suspended solids and Sulfates were consistently low.

OB11

The pH at this site was circumneutral and complied with ANZECC aquatic ecosystem guidelines on all occasions. Electrical conductivity exceeded the guideline for 80% aquatic protection on all occasions but was in compliance with the stock water guideline. Dissolved metals (Cd, Cu, Mn, Ni and Zn) often exceeded the aquatic ecosystem 80% protection guideline on numerous occasions but were generally in compliance with the stock water guidelines. The exception was manganese, which exceeded the stock water guideline once. Cobalt exceeded 95% ANZECC aquatic ecosystem guidelines but complied with the 80% guidelines. Sulfate levels exceeded all guidelines on all occasions. Chloride levels all exceeded 95% ANZECC aquatic ecosystem guidelines and exceeded the 80% guidelines once. Levels of total suspended solids were all low.

G1

There was only one sample taken for the monitoring point G1 in the reporting period.

The pH at this site was circumneutral and complied with ANZECC aquatic ecosystem guidelines. Electrical conductivity exceeded the guideline for 80% aquatic protection but was in compliance with the stock water guideline. Dissolved metals concentrations were less than the aquatic ecosystem 95% protection guideline. Cadmium was the exception as it exceeded the 95% protection guidelines but was in compliance with the 80% protection guidelines. Sulfate levels just exceeded the stock water guidelines. Chloride level was in compliance with the 95% ANZECC aquatic ecosystem guidelines. Concentration of total suspended solids was low.

G2

There was only one sample taken for the monitoring point G2 in the reporting period.

The pH at this site was alkaline (pH 8.74) but complied with stock water guidelines. Electrical conductivity complied with 95% ANZECC aquatic ecosystem guidelines. Dissolved metals concentrations were less than the aquatic ecosystem 95% protection guideline on all occasions. Chloride and sulphate levels all complied with 95% ANZECC aquatic ecosystem guidelines. Concentration of total suspended solids was low.

G8

Water quality data indicates the effects of ARD at this site. On all occasions monitored the pH at this site was below 5 with one sample outside the pH range for the stock water guideline. Salinity (electrical conductivity (EC)) exceeded the guideline for 80% aquatic protection on all occasions but was in compliance with the stock water guideline. Lead concentrations exceeded the 95% aquatic protection guidelines, zinc levels also exceeding 80% protection guidelines on all occasions. Concentrations of some dissolved metals (Al, Cd, Co, Cu, Mn and Ni) were regularly well above the stock watering guidelines. Sulfate levels complied with 95% protection guidelines on all occasions. Chloride levels all exceeded 80% ANZECC aquatic ecosystem guidelines but complied with the stock water guidelines. Concentrations of total suspended solids were consistently low.

G9

The pH and salinity at this site complied with ANZECC stock water guidelines on all occasions, with some samples complying with the 95% ANZECC aquatic ecosystem guidelines. Dissolved metals (Cu, Pb, Ni and Zn) concentrations exceeded the 80% aquatic ecosystem protection guideline on numerous occasions but complied with stock water guidelines. Lead was the exception as it exceeded stock water guidelines on one occasion. Major ions and TSS were all either below detection limits or in compliance with ANZECC 80% protection guidelines. Chloride levels exceeded 95% ANZECC aquatic ecosystem guidelines on all occasions but complied with the 80% guidelines.

RN29694 (WB4)

There was only one sample taken for the monitoring point RN29694 (WB4) in the reporting period.

The pH at this site was alkaline (pH 8.91) but complied with stock water guidelines. Electrical conductivity complied with the 95% aquatic protection guideline. Dissolved metals concentrations and major ions are all less than the 95% protection guidelines, the exception being chloride, which is compliant with the 80% protection guideline. Concentrations of total suspended solids were low.

P100

There was only one sample taken for the monitoring point P100 in the reporting period.

The pH at this site was circumneutral and complied with all guidelines on all occasions. The electrical conductivity exceeded the 80% protection guideline occasions but concentrations were compliant with the stock water guideline. All dissolved metal concentrations were under the 95% aquatic ecosystem protection guideline except cadmium which complied with 80% aquatic ecosystem protection guideline and zinc which complied with the stock water guideline. Major ions and total suspended solids were low throughout the monitoring period, the exception being chloride, whose levels exceeded the 80% protection guideline.

Table 7.19 Summary of monitoring data recorded at Ridge Bore

Ridge Bore	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Minimum	6.1	87	14	<1	<0.1	<1	<1	<1	4,300	<1	700	2	31	3.6	1.2	<1	6	18
Maximum	6.8	104	24	<1	0.4	5	<1	2	9,200	<1	710	9	36	3.7	1.3	<1	6	28
Median	6.45	95	19	<1	0.2	2.5	<1	1.0	6,250	<1	705	5.5	33.5	3.65	1.25	<1	6	23
Standard Deviation	0.35	8.0	5.0	0.0	0.2	2.5	0.0	1.0	1,950	0.0	5	3.5	2.5	0.5	0.5	0.0	0.0	5.0
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.20 Summary of monitoring data recorded at Bore 11

Bore 11	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Minimum	7.3	238.1	<10	<1	<0.1	<1	<1	<1	32	<1	94	<1	1	9.3	9.9	<1	7	9
Maximum	8.03	241.4	27	<1	<0.1	<1	<1	<1	920	<1	210	2	7	11	11	<1	7	11
Median	7.66	239.7	18.5	<1	<0.1	<1	<1	<1	476	<1	152	1.5	4	10.15	10.4	<1	7	10
Standard Deviation	0.36	1.6	9.5	0.0	0.0	0.0	0.0	0.0	444	0.0	58	0.5	3	0.8	0.5	0.0	0.0	1.0
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.21 Summary of monitoring data recorded at OB11

OB11	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Minimum	6.1	4,300	16	1	4.3	41	<1	1	17	<1	3100	220	89	450	530	2,800	8	6
Maximum	6.69	4,754	29	2	5.4	130	<1	6	61	<1	11,000	600	210	480	570	3,800	14	19
Median	6.39	4,527	22.5	1.5	4.85	85.5	<1	3.5	39	<1	7050	410	149.5	465	550	3,300	11	12.5
Standard Deviation	0.3	227.0	6.5	0.5	0.55	44.5	0.0	2.5	18.0	0.0	4050.0	190.0	60.5	15.0	20.0	500.0	3.0	6.5
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.22 Summary of monitoring data recorded at G1

G1	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Sample	6.75	2,367	17	5	0.3	<1	<1	<1	630	<1	110	8	8	280	160	1,200	1.5	10
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

***only one sample taken**

Table 7.23 Summary of monitoring data recorded at G2

G2	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Sample	8.74	175.0	30	2	<0.1	<1	<1	<1	44	<1	37	<1	5	6.6	9.6	1	1.5	9
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

*only one sample taken

Table 7.24 Summary of monitoring data recorded at G8

G8	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Minimum	3.9	850	5,800	4	36	690	<1	1,500	89	4	12,000	1,300	3,300	45	49	330	4.7	8
Maximum	4.28	1,494	13,000	10	74	1100	<1	1,500	2,200	7	20,000	1,600	6,400	84	96	670	6.5	26
Median	4.09	1,172	9,400	7	55	895	<1	1,500	1145	5.5	16,000	1,350	4,850	64.5	72.5	500	5.6	17
Standard Deviation	0.19	322.0	3,600.0	3	19.0	205.0	0.0	0.0	1065	1.5	4,000	116.9	1,550	19.5	23.5	170	0.9	9
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.25 Summary of monitoring data recorded at G9

G9	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Minimum	5.06	90.7	12	1	0.2	10	<1	<1	18	<1	330	29	24	4.6	2.7	34	4	2.5
Maximum	7.1	889	48	7	2.2	13	<1	15	180	140	1,000	54	120	89	54	190	6	13
Median	6.06	489.8	30	4	1.2	11.5	<1	7.5	99	70	665	41.5	72	46.8	28.3	112	5	9
Standard Deviation	1.02	399.2	18.0	3.0	1.0	1.5	0.0	7.5	81	70.0	335.0	12.5	52	42.2	25.6	78.0	1.0	4.0
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.26 Summary of monitoring data recorded at RN29694

RN29694	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Sample	8.91	138.3	19	0.5	0.05	0.5	0.5	0.5	33	0.5	30	0.5	3	6.6	1.8	0.5	4	2.5
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

Table 7.27 Summary of monitoring data recorded at P100

P100	pH	EC (µS/cm)	Al (µg/L)	As (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Mn (µg/L)	Ni (µg/L)	Zn (µg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl^- (mg/L)	TSS (mg/L)
Sample	6.13	1,285	5	10	0.3	0.5	0.5	0.5	66	0.5	8	4	53	100	60	450	15	29
ANZECC 95%	6 to 8	250	55	13	0.2	30	1	1.4	ID	3.4	1,900	11	8	1,000	1,000	1,000	3	NA
ANZECC 80%	6 to 8	250	180	140	0.8	1,000	40	2.5	ID	9.4	3,600	17	31	1,000	1,000	1,000	13	NA
SWG	4 to 9	5,970	5,000	500	10	1,000	1,000	1,000	ID	100	10,000	1,000	20,000	1,000	1,000	1,000	NA	NA

8. STRATEGIC PLANNING

8.1 Brief History of the Water Management System (WMS)

The Tom's Gully water management system infrastructure was developed during the initial establishment of the mine and the framework set up under the associated waste discharge license. Since the end of 2010, the Toms Gully Mine site has been in care and maintenance and as such the water management system has changed to reflect this status as described in this WMP. In 2013-2014 Tom's Gully Project Area will move from Care and Maintenance into a refurbishment, commissioning and production phase. There will be a focus on removing water from the Tom's Gully pit, upgrading the Evaporation Ponds, the New Tailings Dam and the Process Water Pond. (There mining and processing infrastructure will also be refurbished).

8.2 Short-term Objectives and Priority Actions

The short-term objectives and priority actions for this WMP are:

- Undertake monitoring as outlined in this plan including water quality and levels.
- When required, pump water to contingency storage areas such as the evaporation ponds.
- Increase the height of the Evaporation Ponds to increase storage capacity
- Evaporation fans will be installed over the Evaporation ponds and the TG Pit to significantly increase the evaporation rate of the site
- Increase the storage capacity of the New Tailings Dam by installing a vertical raise
- Rockfill the existing erosion on the western side of the SWRD and divert drainage from re-entering this area to prevent further AMD and erosion towards Mount Bundey Creek.
- Inspect and maintain pumping infrastructure to ensure its readiness for the wet season. This includes preventative controlled burning and weed spraying to protect pipelines and infrastructure.
- Monitor overflow from the ODP to ensure compliance at SWTG3 and install a pump (or siphon) and relevant infrastructure to move excess water to the open cut pit via OTD or EP2 as a mitigation measure.

PG is committed to implementing surface water monitoring measures to ensure that:

- Surface water storage inventories are updated on a regular basis (including wetland inventories).
- That site management personnel are able to respond quickly to any issues associated with water levels (e.g., impending storage overtopping) and water quality issues. Barry Coulter and his team will be available to do this.

PG will commission a surface water and hydrogeological study during the dry season of 2014 to gain a better understanding of future management options for the site. The scope of this study will cover the following:

- Surface drainage of the SWRD to determine whether rock fill and bunding is a suitable management option to remediate eroded areas of the SWRD and improve quality of surface flows.

- Determining groundwater in-flow rates to the open pit.
- Investigating groundwater quality data trends and develop practical mitigation measures to ensure no deterioration of groundwater quality.
- Assessing whether new monitoring bores are needed and where they should be located (including potential re-commissioning existing bores).
- Identifying potential risk areas for impact on groundwater quality and areas where groundwater management can be improved.

8.3 Commitments and Proposed Works

The objective of the water management system is to manage surface and groundwater resources, to improve the quality of water both onsite and that being discharged to the environment.

Objectives, priority actions and initiatives for the 2013-2014 period are detailed in Table 8.1.

Table 8.1 Summary of commitments for the 2013-2014 WMP

No	Commitment	Timeframe
1	Contain poor quality water on site with the potential to impact on SWTG3 stock watering guideline values with no active discharge to Mount Bundey Creek. To achieve this PG will ensure water from the ODP is monitored and should there be potential to impact on SWTG3, be pumped to the open cut pit; and surface water runoff from the western side of the SWRD is improved through reduced contact with acid generating material exposed through erosion gullies in the WRD before it leaves the site.	Ongoing
2	Monitor groundwater and surface water in line with the proposed plan outlined in Section 6.2.	Ongoing
3	Regularly monitor water levels in the water management infrastructure and transfer to contingency storages as required. Monitoring will be weekly during the dry season and daily during the wet season.	Ongoing
4	Inspect and maintain pumping infrastructure to ensure it is functioning in readiness for the wet season. Inspections are to be performed routinely during the wet season and any maintenance completed and pumps in place prior to the wet season (by November). Pumps that are hired, will be done so prior to the wet season to ensure units are of satisfactory capacity and in good working order.	Prior to the wet season
5	Maintain surface water storage inventories and ensure personnel are available to respond quickly to any issues related to potential overflowing or water quality impacts. The Tom's Gully Mine site caretaker will carry out daily checks of all water holding facilities during the wet season. When significant rainfall events are forecast, the pumps are to be turned on to increase water storage capacity and reduce the risk of overflow.	Ongoing
6	Undertake investigative and/or remediation action if 80% protection (action) guideline is exceeded at Arnhem bridge (SWTG2) (for parameters that have not historically been exceeded at these sites). Report to authorities if stock water guidelines (upper limit) are exceeded at these locations (for parameters that have not historically been exceeded at these sites).	Ongoing
7	Conduct daily checks of the integrity of pipes, pumps and water storage infrastructure (during the wet season or when pumping is occurring). Check sheets that list the checks and status of all pipes, pumps and water storage infrastructure are to be completed each day.	Daily during wet season
8	If pipe leakage is detected, immediately repair the pipe and investigate the	During wet season

	cause and implement measures to stop it happening again.	and pumping
9	If a groundwater incident is detected during monitoring, PG will increase the frequency of monitoring, notify DOR and assess (in conjunction with a hydrogeologist and geochemist) the management options for the poor quality water. If a groundwater incident is detected off site (or data trends indicate this could occur), PG will undertake appropriate management measures in consultation with DOR and NRETAS to remediate the affected groundwater. Where parameters exceed upper limit trigger values (ANZECC stock water guidelines), where previously they were not exceeded, this will trigger an investigation into the cause of the exceedances.	If unacceptable groundwater contamination is detected.
10	Undertaken investigations during the 2014 dry season, which will allow a greater understanding of the risks associated with managing surface water in the mine site. These investigations will assess: • Groundwater infiltration and seepage. • Stage storage and the stage area relationship for storage.	During the 2014 dry season
11	Biological monitoring will be undertaken near the end of the 2013/2014 wet season.	During the 2013/2014 wet season
12	Immediately notify DoR if there is the potential for offsite release and notify DoR and NRETAS if an incident is detected off site. Notification to DoR and NRETAS will occur within 24 hours and reporting of the incident will be within 48 hours.	If an incident occurs
13	Immediately report any critical incidents or serious accidents to DoR in accordance with Section 29 of the Mining Management Act procedure for Notification of a Serious Accident or Critical Incident (DoR, 2011).	If an incident occurs
14	Report any environmental incidents in line with the internal PG System. The source of the incident will be investigated and isolated and contained (if possible and safe to do so). All internal reporting must be completed with 12 hours of the incident occurring. It is the responsibility of the supervisor to also contact the PG Environmental Manager and Director immediately if there is any discharge greater than 20 L into a waterway.	If an incident occurs
15	Monitor water quality of runoff from the SWRD towards Mount Bundey Creek during times of rainfall runoff.	During times of runoff from SWRD
16	PG will investigate decommissioned and damaged historical bores (G6 – south of Old Tailings Dam; Bore 6 – north of Oxide Waste Rock Dump). PG will assess the integrity of these bores and Bore 7 and their potential for inclusion in the monitoring program before commissioning new bores.	2014dry season

9. CHANGES SINCE THE LAST WMP

Table 9.1 details those commitments made in the previous WMP that have either been completed, are incomplete, or are no longer planned for continuation.

Table 9.1 Water storage and infrastructure

Commitment	Current Status	Comments and Plan
Rehabilitate both the OTD and the NTD once suitable oxide cover material is sourced, with OTD to be rehabilitated as a priority. CGAO will commission investigations (including test drilling) in the 2012 dry season to determine the suitability of using material from the oxide waste rock dump or from a small hill east of OTD. Investigations will occur in the 2012 dry season with rehabilitation likely to occur in the 2012/1013 dry season.	Incomplete.	The material in OTD is to be sampled with an aim to retreat the rest of this material. The NTD will be increased in capacity to be used during operation. Neither dam are to be rehabilitated at this stage.
Commission a hydrogeological study before the next wet season to assess whether new monitoring bores are needed and where they should be located. This investigation will also identify high-risk areas for contamination of groundwater and areas where groundwater management can be improved.	Incomplete.	Due to the sale of TGPA this was not achieved. The bores will be reviewed as part of the site refurbishment and a hydrogeological study undertaken as part of the new site water balance to determine pit and underground mine inflows.
If a groundwater incident (see Section 6.3.2 for definition of incident types) is detected during monitoring, increase the frequency of monitoring and notify DoR and NRETAS and assess the option of extracting the contaminated water. If groundwater incident is detected off site (or data trends indicate this could occur), install interception bores (in consultation with DoR and NRETAS) to extract some of the contaminated	No incidents.	Not to date. No new groundwater incidents have been detected.

Commitment	Current Status	Comments and Plan
groundwater and discharge to storage facilities.		
Undertaken investigations during and after the wet season in 2012, which will allow a greater understanding of the risks associated with managing surface water in the mine site. These investigations will assess: • Groundwater infiltration and seepage. • Stage storage and the stage area relationship for storage.	Partially complete.	Some investigations complete – overflow of ODP into mixing area, did not improve water quality to acceptable levels, will be directed to the pit in the future. SWRD AMD runoff investigations ongoing.
Immediately notify DoR if there is the potential for offsite release and notify DoR and NRETAS if an incident is detected off site. Notification to DoR and NRETAS will occur within 24 hours and reporting of the incident will be within 48 hours.	Ongoing	No offsite releases exceeding stock watering guidelines occurred at the downstream site SWTG3.
Immediately report any critical incidents or serious accidents to DoR in accordance with Section 29 of the Mining Management Act procedure for Notification of a Serious Accident or Critical Incident (DoR, 2011).	No incidents.	No – No critical incidents or serious accidents have occurred.
Report any environmental incidents in line with the internal PG system'. The source of the incident will be investigated and isolated and contained (if possible and safe to do so). All internal reporting must be completed with 12 hours of the incident occurring. It is the responsibility of the supervisor to also contact the PG Environmental Manager and Director immediately if there is any discharge greater than 20 L into a waterway.	Ongoing	Ongoing
Biological monitoring will be undertaken near the end of the 2012/2013 wet season.	Not undertaken.	This was not done due to the sale process. This will be undertaken near the end of the 2013-2014 wet season and the results will be incorporated into the next WMP.
CGAO will investigate decommissioned and damaged historical bores (G6 – south of Old Tailings Dam; Bore 6 – north of Oxide Waste Rock Dump). CGAO will assess the integrity of these bores and Bore 7 and their potential for inclusion in the monitoring program before commissioning new bores.	Not sure if this was undertaken.	This will be completed by PG as part of the mine refurbishment in 2013-2014.

10. REFERENCES

BoM. 2012. Climate Statistics for Middle Point (site 014090). Bureau of Meteorology, Canberra. A WWW publication accessible at http://www.bom.gov.au/climate/averages/tables/cw_014090.shtml

ANZECC/ARMCANZ. 2000. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy- Paper No 4. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

DoR. 2011. Notification of a Serious Accident or Critical Incident (Environmental) – Section 29 of the Mining Management Act. Department of Resources, Northern Territory. A WWW publication accessible at http://www.nt.gov.au/d/Minerals_Energy/index.cfm?header=Mining%20Documentation

Coffey Environment 2014. Revised Water Balance Model - Toms Gully mine site