Appendix 4 Water Management Plan Framework (GHD, October 2017)

GHD

Arafura Resources Limited

Nolans Project

Water Management Plan Framework

October 2017

Document Status

Version	Author	Reviewer	Approved by	Date	Status

Amendments

Section	Details

Audit Summary

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Table of contents

Table index

Figure index

Appendices

Abbreviations

Term	Description
ACM	Acid Consuming Material
ADWQ	Australian Drinking Water Guidelines
AHD	Australia Height Datum
AMD	Acid and Metalliferous Drainage
AMDMP	Acid and Metalliferous Drainage Management Plan
ANC	Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Annual Recurrence Interval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedure
AST	Above Ground Storage Tanks
BaP	Benzo[a]pyrene
BFD	Blind Field Duplicate
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CSM	Conceptual Site Model
DLRM	Department of Land and Resource Management
DME	NT Department of Mines and Energy
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP	Evaporation Pond
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FTSF	Flotation Tailings Storage Facility
GDE	Groundwater Dependent Ecosystem
GL	Gigalitre
HDPE	High Density Polyethylene
H_2SO_4	Sulphuric Acid
JORC	Joint Ore Reserves Committee
kg	Kilogram
L	Litre
LOM	Life of Mine
µg	Microgram
µS	Microsiemens
mg	Milligram
M&I	Measured and Indicated
ML	Mining Lease
ML	Megalitre
MMP	Mining Management Plan
MPA	Maximum Potential Acidity
NAF	Non-acid Forming
NAG	Net Acid Generation
NMD	Neutral Mine Drainage
NTEPA	Northern Territory Environmental Protection Agency
PAF	Potentially Acid Forming
PAH	Polycyclic Aromatic hydrocarbons
PMF	Probable Maximum Flood
PPL	Perpetual Pastoral Lease
RE	Rare Earths
REE	Rare Earth Elements
ROM	Run of Mine
RSF	Residue Storage Facility

Term	Description
S	Sulfur
SD	Saline Drainage
SOCS	Site of Conservation Significance
SSTV	Site Specific Trigger Value
SSGTV	Site Specific Groundwater Trigger Values
STP	Sewage Treatment Plant
ToR	Terms of Reference
TRH	Total Recoverable Hydrocarbon
WDL	Waste Discharge Licence
WMP	Water Management Plan
WRD	Waste Rock Dump
WSD	Water Storage Dam

1. Introduction

1.1 Purpose

The purpose of this Water Management Plan (WMP) is to provide a framework for the management of surface and groundwater resources within the vicinity of the Nolans Rare Earths Project (Project) which includes the mine site, processing site, borefield and accommodation village. The Project phases include construction, mining, processing, rehabilitation and decommissioning. Currently the mine design is in the preliminary design stage with limited staging information available for the expansions throughout the Life of Mine (LOM) (55 years).

This WMP has been developed to:

- Establish a systematic and planned series of monitoring events;
- Determine baseline conditions and operational impacts upon the surrounding environment; and
- Implement and assess rehabilitation goals.

This WMP forms part of the Environmental Management Plan (EMP) requirements of the NT EPA Terms of Reference (ToR) issued in May 2015 (NT EPA, 2015). The WMP is in draft and will be reviewed and updated post detailed design and prior to Project construction.

The final EMP will be appended to the Mine Management Plan (MMP) for submission to the Department of Primary Industry and Resources.

1.2 Objectives

The WMP objectives include:

- Establish surface water, stormwater, processing water (onsite water storage), groundwater and sediment sampling regimes and procedures; and
- Provide requirements for establishing groundwater site specific trigger values for the mine site and processing site.

1.3 Associated Documentation

Several sub-management plans, procedures and technical studies relate to the WMP as follows:

- Management Documentation:
  - Surface Water Sampling Procedure (Appendix A)

    Field guide to sampling surface water bodies across the Project including procedures for sampling seepages and emergency overflow.
  - Sediment Sampling Procedure (Appendix B)

    Field guide to sampling sediment across the Project.
  - Groundwater Sampling Procedure (Appendix C)

    Field guide to purging and sampling groundwater across the Project
  - Erosion and Sediment Control Plan (Appendix D)

    A draft Erosion and Sediment Control Plan (ESCP) has been developed for the Project. The ESCP includes details of permanent and temporary erosion and sediment control methods and treatments to be implemented and is consistent with the International Erosion Control Association's Best Practice publication. The ESCP will be updated following detailed design of the Project.

- Emergency Response Management Plan (ERMP) (Environmental Management Plan, Appendix E)

  The ERMP summarises processes for managing environmental investigations across the project including the development of Sampling, Analysis and Quality Plan, Site Investigation and Incident Assessment Report requirements. A draft ERMP is included in Appendix F of Appendix X (EMP) of the EIS. The ERMP will be adapted following detailed design.

- Technical Studies
  - Hydrogeological Assessment (EIS Appendix K)
  - Surface Water Technical Report (EIS Appendix I)
  - Acid and Metalliferous Drainage (AMD) Assessment and Management Plan (EIS Appendix L) and
  - Kerosene Creek Diversion Management Plan.

1.4 EIS ToR Requirements

The WMP has been developed in accordance with the Northern Territory Environmental Protection Authority (NT EPA) ToR for the Project. A summary to address ToR requirements and the provision of relevant sections of the WMP or other management documentation is provided in Table 1-1.

The WMP has been updated since the submission of the EIS to address changes to the project (i.e. LOM, layout, water demand) and stakeholder responses requesting additional detail as part of the supplementary reporting process.

The WMP has undergone a process of technical peer review by appropriately qualified specialists. This WMP has been drafted by GHD as a party independent of Arafura Resources.

Table 1-1 Summary of ToR Requirements

ToR Requirement		WMP Management Summary
The WMP should include but not be limited to measures that avoid or minimise:	Project contamination of surface or groundwater resources.	The potential for contamination of surface water and groundwater has been established within a preliminary assessment of potential source-pathway-receptor. The potential source-pathway-receptor table is provided in Section 5.
	Impacts to water dependent ecosystems.	The riparian vegetation immediately adjacent to the mine area (upstream to the point of the diversion and downstream in Kerosene Camp Creek to about the confluence of Nolans Creek) is highly likely to be catastrophically impacted by the mining operations (i.e. riparian vegetation will die and not recolonise the area). Modelled drawdown from the Borefield may peak in the order of 1.0 m in the vicinity of Day Creek during extraction. The drawdown rebounds rapidly once extraction ceases. The current depth to groundwater is generally 20 m and it is considered likely that existing vegetation would be capable of extending root systems during the extraction period. Napperby Creek is approximately 18 km further west than Day Creek is from the Borefield and as such drawdown is significantly reduced. Drawdown peaks at 0.1 m at the end of mining and recovers to less than 0.1 m one hundred years post closure. The predicted drawdowns are negligible in the Lake Lewis area and are not likely to be measureable. However, the peak decreases in groundwater availability for evapotranspiration in the Lake Lewis area of the Southern Basins is 3% or 712 m^3/day (8 L/s) and this rebounds to approach steady state

ToR Requirement		WMP Management Summary
		with a decrease of approximately 0.5% or 103 m^3/day (1 L/s).
	Impacts to existing users of bores and/or surface waterways.	The initial impacts on the groundwater system will be localised drawdown at the mine site (from dewatering) and Borefield (from production bore extractions). Laramba and Napperby groundwater supply (drinking water) situated on the western side of Day Creek north of the Reaphook Range is expected to experience a peak modelled drawdown of about 1.5 m at the end of mining and decrease to 0.1 m one thousand years post closure.
	Exposure of sensitive biological receptors to contaminants or water of a poor quality that may be harmful. Release of contaminated Project waters or hazardous materials to the environment, including post-closure.	The Project is being established as a nil discharge site. Contingency measures in place will include: • ROM Pad and long term stockpile pad constructed with impermeable bases with drainage to stormwater retention ponds; • Tailings Storage Facility (TSF) constructed with low permeability soil liner and seepage collection system; • Residue Storage Facility (RSF) constructed with HDPE/low permeability soil liner system, combined with basin drainage and a leakage collection and recovery system; • Evaporation Ponds (EPs) constructed with HDPE liner; • Fuel stored in self-bunded Above Ground Storage Tanks (ASTs); and • Chemical Storage Shed with internal bunding. Failure of primary containment controls within designated water containment structure basins and/or Processing infrastructure will be pumped into the pit to reduce the risk of uncontrolled discharge. The Project will be rehabilitated and the working strategy for the TSF, RSF and EPs includes revegetation, top flow diversion banks to a rock lined chute with energy dissipater and recessed rock pad (outlet structure) at the toe of the structures. The groundwater model indicates the pit is likely to become a long term groundwater sink (evaporation losses exceed inputs from runoff, precipitation and groundwater inflows). As a result, the pit water is expected to show continual increases in acidity, metals and salt concentrations over time through accumulation of solutes introduced via groundwater inflows, run-off and precipitation. However, the pit lake is not considered a contaminant risk to the local or regional aquifers as it will remain a terminal sink.
Measures to treat and manage domestic wastewater and sewage.		Wastewater (non-Processing water) from the accommodation village, processing site and mine site will be pumped to a sewage treatment plant (STP) adjacent to the processing site or at the mine site. Treated effluent will be discharged to the evaporation ponds and sludge will be disposed offsite at an appropriately licenced facility.
Measures to ensure treatment / neutralisation of hazardous materials to identified safe levels, before any controlled environmental release is considered.		The Project has been established as a nil discharge site. Contingency measures will include the installation of leak detection systems at the TSF, RSF and EPs. Failure of primary containment controls within designated water containment structure basins and/or Processing infrastructure will be pumped into the pit to reduce the risk of uncontrolled discharge.
Outline details of monitoring programs to be implemented throughout the life of the Project to determine effectiveness		Monitoring will comprise surface water (when available), sediment and groundwater. The monitoring

ToR Requirement		WMP Management Summary
of the mitigation measures (Section 5.3.3), and to monitor for impacts to water resources from the Project.		program has been designed in accordance with the Multiple Before-After Control-Impact (MBACI) methodology. A baseline will be established throughout the construction phase (24 months) for all elements of the monitoring program. It is intended to use the baseline to develop site specific trigger values for groundwater and provide reference points for surface water and sediment. Monitoring programs are detailed in Section 6.
Proposed monitoring should be described for leaks, spills or seepage of materials from pipelines, storage / disposal facilities (including tailings disposal facilities) and transport operations to identify impacts, should they occur, to local soils, aquifers, environments, workers and/or the general public.		Leaks and seepage of hazardous substances will be managed in accordance with the Hazardous Substances Management Plan. Spills or sabotage will be managed in accordance with the Emergency Reponses Management Plan (ERMP). These management plans are provided within the Environmental Management Plan (EMP).
The monitoring programs should include relevant water quality target values based on appropriate guidelines and/or standards. The monitoring program should outline reporting procedures and contingencies that will be implemented in the event monitoring activities identify performance indicators have been triggered, or other water related hazard or emergency.	Methods to monitor the impacts of the Project on surface and groundwater quality and quantity during mine operations and beyond mine closure.	Monitoring locations have been established outside of the of the LOM footprint for surface water, sediment and groundwater across the Project. These locations will be utilised to establish a baseline, assess impacts during operation and confirm successful rehabilitation of the Project. The locations include control sites (upstream / up gradient), adjacent site (point of discharge) and impact sites (downstream / downgradient).
	Provisions to notify and respond to environmental and human health risks associated with water quality, or other water related emergency.	Statutory notification procedures for hazardous substances spills/leaks and/or environmental incidents are provided within the Hazardous Substances Management Plan and ERMP within the EMP. An environmental investigation procedure has been established for the response to incidents with the potential to cause environmental impacts. The procedure includes development of a Sampling, Analysis and Quality Plan (SAQP), Site Investigation and Incident Assessment Report (IAR) and is detailed within the ERMP. Procedures for responses to structural failures, hazardous substances spills and vehicle incidents are provided within the ERMP.
	Contingency plans to be implemented should monitoring identify an unacceptable impact.	Trigger values have been determined for sediment and groundwater across the Project including ANZECC Interim Sediment Quality Guideline (ISQG) for sediment and Stockwater, Drinking Water and Irrigation for groundwater. However, it is noted that groundwater sampling to date includes local values already exceeding several trigger values and therefore site specific trigger values will be established for groundwater prior to Project operation commencing. During operation, analytical results will be compared to trigger values. If the trigger values have been exceeded across three consecutive occasions (in accordance with Sections 6.2.4, 6.3.3 and 6.4.1) additional investigations will be undertaken to determine the root cause and assess additional management measures.
Erosion and Sediment Control Plan (ESCP) including permanent and temporary measures.		An ESCP has been established for the Project and is provided in Appendix D. The Plan covers construction (initial clearing), operation and closure scenarios.

1.5 Guidelines

The WMP has been developed with reference to the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines including the National Water Quality Management Strategy Documents as follows:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a);
- Australian Guidelines for Water Quality Monitoring & Reporting (ANZECC/ARMCANZ, 2000b);
- Australian Drinking Water Guidelines (NHMRC/ARMCANZ) (2004); and
- Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ, 2013).

2. Overview

2.1 Location

The Project is situated approximately 135 km northwest of Alice Springs and 13 km west of Aileron in the Northern Territory.

2.2 Operator Details

The Nolans Rare Earths Project is 100% owned by Arafura, an Australian stock exchange listed company. The Project will be the company's first operational mine. A summary of the operator details are provided in Table 2-1.

Table 2-1 Operator Details

Company	Arafura Resources Limited
Contact	Brian Fowler NT General Manager and Sustainability
Street address	18 Menmuir Street, Winnellie, NT 0820
Postal address	PO Box 37220, Winnellie, NT 0820
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ABN	22 080 933 455
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2.3 Development Schedule

Arafura plans to mine, concentrate and chemically process Rare Earth (RE) bearing ore at the Nolans site and transport an intermediate product to an offshore refinery (separation plant) for final processing. The construction phase for the Project is expected to take 2 years followed by a 55 year mine production period. A summary of the Project development is provided in Table 2-2.

Table 2-2 Project Development Summary

Description	Unit	LOM Case
Construction	Years	2
Mine Pit Stages	Number	11
Waste Rock Dumps	Number	5
Flotation Tailings Storage Facility	Number	1 (2 cells)
Residue Storage Facility	Number	1 (4-6 cells)
Evaporation Pond	Number	1 (6 cells)
Total Mine Life	Years	57
Effective Mine Production Period	Years	55
Rehabilitation and Closure	Years	-

Note: LOM case refers to the Project's total inventory of Mineral Resources, represented by Measured, Indicated and Inferred classifications in accordance with the 2012 JORC code.

2.4 Background

2.4.1 Project and Surrounding Land Use

The Project is situated on the Aileron Perpetual Pastoral Lease (PPL 1097) held by Aileron Pastoral Holdings Pty Ltd. Napperby Perpetual Pastoral Lease is situated to the west of this lease (west of the borefield). The leases have been used for grazing cattle and extraction of stockwater since the late 1800's.

2.4.2 Communities

Aileron Roadhouse is the closest community to the Project situated approximately 12 km to the east of the mine site. Laramba is the closest community to the borefield situated approximately 30 km from the western end of the borefield to the northwest. Additional small communities or outstations adjacent to the Project include:

- Aileron station – 4,078 km^2 cattle station within which the entire footprint of the Project is contained;
- Alyuen (Aileron) – a family outstation 130 km north of Alice Springs and 3 km south of the Aileron roadhouse (population approximately 20 people);
- Alkuptija (Gillians Bore) – a family outstation 3 km east of Stuart Highway and 75 km southeast of the Project (population approximately 20 people);
- Burt Creek (Rice's Camp) – a family outstation close to Stuart Highway and 85 km southeast of the Project (population approximately 15 people);
- Injulkama (Amburla) – a family outstation 56 km south of the Project and 100 km to the northwest of Alice Springs (population approximately 10 people);
- Laramba – key community due to its relative proximity to the borefield. Access to the community is by the Napperby Station Road, which runs west from the Stuart Highway. The community is located 83 km from the turnoff. Laramba is a large community of mostly Aboriginal people (population approximately 300 people);
- Napperby Station – cattle station with homestead located 50 km to the west of the mine site which has been owned and operated by the Chisholm family since 1948;
- Pine Hill (Anyumgyumba) – a family outstation located 35 km west of the Stuart Highway and approximately 27 km north west of the Project (population varies from 0-20 people);
- Pmara Jutunta (Six Mile) – a major community of approximately 200 people 45 km to the northeast of the Project and close to the Stuart Highway and Ti Tree community; and
- Ti Tree – a community located 170 km north of Alice Springs along the Stuart Highway (population approximately 280 people).

2.4.3 Topography

The mine site lies at the head of Kerosene Camp Creek valley on the north facing slopes of an east – west trending ridge of the Reynolds Range. The processing site is situated on the southern slopes of the same ridge. Topographic elevation is 886 m above sea level (m ASL) at Mt Boothby to the east of the mine site, and 1006 m ASL at Mt Freeling to the west. Most of the Kerosene Camp Creek valley floor at the mine site is typically between 650 and 700 m ASL, and longitudinal gradients along local creeks to the north and south of the ridge line are typically less than 0.5 percent, with steeper gradients of about 10 percent on isolated hills.

The accommodation village and borefield are relatively flat locations with poorly defined natural waterways and/or drainages.

2.4.4 Vegetation

A total of 14 vegetation communities were identified across the Project. These vegetation communities each display a degree of variation which is to be expected given the influence of differing geology, soils, hydrology, fire regimes and grazing pressures.

The dominant vegetation types at the Project are Mulga shrublands, which occur on alluvial fans and plains containing clayey red earths and Triodia hummock grasslands which grow on sandy plains.

In more fertile riparian areas and associated floodplains there is evidence of impacts associated with cattle grazing including weed invasion, reduction in ground cover species richness and soil erosion. In particular there is a high abundance of the introduced Buffel Grass (*Cenchrus ciliaris*).

2.4.5 Acid, Metalliferous and Saline Drainage Potential

A total of 200 stage one and 25 stage two Acid Metalliferous Drainage tests were undertaken. The results of static Net Acid Generation (NAG) tests indicate the majority of material is non-reactive and Non-Acid-Forming (NAF). One recorded sample was recorded as Potential Acid Forming (PAF) with a relatively low Maximum Potential Acidity (MPA) and low Acid Neutralising Capacity (ANC). Final kinetic NAG pH showed that single addition NAG pH is suitable for identifying PAF and reaction times are relatively slow. The tests ultimately indicated there was a very low risk of acid generation either during short-term storage of ore or long-term storage of waste rock.

The abundance of NAF and Acid Consuming Material (ACM) provides a conservative cut-off value of 0.3% Sulfur (S) or 10 kg/t Sulfuric Acid (H_2SO_4) for PAF material. Confirmatory field NAG testing will be carried out on samples with a sulfur content of greater than 0.15% S, unless pre-production testing provides sufficient information for a revised cut-off.

The 25 leachate tests indicate the majority of the waste rock was non-sulfidic and relatively benign, with small amounts of material with slightly elevated sulfur. Although neutralised by the excess ANC the material may, however, contain metals such as zinc that form soluble carbonates when their sulfide forms are oxidised and neutralised with carbonate minerals. Leachate salinity was low and fluoride was elevated in one sample, hence the risk of generation of saline or fluoride-rich leachate is low.

One sample of pegmatite produced Australian Standard Leaching Procedure (ASLP) leachate with a lead concentration 1,054 times greater than the average groundwater concentrations (due to the low concentration in groundwater). The critical leachate constituents appear to be aluminium and zinc which were consistently elevated against ambient groundwater concentrations.

Leachate from WRDs is considered unlikely to pose significant risks to the existing groundwater and/or ephemeral surface water systems at the Project.

Based on the geochemistry of the waste rock and ore, the risk of acid, metalliferous or saline drainage is low and the material can generally be managed as NAF waste. The Acid and Metalliferous Drainage Management Plan (AMDMP) will be implemented and provide contingency for management of the nominally <0.05 % PAF material.

The AMDMP is provided in Appendix B of the EMP.

2.4.6 Climate

Rainfall and Evaporation

The mean annual rainfall is approximately 316.7 mm, with a seasonal pattern of more summer rainfall than winter rainfall. Average monthly rainfall totals range from 4.7 mm in August to 65.8 mm in February. Average three-monthly rainfall totals range from 18.3 mm in June/July/August to 178.7 mm in December/January/February. However, any month can receive relatively large rainfall totals, or little or no rain at all.

Evaporation is greatest during months of higher mean rainfall with the highest average evaporation occurring in December and January at 375 mm. Rates of evaporation are significantly lower from May to August coinciding with lower mean rainfall and temperatures. The annual average evaporation is 3,000 mm, approximately 847% greater than the annual average rainfall of 316.7 mm.

The rainfall and evaporation rates are provided in Table 2-4.

Rainfall Statistics

Rainfall at the site is generally characterised by infrequent and intense rainfall events, single events can deliver > 50 mm within 24 hours. The Bureau of Meteorology Intensity–Frequency–Duration (IFD) indicates 305 mm for a 1 in 100 year, 72 hour rainfall event. A summary of the IFDs are provided in Table 2-3.

The Probable Maximum Precipitation (PMP) is the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area (World Meteorological Organization, 1986). The PMP 72 hour storm depth is 1,100 mm at the Project.

Table 2-3 IFD Rainfall Depth (mm) (Source: BOM IFD AR&R87 Tool)

Duration	Return Period (Years)						
	1	2	5	10	20	50	100
5	5	6	9	10	12	15	17
6	5	7	10	12	14	17	19
10	7	10	14	16	19	24	27
20	11	15	21	25	30	37	43
30	14	19	27	32	38	47	54
1	19	25	37	44	53	66	76
2	24	32	47	57	69	86	100
3	26	35	53	64	79	99	115
6	31	42	64	79	97	123	145
12	36	50	78	97	120	155	182
24	45	62	97	121	151	194	229
48	56	77	120	148	185	238	281
72	60	83	129	161	200	257	305

Temperature and Humidity

The Project area experiences hot and arid conditions. The hottest months are November to March, with monthly mean daily maximum temperatures above 35 ºC, and monthly mean daily minimum temperatures not dropping below 18 ºC. The coolest months are May to August, with monthly mean daily maximum temperatures remaining at or below 25.5 ºC, and monthly mean daily minimum temperatures not rising above 9.5 ºC.

The average humidity at the Project is 40% at 09:00 and 25% at 15:00, this is consistent across the year with monthly afternoon humidity readings being 15% lower than the morning. The highest levels of humidity are experienced in June at 53%. This coincides with lower temperatures occurring.

The temperature and humidity rates are provided in Table 2-4.

Wind

The winds at the Project are predominant south easterly wind direction throughout the year. The average wind speeds range from 2.50 to 3.17 m/s (9.0 to 11.4 km/h) with an annual average of 2.86 m/s (10.3 km/h).

The wind roses are provided in Figure 2-1 and speeds are summarised in Table 2-4.

Table 2-4 Summary of Climate Statistics (BoM 2015; Territory Grape Farm NT 1987-2014)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)												
Highest	280.4	**342.2**	109.2	151.7	136.3	53.8	34.2	39.4	96.6	56.8	119.2	119.2
95th percentile	159.0	**244.2**	96.9	89.9	100.1	48.7	21.3	26.9	41.7	51.3	81.4	109.9
Mean	62.4	**65.8**	21.9	18.0	23.3	8.7	4.9	4.7	10.3	15.3	30.9	50.5
5th percentile	3.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	**8.9**
Lowest	**2.2**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Evaporation (mm)												
Total	**375**	300	290	210	150	125	145	180	200	300	350	**375**
Temperature (°C)												
Maximum[1]	**37.3**	36.2	34.3	30.5	25.5	22.2	22.5	25.3	30.5	33.3	35.6	36.3
Minimum[2]	**21.9**	21.6	19.5	14.6	9.5	6.2	5.2	7.1	12.1	15.6	18.8	21.1
Humidity (%)												
Mean 9 am	38	40	37	37	47	**53**	51	38	32	32	34	37
Mean 3 pm	24	**28**	27	25	27	**28**	**28**	22	21	21	22	26
Wind (km/h)												
Mean 9 am	17.0	18.1	**19.7**	18.9	15.2	12.8	14.3	17.3	18.2	19.6	18.2	18.0
Mean 3 pm	15.8	**16.7**	16.6	14.9	14.2	13.5	14.0	16.0	15.5	14.8	14.1	14.5

Notes: [1] Monthly mean maximum temperature is the average of the available daily maxima for that month.

[2] Monthly mean minimum temperature is the average of the available daily minima for that month.

Highest values are indicated in bold.

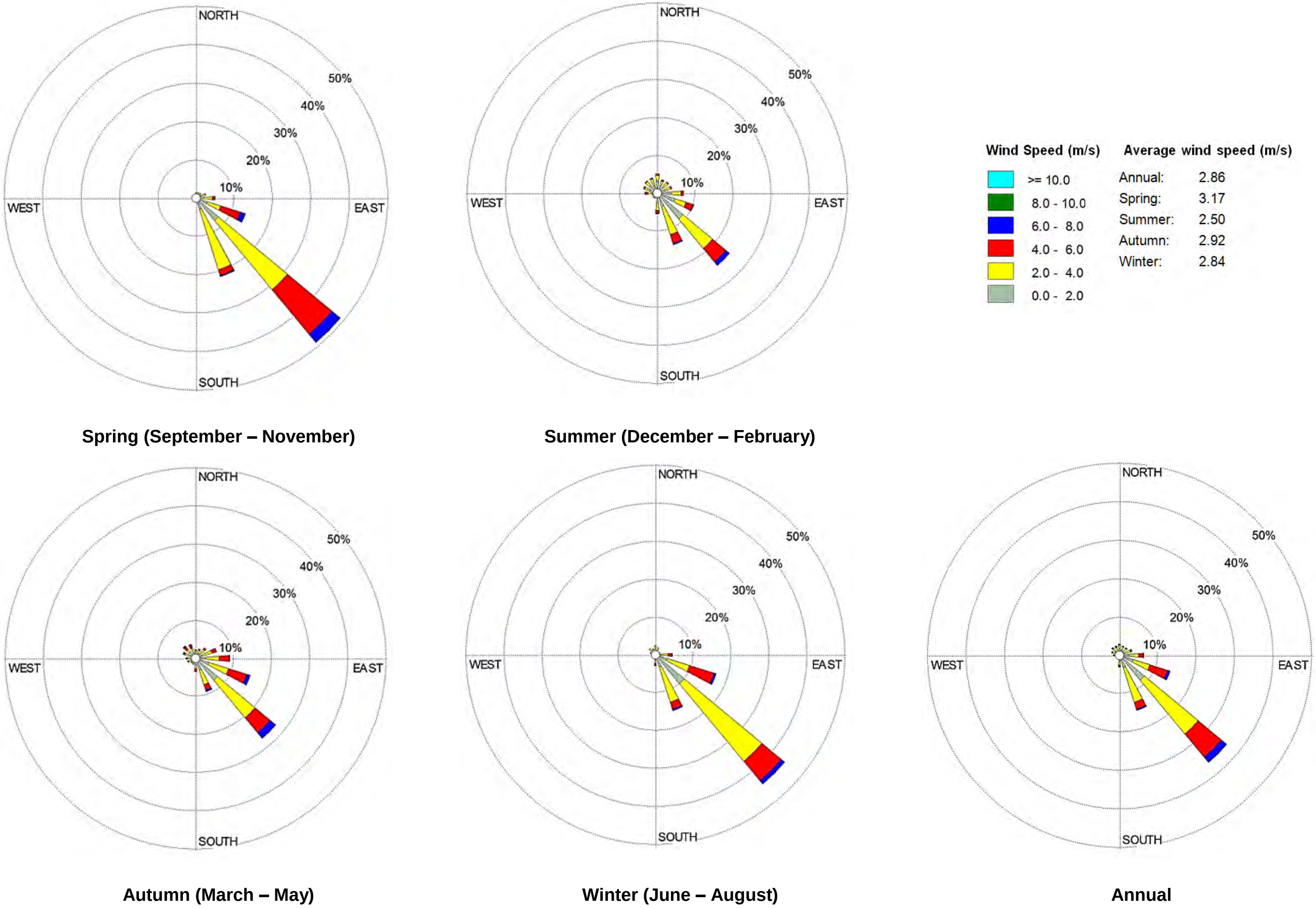


Figure 2-1 Annual and Seasonal Wind Roses (Source: BOM, Territory Grape Farm Station No. 015643)

3. Surface Water

3.1 Drainage

Semi-arid regions, such as the area in which the Project is located, are typically characterised by conditions in which actual evaporation closely matches rainfall and virtually all rainfall evaporates resulting in almost no surface runoff. Therefore, the occurrence of surface runoff and flows within local creeks is infrequent and only occurs during exceptional rainfall events associated with the occasional southward extension of the monsoon trough or periodic incursion of north-west cloud bands over the interior.

Semi-arid regions such as the area in which the Project is located are typically characterised by conditions in which actual evaporation during events closely matches rainfall and virtually all rainfall evaporates. Therefore, the occurrence of surface runoff and flows within local creeks is infrequent and only occurs during exceptional rainfall events associated with the occasional southward extension of a tropical monsoon trough or periodic incursion of north-west cloud bands over the interior of the continent.

Local creek beds tend to be mobile with deep sand deposition and banks that show signs of active erosion. Creek channels are typically 1.0 m deep with a base width of 5 m. Intense, short duration rainfall events can be expected to occur over the Project area and the relatively shallow depth of creek channels will lead to out-of-bank flow and possibly temporary and short-term flooding of adjacent areas.

3.1.1 Mine Site

The mine site is situated within the Ti-Tree Basin which has a large catchment area.

Kerosene Camp Creek is the main creek which flows through the mine site, the creek flows from south to north across the Site. Kerosene Camp Creek is fed by several creeks across the mine site. The catchment area of Kerosene Camp Creek and its tributaries upstream of the mine site is approximately 18 km^2.

Nolans Creek joins Kerosene Camp Creek approximately 500 m downstream of the mine site northern boundary. However, Nolans Creek also transects the mine site flowing adjacent to the TSF and between Waste Rock Dump 2 and 3. It has an upstream catchment of 26 km^2.

Kerosene Camp Creek joins the Woodforde River approximately 12 km from the mine site northern boundary. Woodforde River ultimately becomes a flood-out approximately 62 km north of the mine site northern boundary with the potential to discharge to the Hanson River.

The mine site surface water features are illustrated in Figure 6-2.

3.1.2 Processing Site

The processing site is situated on the head waters of the Southern Basin. This site has poorly defined natural waterways and/or drainages. Areas draining towards the Project are typically less than 1 km^2 in extent and channels are ill-defined with runoff likely to be dispersed across the south facing hillslope. The processing site surface water features are illustrated in Figure 6-5.

3.1.3 Accommodation Village

The accommodation village is situated on a plain with rocky hills nearby to the eastern side. This area has poorly defined natural waterways and/or drainages.

3.1.4 Borefield

The borefield is situated within the Southern Basin. No major creek/river system is present within the borefield itself. Day Creek is the closest watercourse situated approximately 10 km from the western end of the borefield and flows in a southerly direction.

Napperby Creek is the next closest watercourse located 30 km to the west of the borefield and also flows in a southerly direction directly into Lake Lewis.

Lake Lewis is approximately 42 km southwest of the borefield and considered a Site of Conservation Significance (SOCS No. 54) by the Department of Environment and Natural Resources (DENR). It is considered to be of national significance in relation to providing:

- An important ecosystem for waterbird species, endemic and restricted range plant species; and
- Supporting a fish population during times of flood.

3.2 Flow Records

Long-term gauging of flow in watercourses that traverse or flow near to the Project has been carried out at one location, namely Arden Soak Bore on the Woodforde River. A summary of gauging is provided in Table 3-1. This gauge is located approximately 26 km downstream of the mine site and comprises a water level gauge board in the sandy river bed.

A second gauge at Allungra Waterhole is located about 42 km to the east and is outside the catchment of the Project and its infrastructure.

The Arden Soak Bore and Allungra gauges both provide records of water level from which discharge can be calculated. Gauging of water levels is also carried out at a third location, Pine Hill on the Hanson River, which is situated 33 km to the west, also outside the catchment of the Project and its infrastructure. No flow records are available for this latter gauge.

Arden Soak Bore on the Woodforde River measures runoff from a catchment area (393 km^2) that is an order of magnitude greater than that subtended by the mine site (54 km^2). However, given the similarity of catchment conditions the recorded time series of water levels and discharge are likely to be indicative of the pattern of runoff (but not the magnitude) from catchments at the mine site.

An analysis of the flow record at Arden Soak Bore (Figure 3-1) confirms that flow events are relatively infrequent with only 25 percent of flow days during the 41 year record having a total daily flow greater than 3 ML (arbitrarily selected threshold discharge of 0.03 m^3/s). Runoff is most likely in months during the summer season, December to March (Figure 3-2). The low frequency of flow events suggests that only one or two flow events can be expected in most years (Figure 3-3).

The maximum recorded flow at Arden Soak Bore on Woodforde River is 206 m^3/s and occurred in January 2010 (Figure 3-4) with a measured water depth of 3.7 m. Whilst this flow was recorded 26 km downstream of the proposed Project it serves to show the relatively 'flashy' response and short duration of flow events for drainage systems in this region.

Both the flow frequency curve (Figure 3-1) and hydrograph of the maximum recorded flow event (Figure 3-4) at Arden Soak Bore on Woodforde River illustrate the absence of baseflow (surface flow sustained by groundwater). However, anecdotal evidence[1] states that during 2010 and 2011 (wet years) water drained out of the local hills for months and a 'soak' upstream of the mine site was wet most of the year. This suggests that surface runoff infiltrates into the alluvium of creek channels where it will form shallow groundwater flow moving down gradient along the creek channel.

[1] Nolans Feasibility Study – Preliminary Studies Project Drainage and Land Tenure, AMC Consultants, February 2015. Comments on report by K Hussey.

The volume of surface runoff relative to locally recorded rainfall for the January 2010 event at Arden Soak Bore is estimated to be nine percent and indicates relatively high rainfall losses of over 90 percent. What proportion of this 'loss' infiltrates to a shallow aquifer and what proportion is lost to the atmosphere through evapotranspiration is uncertain but serves to confirm the typically low rate of surface runoff in the area.

Table 3-1 Hydrometric Gauges

Type	Gauge Number	Name	Latitude	Longitude	Record Start	Record End	Record Length (years)	Location Relative to Mine Project
River Flow	0280010	Woodforde River - Arden Soak	22.367	133.324	1974	open	41	Same river system 26 km downstream.
River Flow	0280004	Allungra Creek - Allungra Waterhole	22.689	133.631	1996	open	19	Different river system 42 km to east.
River Height	0280010	Woodforde River - Arden Soak Bore	22.367	133.324	1974	open	41	Same river system 26 km downstream.
River Height	0280004	Allungra Creek - Allungra Waterhole	22.689	133.631	1996	open	19	Different river system 42 km to east.
River Height	0280021	Hanson River At Pine Hill	22.367	133.025	1968	1977	9	Different river system 33 km to west.
Surface Water Quality	0280010	Woodforde River - Arden Soak Bore	22.367	133.324	1974	open	41	Same river system 26 km downstream.
Surface Water Quality	0280004	Allungra Creek - Allungra Waterhole	22.689	133.631	1996	open	19	Different river system 42 km to east.

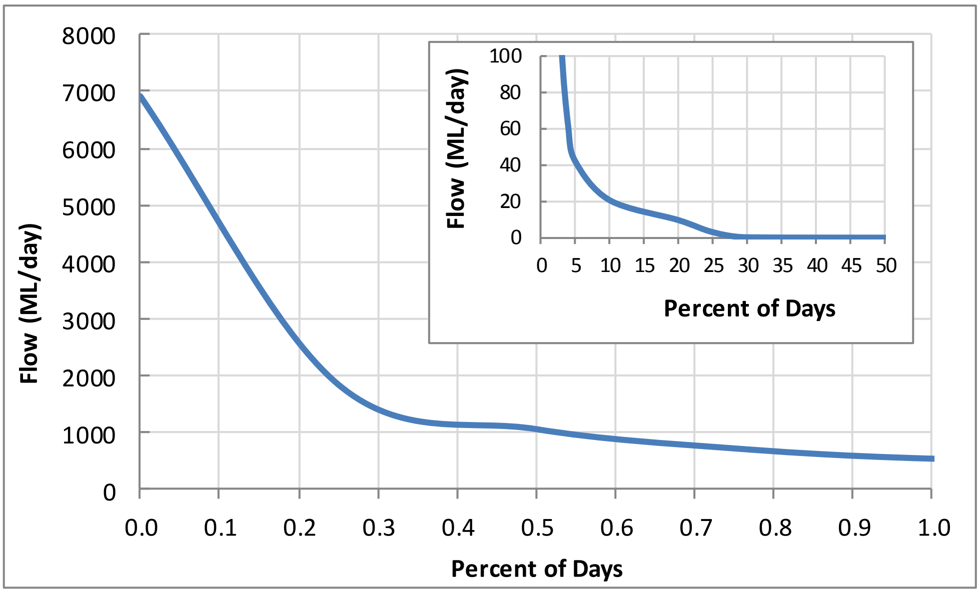


Figure 3-1 Flow frequency curve for Woodforde River at Arden Soak Bore

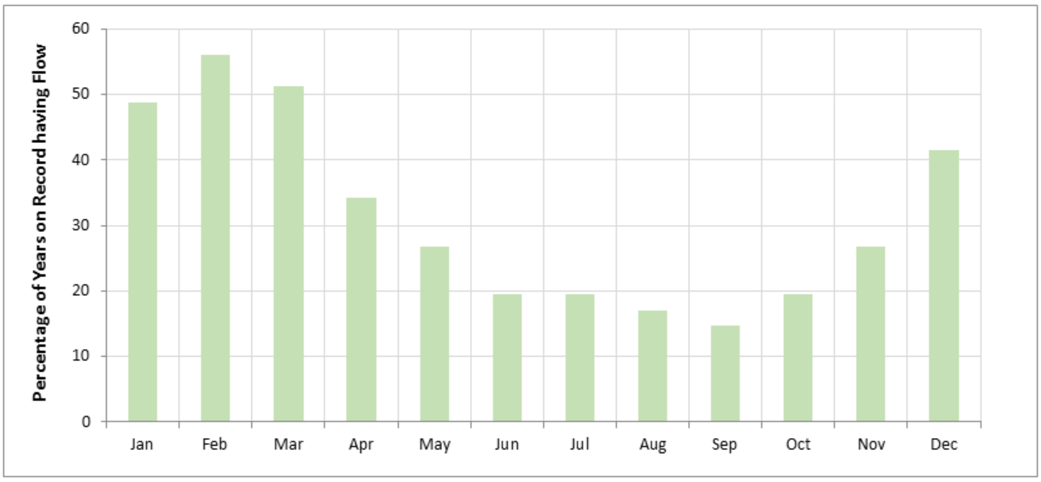


Figure 3-2 Occurrence of flow at Arden Soak Bore on Woodforde River

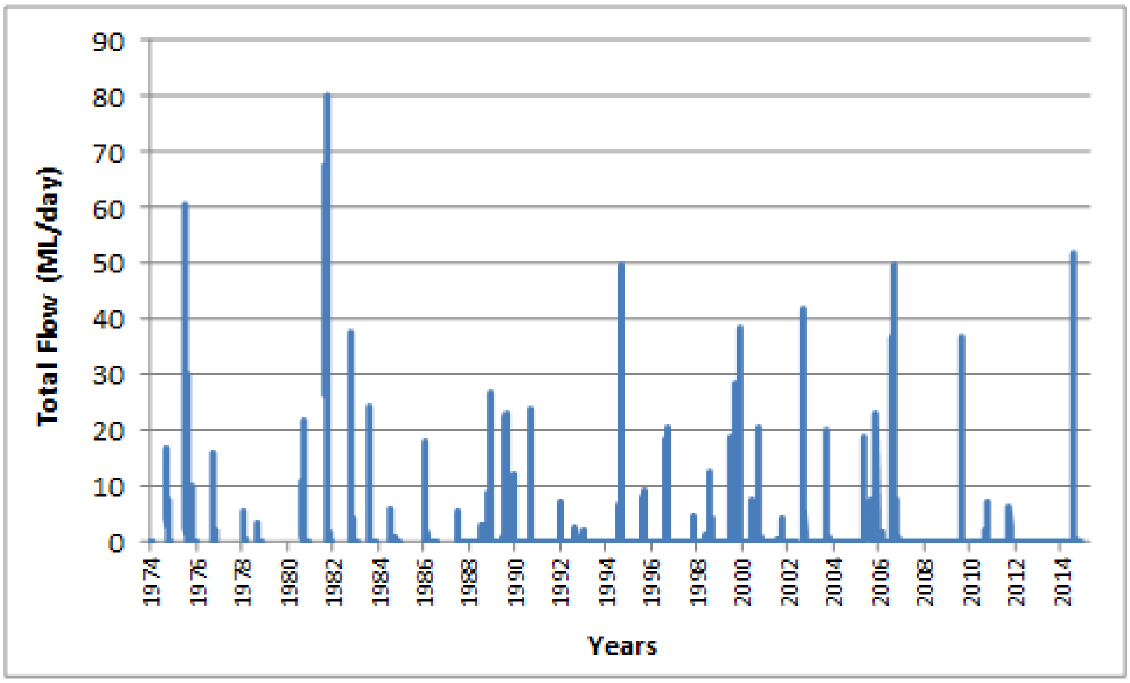


Figure 3-3 Time series of recorded flow at Arden Soak Bore on Woodforde River

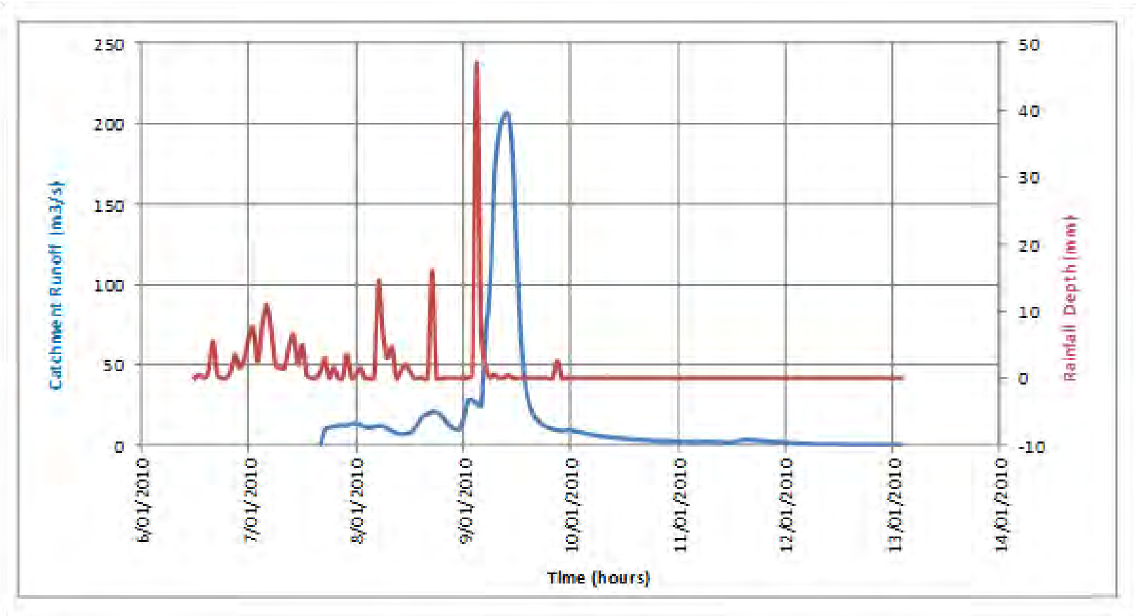


Figure 3-4 Maximum recorded flow at Arden Soak Bore on Woodforde River

3.3 Flood Risk

A flood assessment and modelling was undertaken for the mine site to establish potential flood related impacts. Recorded flow events at the mine site are infrequent and the probability of flood events occurring during the 55 year operation of the Project is summarised as follows:

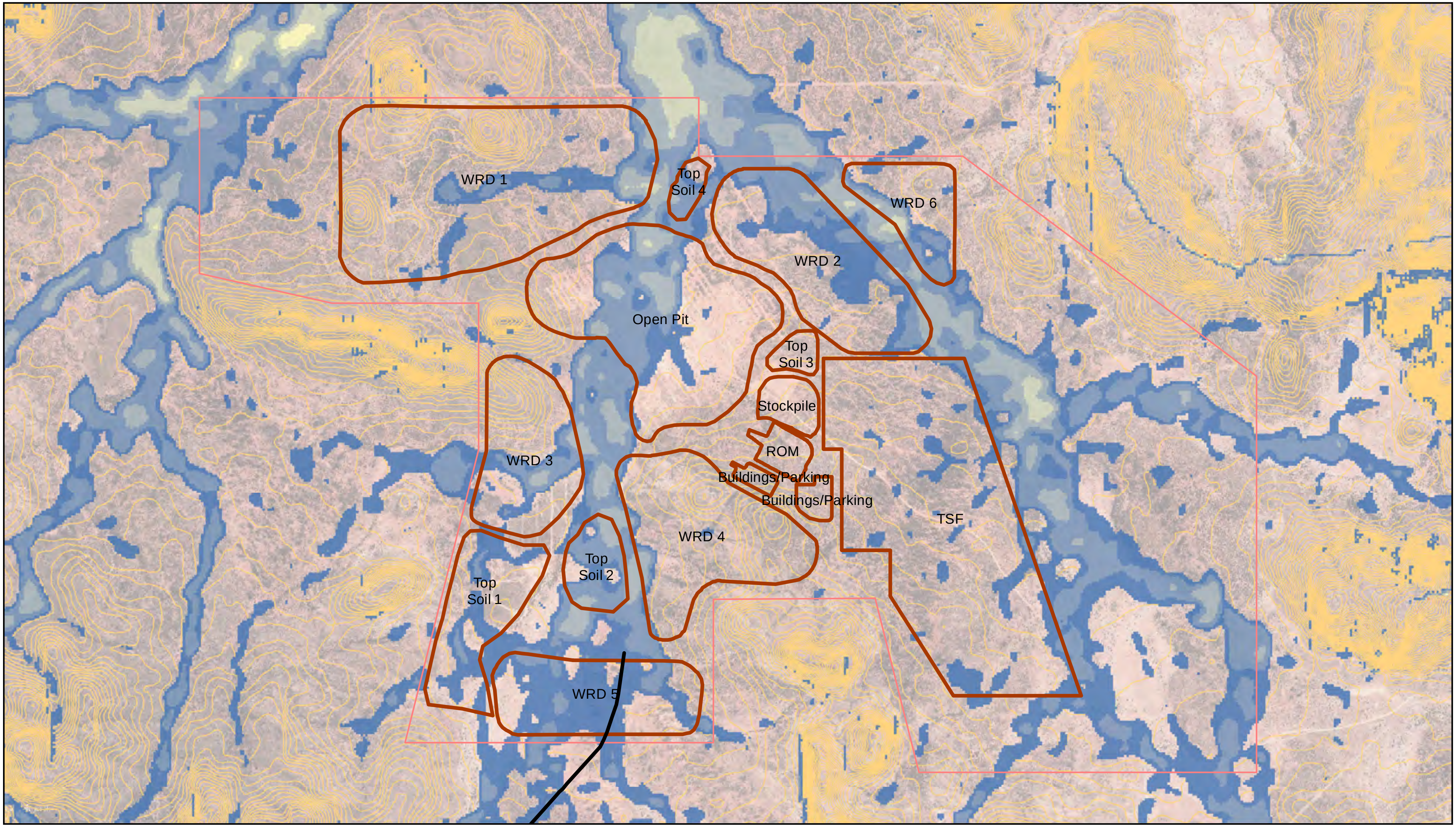
- 1 in 10-year ARI flood event – 99%;
- 1 in 50-year ARI flood event – 67%;
- 1 in 100-year ARI flood event – 42%; and
- 1 in 1000 year ARI flood event – 5%.

Modelling of the 1:1000 ARI flood event for the current conditions (i.e. without LOM mine infrastructure present) and with proposed infrastructure was undertaken. Modelling included two separate types including:

- XP-RAFTS model to determine flood peak flows and velocity; and
- 2-D rain-on-grid flood modelling to establish extents and depth of floods.

The flood extents for the Mine site is provided in Figure 3-5 and Figure 3-6 and flood extents for the Processing site is provided in Figure 3-7 and Figure 3-8, respectively.

Further details on the flood model are provided within the EIS, Appendix I.



1:35,000 @ A4

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Proposed Haul Roads
- 2m Contours
- Proposed Infrastructure
- Mine Site Boundary

Pre-Mining Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 4.0 - 4.5

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Job Number	4322301
Revision	0
Date	16 Aug 2017

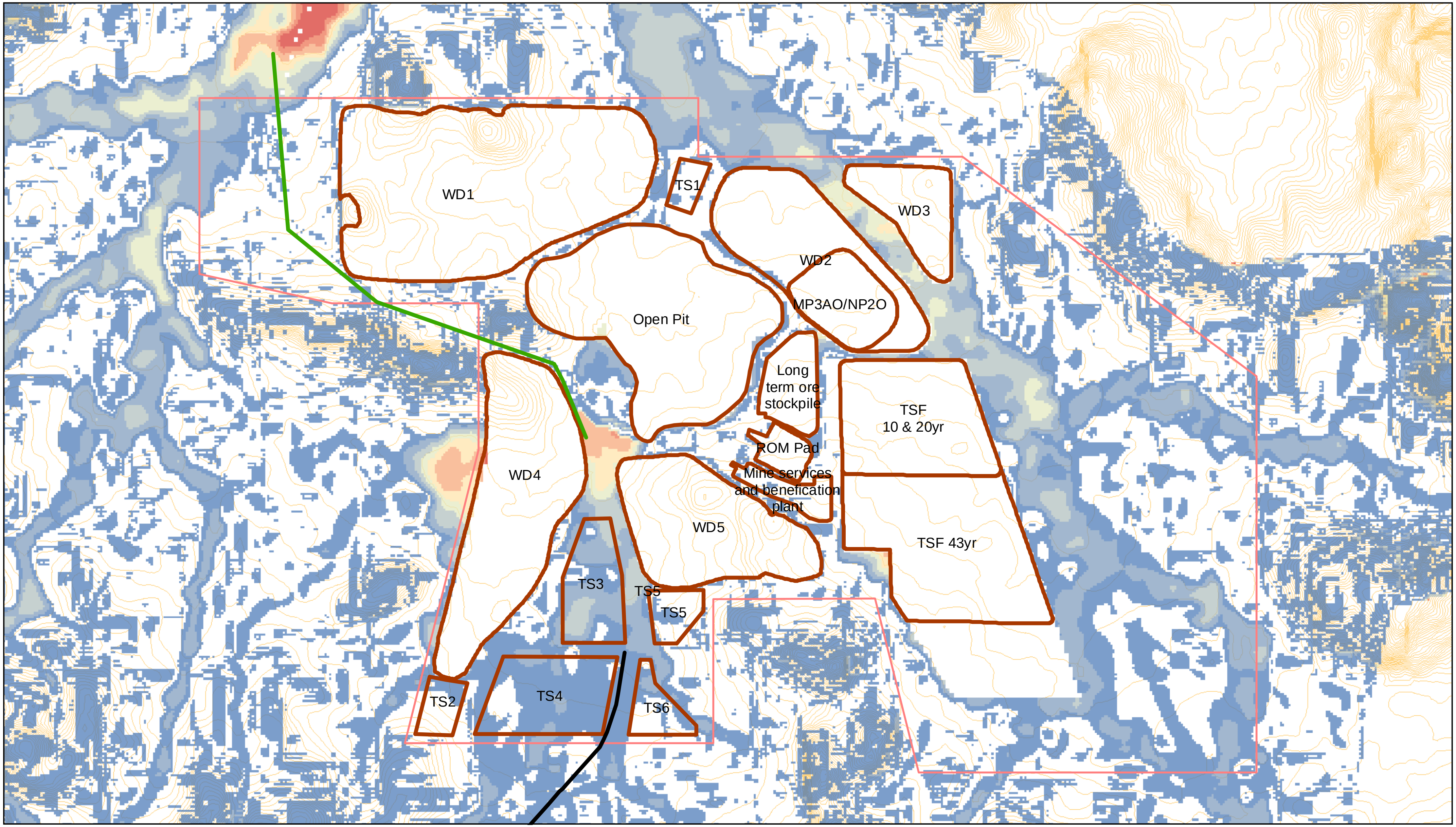
Flood depth for 1000 year ARI event - pre-mining

Figure 3-5

G:\43\22301\GIS\Maps\4322301_565_FloodDepthPreMine.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Haul Roads, Existing Creek Channels, Proposed Infrastructure (2015). CSIRO - 2m Contours (derived from SRTM) (2015). GHD - Flood Data (2016). Created by: CM



1:35,000 @ A4

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Proposed Diversion
Proposed Haul Roads
2m Contours
Proposed infrastructure
Mine Site Boundary

Post-Mining Flood Velocity (m/s)

0.0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5
3.5 - 4.0

Arafura Resources Limited
Nolans Project

Job Number 4322301
Revision 0
Date 04 Oct 2017

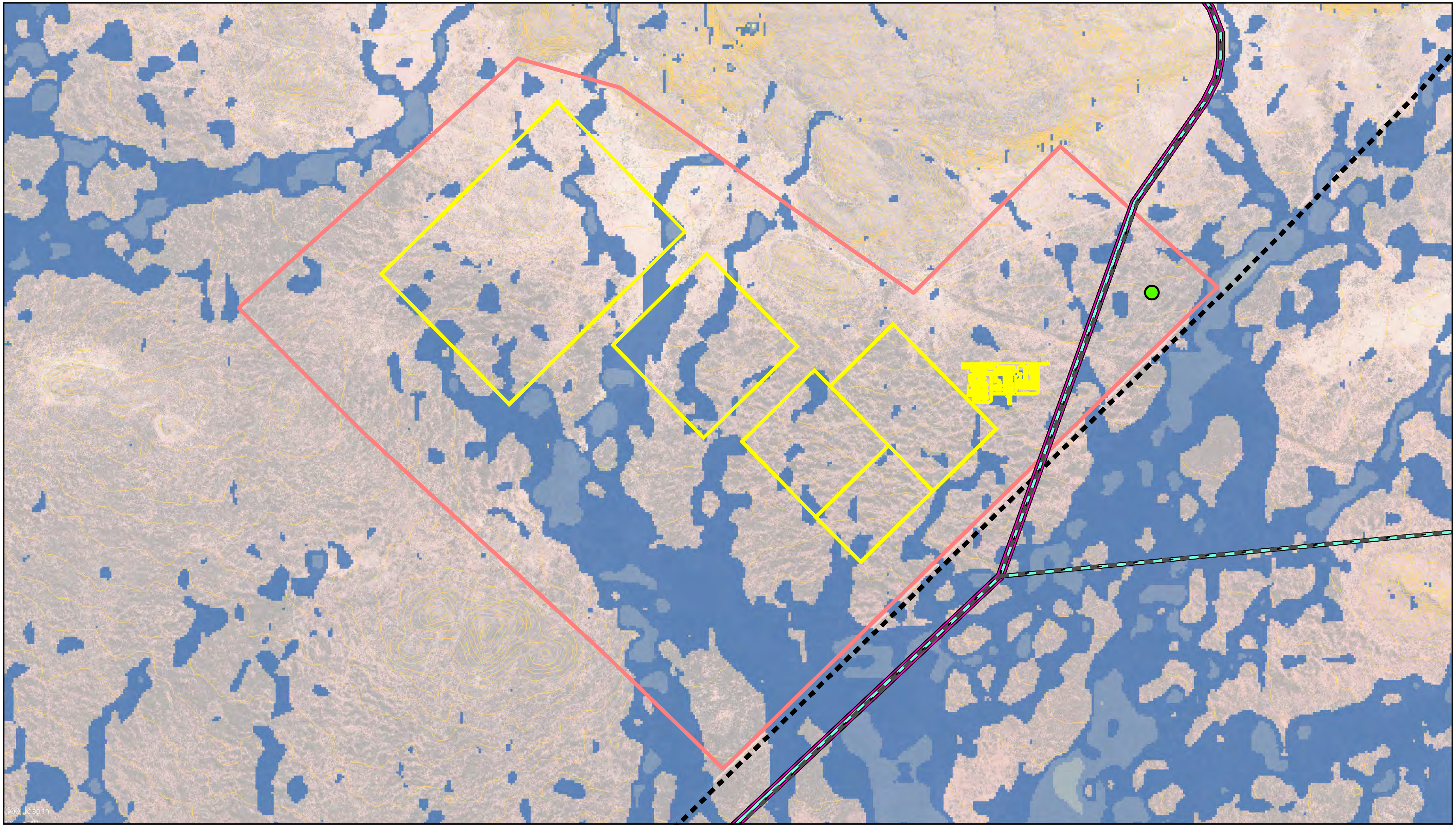
Flood depth for 1000 year ARI event - post-mining

Figure 3-6

G:\43\22301\GIS\Maps\4322301_568_FloodDepthPostMine.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Haul Roads, Existing Creek Channels, Proposed Infrastructure (2015). CSIRO - 2m Contours (derived from SRTM) (2015). GHD - Flood Data (2016). Created by: CM



1:35,000 @ A4

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Power Station
- Residue storage facilities (RSFs) and evaporation ponds
- Powerline
- Potable Water Pipeline
- Process Water Supply Pipeline
- Existing Gas Pipeline
- 2m Contours
- Processing Site Boundary

Pre-Mining Flood Depth (m)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5

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Nolans Project

Flood depth for 1000 year ARI event - pre-mining

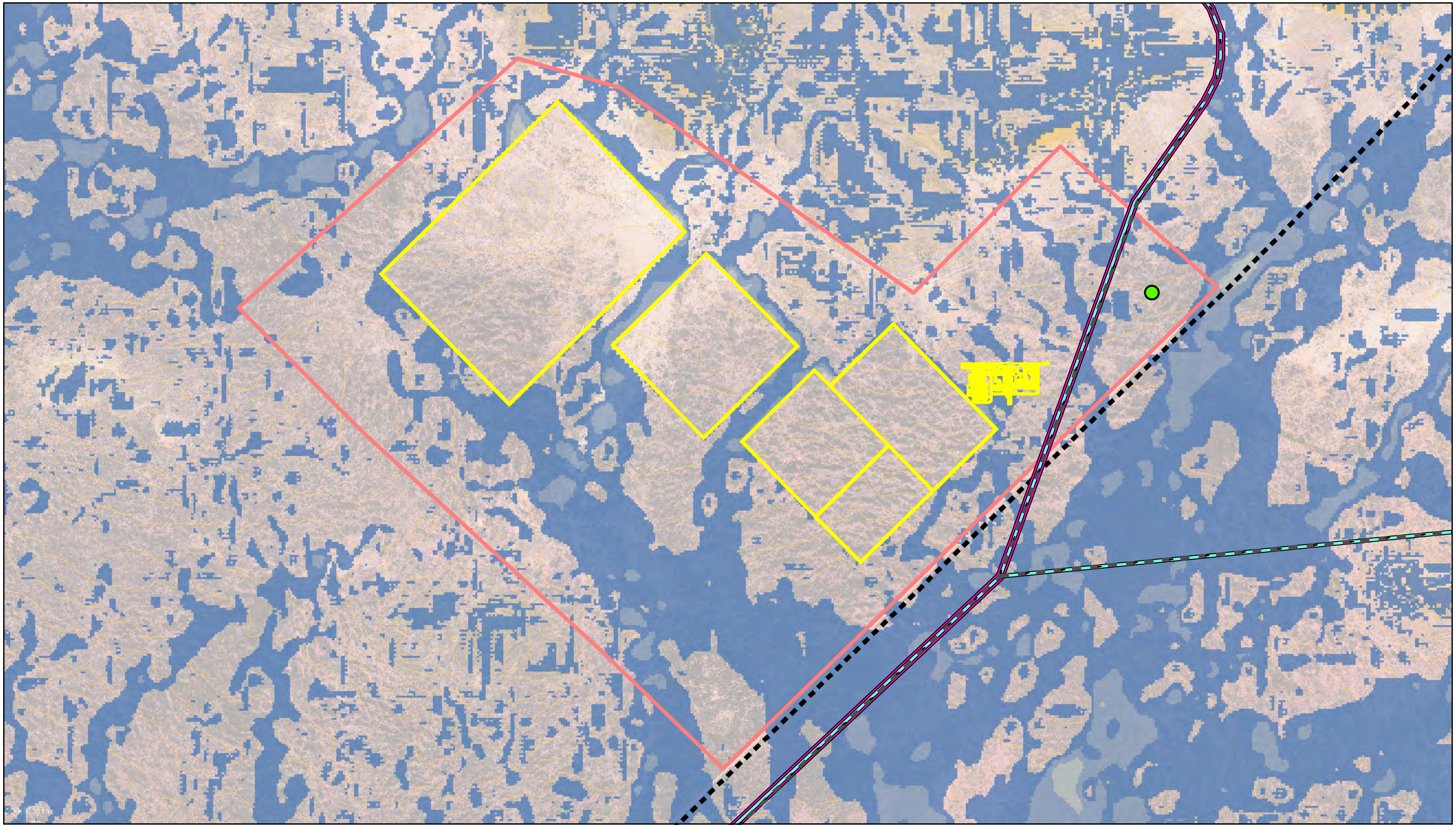
Job Number	4322301
Revision	0
Date	04 Oct 2017

Figure 3-7

G:\43\22301\GIS\Maps\4322529_013_FloodDepthProcessingPreMine.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Haul Roads, Existing Creek Channels, Proposed Infrastructure (2015). CSIRO - 2m Contours (derived from SRTM) (2015). GHD - Flood Data (2016). Created by: CM



1:35,000 @ A4

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Power Station
- Residue storage facilities (RSFs) and evaporation ponds
- Powerline
- Potable Water Pipeline
- Process Water Supply Pipeline
- Existing Gas Pipeline
- 2m Contours
- Processing Site Boundary

Post-Mining Flood Velocity (m/s)

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0

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Arafura Resources Limited
Nolans Project

Job Number	4322301
Revision	0
Date	04 Oct 2017

Flood depth for 1000 year ARI event - post-mining

Figure 3-8

G:\43\22301\GIS\Maps\4322529_014_FloodDepthProcessingPostMine.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 29/04/2015). ARL - Proposed Haul Roads, Existing Creek Channels, Proposed Infrastructure (2015). CSIRO - 2m Contours (derived from SRTM) (2015). GHD - Flood Data (2016). Created by: CM

3.4 Infrastructure

The TSF and RSF will be constructed to an acceptable engineering standard and will meet the ANCOLD standard for tailings storages. Accordingly, there will be allowances for freeboard in accordance with these design standards and design criteria.

Other infrastructure with the ability to collect direct rainfall such as the EP will be constructed with sufficient freeboard to collect a minimum of a 1:100 year 72 hour rainfall event (305 mm) whilst retaining sufficient additional freeboard to accommodate a PMP 72-hour storm rainfall event (1,100 mm).

Contingency management measures for water storages will include the installation of pumps and HDPE piping to transfer water to alternative storages (including the pit). A summary of Processing infrastructure, anticipated water quality and expected freeboard is provided in Table 3-2.

Table 3-2 Processing Infrastructure and Anticipated Water Quality

<table>
<tr><th rowspan="2">Infrastructure</th><th rowspan="2">Liner</th><th rowspan="2">Drainage</th><th rowspan="2">Water Classification</th><th colspan="2">Rainfall Management</th></tr>
<tr><th>Freeboard*</th><th>Contingency</th></tr>
<tr><td>Tailings Storage Facility</td><td>Low permeability soil liner.</td><td>Seepage collection system.</td><td>Elevated metal and metalloids.</td><td rowspan="3">100 year 72 hour ARI plus PMP 72 hour event</td><td rowspan="3">Pump transfer to alternative storage/pit.</td></tr>
<tr><td>Residue Storage Facilities</td><td rowspan="2">High Density Polyethylene (HDPE)/low permeability soil liner.</td><td>Basin drainage and a leakage collection and recovery system.</td><td rowspan="2">Elevated metal and metalloids.
Low pH.</td></tr>
<tr><td>Evaporation Ponds</td><td>-</td></tr>
</table>

*dependant on ANCOLD assessment.

Dirty water catch drains

Depending on the location, dirty water catch drains are typically sized to safely convey the flows generated by the 20 year ARI (approximately equivalent to the 5% AEP) critical duration design storm event.

Dirty water catch drains typically include a shallow excavated channel with an embankment along the downstream bank (Figure 3-9). Where possible longitudinal slopes should be about 1:100 (v:h).

Scour protection measures, including rip-rap and rock check dams (Figure 3-10), may be required to protect the dirty water catch drains from erosion and scour.

Regular inspection of the dirty water catch drains should be included in the routine monitoring program, with repairs undertaken as necessary in accordance with a suitable response plan.

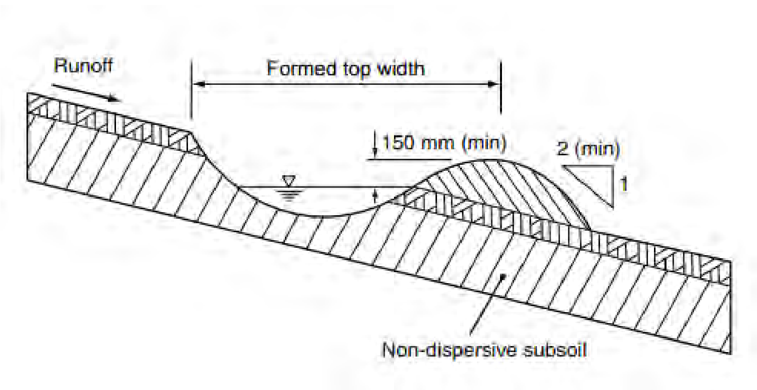


Figure 3-9 Typical catch drain, from Standard Drawing CD-01 (IECA 2008)

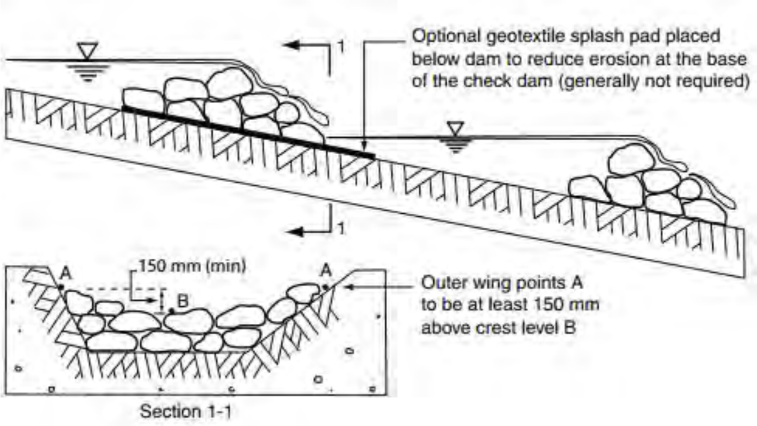


Figure 3-10 Typical check dam, from Standard Drawing RCD-01 (IECA 2008)

Sediment basins

Sediment basins consists of a *settling zone* and a *sediment zone* (Figure 3-11). The *settling zone* has a volume equivalent to the runoff generated by the 90th percentile 5-day rainfall event, whilst the *sediment zone* has a capacity of at least 50 percent of the s*ettling zone* (IECA 2008). Sediment basins designed to meet this criteria are expected to overtop on average five to seven times per year during larger rainfall events.

The *settling zone* is to be dewatered within 5 days of a rainfall, either by discharging offsite or transferring to a water storage dam for reuse on site.

If intercepted water is to be discharged offsite, flocculants and / or coagulants may be required to improve the removal of suspended sediments to achieve the target water quality prior to discharging. A *forebay* (Figure 3-11) may be used to simplify the dosing of flocculants and / or coagulants.

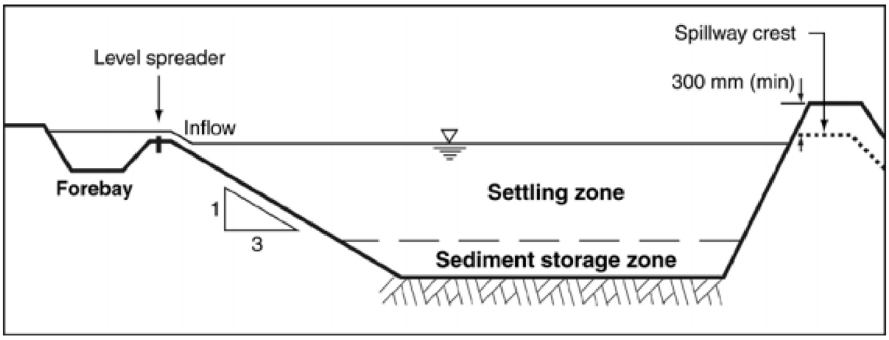


Figure 3-11 Typical Type D sediment basin (IECA 2008)

Sediment accumulates within the *sediment zone*, which will need to be cleaned at least twice per year.

Sediment basins are to include an emergency spillway designed to safely manage estimated overflows generated by the 1% AEP flood event (Figure 3-12). The emergency spillway is to include appropriate scour protection measures to minimise the failure.

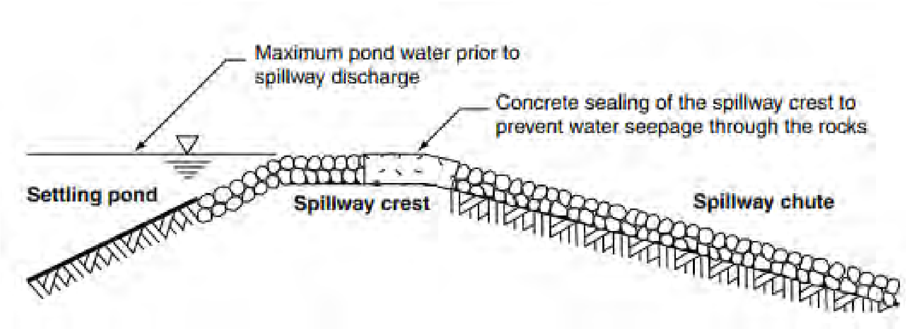


Figure 3-12 Typical emergency spillway, from Standard Drawing ES-1 (IECA 2008)

The concept dirty water management system indicates that about 14 sediment basins could be required to manage the sediment-laden runoff generated by the waste rock dump areas. Table 3-3 provides a summary of the estimated sediment basin capacities, based on the concept dirty water management system.

Table 3-3 Indicative sediment basin volumes

Sediment basin	Catchment area (ha)	Settling zone volume (m^3)	Sediment storage zone (m^3)	Total storage volume (m^3)
SB1	3.1	1030	520	1550
SB2	4.4	1460	730	2190
SB3	13.4	4440	2220	6660
SB4	0.9	300	150	450
SB5	3.4	1130	570	1700
SB6	2.4	790	400	1190
SB7	3.6	1190	600	1790
SB8	3.1	1030	520	1550
SB9	8.6	2850	1430	4280
SB10	1	330	170	500
SB11	4.4	1460	730	2190
SB12	2.8	930	470	1400
SB13	2.8	930	470	1400
SB14	3.6	1190	600	1790
Assumptions: 90th 5-day rainfall depth of 0.48 mm (Katherine) Runoff coefficient = 0.69				

Sediment basis are not typically lined and infiltration from the sediment basins can occur. As the water intercepted by the sediment basins is generally from non-mining areas, it is not expected to include elevated pollutants other than suspended sediment. Therefore the potential for the export of pollutants via infiltration from the sediment basins is considered to be low.

Regular inspection of the sediment basins should be included in the routine monitoring program, with repairs undertaken as necessary in accordance with a suitable response plan.

3.5 Erosion and Sediment Control

A draft Erosion and Sediment Control Plan (ESCP) has been prepared (Appendix D) to provide high level strategy for the management of erosion and sediment across the Project areas. The draft ESCP includes the construction, operation and closure phases. Erosion and sediment control will include the diversion of clean water around the site and installation of sediment, erosion and drainage controls. The draft ESCP will be updated following detailed design.

4. Groundwater

4.1 Introduction

4.1.1 Groundwater Management

Groundwater will be managed at the Project in accordance with ANZECC/ARMCANZ (2013). Key principles from this guideline include management in accordance with fundamental economic and social principles including the consideration of current and future generational values.

Management of groundwater across the Project will be aligned with the six underlying principles including:

- Protection of specified Environmental Value

  The current and future landuse of the area is considered to be pastoral (cattle). Application of stock water and irrigation ANZECC values and reference to drinking water values will be used whilst local Site Specific Groundwater Trigger Values are established.

- Risk-based Approach

  The EIS risk assessment has assessed the risks posed by infrastructure and inform mitigation measures. Locations which are likely to provide a groundwater contamination source will be constructed to reduce risks to groundwater include:

  – ROM Pad and long term stockpile pad constructed with impermeable bases with drainage to stormwater sediment retention ponds;
  – TSF constructed with low permeability soil liner and seepage collection system;
  – RSF constructed with HDPE/low permeability soil liner system, combined with basin drainage and a leakage collection and recovery system;
  – EPs constructed with HDPE/low permeability soil liner system;
  – Fuel stored in self-bunded Above Ground Storage Tanks (ASTs); and
  – Chemical Storage Shed with internal bunding.

- Polluter Pays Principle

  The site will be constructed, operated and rehabilitated in accordance with the *Mining Management Act* (MM Act). The MM Act requires the Proponent to report environmental data to assess and understand potential impacts from the Project to the Department of Primary Industries and Resource (DPIR). In accordance with the MM Act, a security bond will be provided as part of the initial grant and maintaining Mine Authorisation. The security bond reinforces the polluter pays principle whereby the bond will be returned to the Proponent following successful rehabilitation or utilised by DPIR to complete rehabilitation (if the Proponent is not able to due to unforeseen circumstances).

- Intergenerational Equity

  Currently the predominate use for groundwater in the immediate vicinity of the mine site and processing site is for pastoral use (i.e. stock drinking water). The development of the Project will be undertaken with consideration of current and potential future generations of pastoralists.

- Precautionary Principle

  Hydrogeological modelling has been undertaken to assess the potential impact of the Project on the surrounding environment. In accordance with the risk-based approach and implications of the polluter pays principal, the site will be operated under a precautionary principle.

- Ecologically Sustainable Development

The Project will be managed in accordance with the above principals to promote ecologically sustainable development.

4.1.2 Hydrogeological Setting

Soils

A geotechnical assessment of the mine site was undertaken by Lycopodium Minerals in 2010 (Lycopodium Minerals, 2010). The assessment indicated soils at the mine site generally comprise clayey sand (colluvium) from surface to approximately 1 m Below Ground Level (BGL). Laboratory testing undertaken on samples indicated 62% sand, 34% silt/clay and 4% gravel. A layer of gravelly sand to sandy gravel is present below the colluvium. The test pits met refusal on gneiss at depths ranging from 0.2 to 2.4 m BGL.

Geology

The basement geology at the Project can be summarised by three significant units including:

- Proterozoic Arunta Block granites and gneiss outcrop forming the bulk of the hills and ranges adjacent to the mine site (including Reynolds Range and Yalyirimbi Range) and basement rocks beneath the basins;
- Proterozoic Vaughan Springs Quartzite and Treuer Member outcropping as the Hann Range and Reaphook Hills as a distinct, almost linear feature across the southern plain, as isolated hills outcropping from the plain at the southern fringe of the Yalyirimbi Range and as basement rocks beneath only a minor section of the Southern Basins; and
- Ngalia Basin sedimentary rocks are also present, but comprise relatively little outcrop in the study area and form the basement of the majority of the Whitcherry Basin section of the Southern Basins.

It is recognised that the Arunta Block also contains multiple units other than granites and gneiss (i.e. schist, quartzite etc.) which may contain higher fracture permeability, but all Arunta Block rocks are collectively grouped as the hydrogeological unit ‘basement’ for the purpose of this assessment.

Only the mineralised areas of the ore deposit that contain primary porosity are considered in isolation as distinct aquifer. The rocks of the Vaughan Springs Quartzite and Treuer Member, as well as those of the Ngalia Basin are, like the units of the Arunta Block, collectively included in the hydrogeological unit ‘basement’.

Basins

The borefield and processing site are located within the Southern Basins and the borefield targets the Reaphook Palaeochannel. Groundwater within the basins generally flows westwards. The mine site and accommodation village are within the Ti-Tree Basin which also comprises palaeochannels. The divide between the basins is located at the ridge line to the north of the processing site.

Groundwater Dependant Vegetation

Vegetation communities associated with Day Creek have been mapped (Desert Wildlife Services 2016). The vegetation that is most likely to be reliant on groundwater are river red gums, bloodwoods and bean trees. Ghost gums may also possibly access groundwater resources, but this has not been examined in central Australia.

Most studies suggest a threshold depth of around 8 to 10 m for reliance on groundwater by vegetation. While some plants may extend roots much deeper than this, water tables at such depth are unlikely to support GDEs. At depths of over 20 m the probability of groundwater use is low. It is considered low as stands of river red gum and bean tree have a basal area of around 8m^2 per hectare (as observed along Day Creek), and increasing root depth to the water table places additional stress on the tree's internal water transport system equivalent to increasing tree height.

Watertable level observations at Day Creek are approximately 28 m below top of collar (RC00026 RN19038). Watertable depths greater than 20 m are unlikely to support riparian woodland vegetation given tree response to water table depth elsewhere including in the adjacent Ti Tree Basin.

Declaration of Beneficial Uses

The mine site is located within the Ti-Tree Water Control District (WCD) within the Western Zone. WCDs are proclaimed areas where the DENR has identified a need to manage water resources (surface and groundwater) to avoid stressing groundwater reserves, river flows or wetlands. DENR manage the Ti-Tree WCD.

The Ti-Tree WCD covers approximately 14,000 km^2 within which the majority of water supplies for the 1000 people are sourced from groundwater. It was initially declared in 1983 and groundwater in the WCD continues to be utilised for agriculture, horticulture and stock and domestic water use (DLRM, 2016).

Mining is exempt from licencing under the *Water Act*. However, extraction and dewatering activities are governed under the *Mining Management Act* administered by the DPIR who have a memorandum of understanding with the DLRM to manage activities so they do not affect other water users.

The borefield and processing site is outside of the Ti-Tree WCD and is not located in an area declared as for beneficial uses under the Water Act.

4.2 Groundwater Modelling

4.2.1 Model

A class 1 numerical groundwater model was developed using the graphical user interface (GUI) GMS 10.1, MODFLOW-NWT with Upstream Weighting (UPW) and Newton (NWT) solver, Evaporation package (EVT1), General Head Boundary package (GHB1), Drains (DRN1) package, Recharge (RCH1) package and automated Parameter Estimation (PEST) packages. The model simulates aquifer conditions to develop a steady-state (existing) model and predicts impacts from Project operations including at 100 and 1000 years post closure. The scenarios included models run for a:

- 43 year LOM using an annualised borefield groundwater extraction rate of 4.5 GL/year (as presented in Appendix K of the EIS); and
- 43 year LOM using an annualised borefield groundwater extraction rate of 2.7 GL/year (as presented in the supplement of the EIS).

Additional scenarios 43 year LOM using an annualised borefield groundwater extraction rate of 2.7 GL/year includes models run for:

- reduced flow rates from the Southern Borefield [Model 301 (303)];
- reduced flow rates and reduced bedrock hydraulic conductivity (on request from Arafura) [Model 307]; and
- reduced specific yield (from 0.10 used in the EIS model) to 0.04 (on request from the Water Resources Division) [Model 400].

4.2.2 Groundwater System

The model used assumed rates for groundwater extraction stock bores, Ti-Tree Basin bore pumping for horticultural irrigation and community pumping (Pmara Jutunta, Alyuen and Laramba). The Project extractions included the development of a pit with associated pit dewatering and production bores in the borefield. Additional model stresses included recharge (diffuse and direct) and evapotranspiration.

4.2.3 Groundwater Flow Regimes

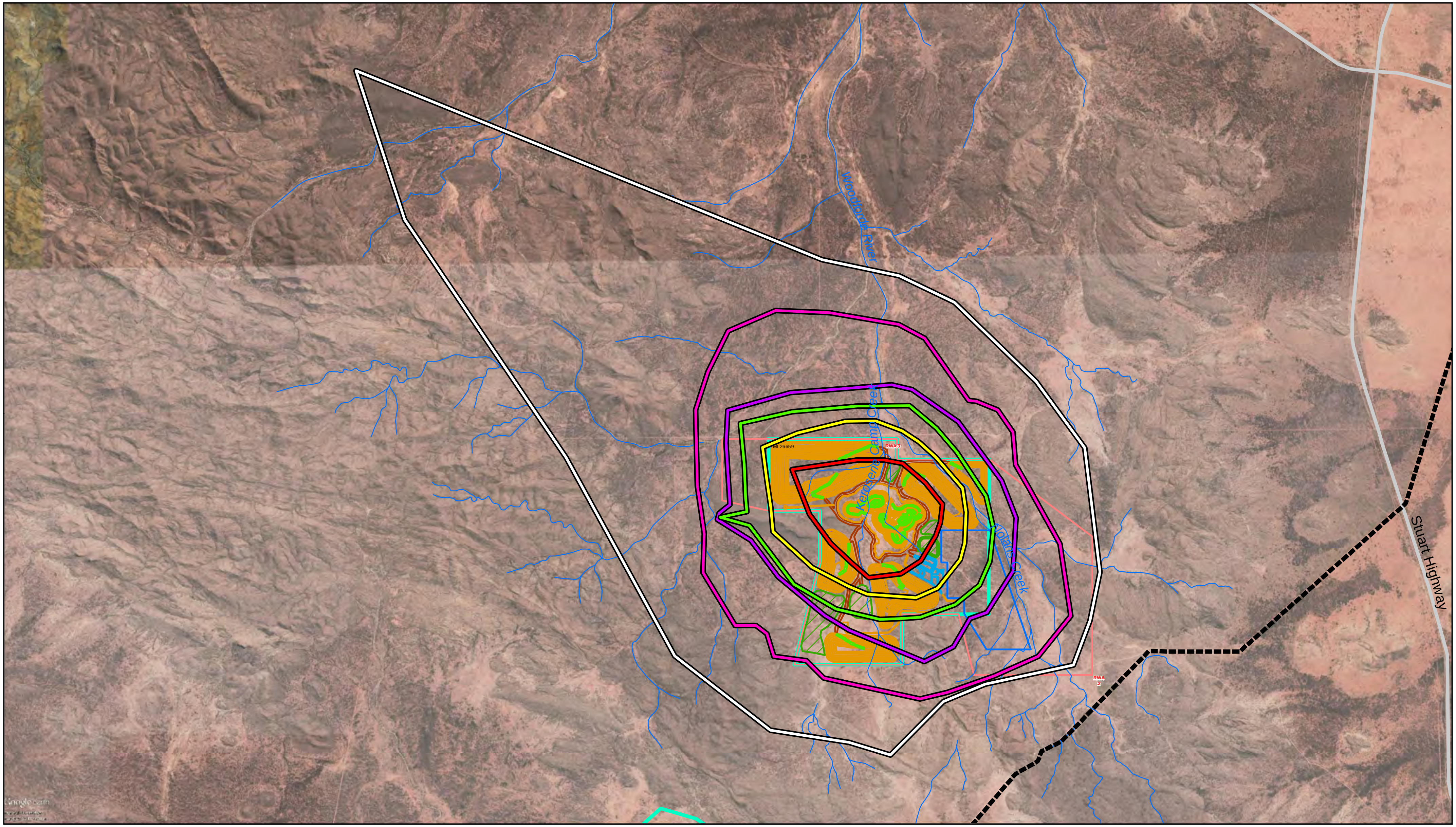
Regional

The model indicates groundwater flow at a regional scale displays no change. The Southern Basin continues to flow to the west and the Ti-Tree Basin continues to flow to the northeast at comparable rates and levels to pre-mining conditions.

Mine Pit Inflow

Immediately adjacent to the pit, the groundwater flow direction reverses and flows report to the pit. The extent of the groundwater reversal increases through the LOM due to the increase in depth of the pit (and required dewatering). At the modelled LOM, the majority of the groundwater within the vicinity of the mine site will flow towards the pit. Following closure, the extent of groundwater reversal continues to extend as the pit operates as a groundwater sink (i.e. evaporation losses exceed inputs from runoff, precipitation and groundwater inflows). The 100 year and 1,000 year post closure pit inflow contour extends beyond the Project lease boundary. The extent and associated periods for pit inflow contours are provided in Figure 4-1.

If mining were to cease prior to reaching the LOM pit shell, the extent of the groundwater reversal would still continue to laterally extend beyond the Project area due to the groundwater inflow to the pit and evaporation from the system (which exceeds precipitation).



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0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- 2028: 10 years
- 2038: 20 years
- 2048: 30 years
- 2058: life of mine
- 2160: 100 years post closure
- 3060: 1000 years post closure
- Waterways
- Roads
- Proposed Mine Site Boundary
- Mineral Lease

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Job Number	4322301
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Modelled Pit Inflow Extent

Figure 4-1

G:\43\22301\GIS\Maps\4322301_606_InflowExtent.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 08/03/2016). ARL - Proposed Pipelines, Proposed Mine Site, Proposed Diversion Channel Options, Tailings Storage Facility (2015). Created by: CM

4.2.4 Modelled Drawdown

Mine Site

The modelled drawdown of groundwater levels adjacent to the pit are due to the removal of groundwater from the system through evaporation and pit dewatering. The drawdown continues to laterally extend following the cessation of mining due groundwater inflow to the pit and evaporation from the system (which exceeds precipitation). Peak pit groundwater inflows are approximately 4,000 m^3/day (45 L/s) and post closure are 700 m^3/day (8 L/s).

The modelled 1 m drawdown contour, based on a pit depth of 225 m, extends beyond the Project lease boundary approximately 500 m at the LOM, 750 m at 100 years post closure and 1.5 km at 1,000 years post closure. The drawdown contours, outlining the extent of the drawdown cone, are provided in Figure 4-1.

Borefield

The extent of the modelled drawdown at the borefield is greater than the mine site which is generally due to the volume of water being removed from the aquifer. The modelled drawdown at the epicentre of the borefield is 7 m (at SB022) excluding actual drawdown within operating bores. The drawdown-rebound is a typical log-linear response to aquifer pumping and recovers to 1 m drawdown approximately 100 years post closure.

4.2.5 Modelled Impacts

The hydrogeological model indicates that there will be drawdown due to pit dewatering and extraction at the borefield. Levels of drawdown range are dependent upon distance from the extraction site. The borefield generally recovers across the closure period but the drawdown associated with the pit continues to expand post closure due to pit acting as a groundwater sink. A summary of predicted impacts is provided in Table 4-1 based on the larger pumped volume/impact of the model presented in Appendix K of the EIS.

Table 4-1 Summary of Modelled Impacts

Area	Impact
Mine Site	
Riparian Vegetation	The riparian vegetation immediately adjacent to the mine area (upstream to the point of the diversion and downstream in Kerosene Camp Creek to the confluence of Nolans Creek) is highly likely to be catastrophically impacted by the mining operations (i.e. riparian vegetation will die and not recolonise in the area).
Groundwater Users	Pine Hill Station bores (RN010759 and RN012624) are likely to experience an increased drawdown to 0.05 m by the end of mining and 0.1 m 1,000 year post closure. Groundwater availability for drinking water, stock, horticulture and viticulture within the Ti-Tree Basin is highly unlikely to be measurably impacted (i.e. less than 0.012 m predicted drawdown). Drawdown at the Aileron Station (homestead and roadhouse locations) is predicted to be impacted by mine dewatering and remain impacted beyond mine closure. Drawdown is likely to commence following the end of mining increasing from 0 m in approximately 2291 to about 0.7 m 1,000 years post closure. However, the water supply for Aileron Station is from the Sothern Basins and is detailed below.
Southern Basins	
Riparian Vegetation	Modelled drawdown from the borefield peaks in the order of 1.5 m in the vicinity of Day Creek during extraction. The drawdown rebounds rapidly once extraction ceases. The depth to groundwater currently is generally 20 m BGL and it is considered likely that current vegetation would be capable of extending root systems during the extraction period. Napperby Creek is approximately 18 km further west than Day Creek is from the borefield and as such drawdown is significantly reduced. Drawdown peaks at 0.7 m by the end of mining and recovers to 0.1 m 1,000 years post closure.

Area	Impact
	The predicted drawdowns are negligible in the Lake Lewis area and are not likely to be measureable. However, the peak decreases in groundwater availability for evapotranspiration in the Lake Lewis area of the Southern Basins is 3% or 712 m^3/day (8 L/s) and rebounds to approach steady state levels in the order of approximately 0.5 % or 103 m^3/day (1 L/s).
Groundwater Users	The old Alyuen Community water supply bore may be impacted by groundwater extraction from the mine site. Alyuen Community is currently supplied from a new bore to the east of the project borefield which will be impacted by the borefield pumping. Drawdown is likely to peak at the end of mining by 0.6 m and decrease to 0.4 m 1,000 years post closure. Laramba and Napperby groundwater supply (drinking water) situated on the western side of Day Creek north of the Reaphook Range is expected to experience a peak drawdown of 1.5 m at the end of mining and decrease to 0.1 m 1,000 years post closure.

4.2.6 Validation

The model requires temporal monitoring and flow gauges to be installed on extraction bores to facilitate validation and recalibrating of the model during Project operations. The monitoring program detailed in Section 6.3 has been designed to validate the model and eventually progress this model to a class 2 in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al, 2012) throughout the operation of the Project. Groundwater Quality

Groundwater sampling has been undertaken across the Project including 158 samples from a total of 71 bores. Sampling methodology is as follows:

- Standing water levels have been periodically measured in 71 bores in the NE Southern Basins, the Nolans Arunta Basement Ti Tree Basin catchment area and in the southern Ti Tree Basin. Baseline water quality monitoring is now being completed in all the 71 NE Southern Basins Bores.
- The baseline groundwater quality consisted of two programs:
  – Sampling from key bores in selected areas for standard ADWQ chemical water quality laboratory analysis (including trace metals)
  – Opportunistic sampling of other bores when access is available. These include pastoral bores, Central Desert Shire Regional Council management bores, NTG bores (e.g. public road maintenance bores)
- To date baseline water quality sampling has focused on samples from the following bores:
  – NE Southern Basins: RC4 (K2- RN 18872); RC 85 (Alyuen 1 production – 18976)
  – Nolan' Bore Area: RC 63 (New Nolans Pastoral Bore – RN 18761) or the adjacent New Nolans observation bore RC 64 – RN 18762); RC 75 (Nolans Dewatering Bore) or adjacent 50 mm PVC cased Dewatering Monitoring Bores # 1 & 7 RC 67 & RC 72
  – Aileron Roadhouse Bore RC 83 (Greg's Hope Bore RN 15971)
  – Southern Ti Tree Basin Dann's Hidden Valley paleochannel, Aileron Station, *Arafura Resources* Monitoring Bore DHV1; RC 92
- As identified in the draft EIS the NE Southern Basins Program is to be expanded to include periodic sampling each year of Arafura Resources production bores and key water investigation bores. Several investigation bores were completed with 100 mm PVC casing to facilitate future quality water sampling. This baseline water sampling program to include:
  – NE Southern Basins Arafura Resources production bores: RC 21, 22, 25, 28 & 27
  – Arafura Resource NE Southern Basins Monitoring Bores: RC 12, 13, 23 & 26

4.2.7 Electrical Conductivity

Groundwater chemistry has been sampled from several different aquifer types across the Southern Basins and Ti-Tree Basin. Electrical Conductivity (EC) measurements have been used to assess the quality of groundwater across the areas. EC is an indirect measurement of salt content and within the Project area is currently likely to be influenced predominately by:

- Chloride and sodium ions followed by carbonates, sulphates, magnesium, calcium and potassium;
- Land Use (irrigation);
- Interaction of basement aquifer (old groundwater) with overlying aquifer (fresher groundwater); and
- Mineralisation (i.e. heavy metals due to metallic ions).

Median values of EC range from approximately 900 to 3,700 µS/cm across the Project area. In general, EC values are higher at the mine site and processing site relative to the borefield as displayed in the minimum and maximum EC values in Figure 4-2 and Figure 4-3 respectively.

4.2.8 General Chemistry

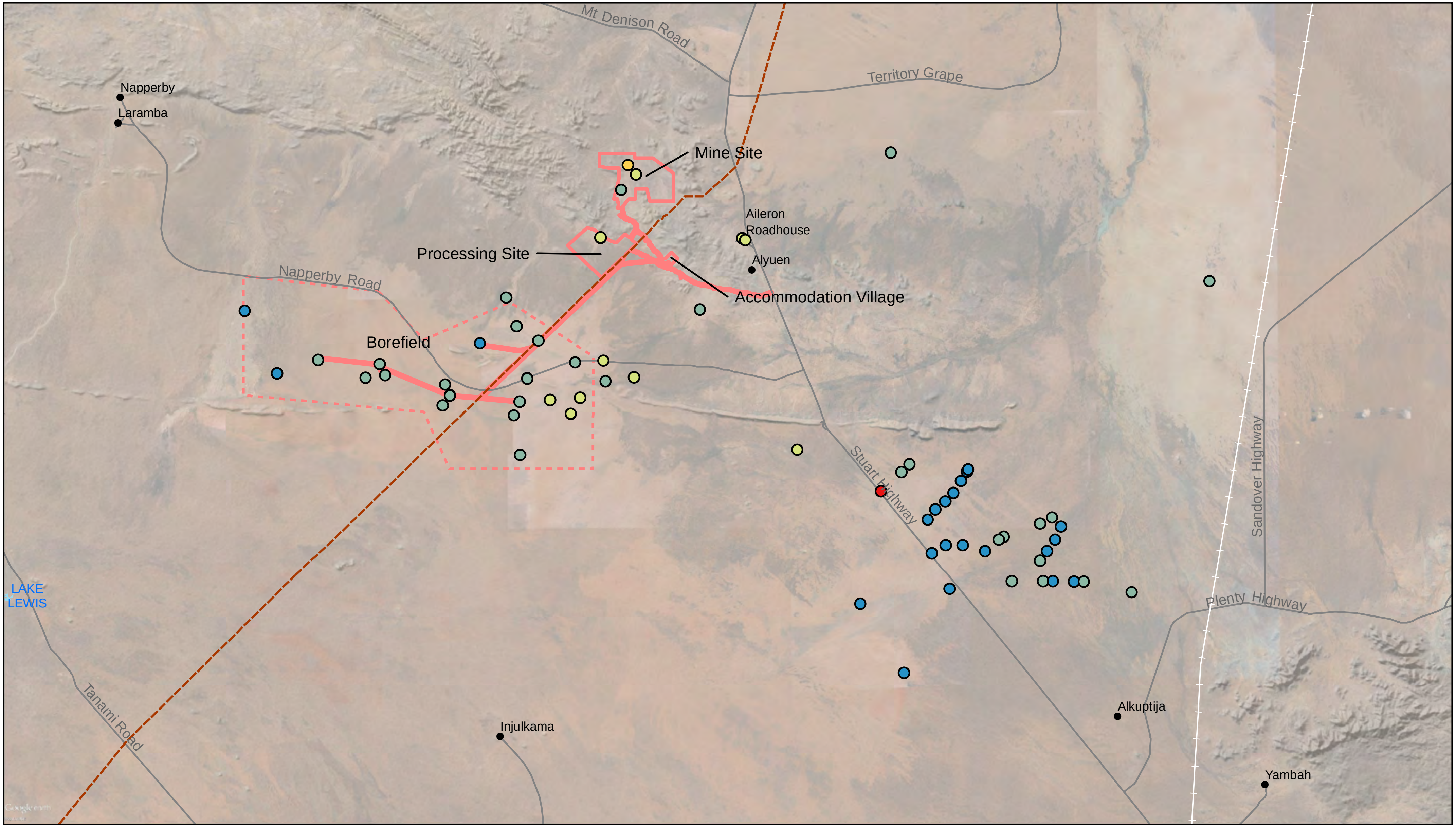
Groundwater chemistry across the Project varies and is dependent upon the geological unit being screened. Initial groundwater chemistry indicates levels generally exceed stock water trigger values in certain analytes across the hydrogeological study area with the exception of the Southern Basins alluvial and calcrete screen bores which exceed drinking water trigger values. Stock water trigger values are the least conservative trigger values (i.e. the guideline/trigger values are generally orders of magnitude greater than drinking water trigger values).

A summary providing an initial overview of current groundwater uses and analytes which exceeded associated trigger values are provided in Table 4-2 and additional data is located within the Hydrogeological Report (EIS, Appendix K). Additional groundwater chemistry will be collected as part of this WMP and monitoring is detailed in Section 6.3.

Table 4-2 Chemistry Summary

Area	Current Groundwater Use			Exceedances
	Stock Water[1]	Drinking Water[2]	Irrigation[3]	
Mine Site	✓			Stock water exceedances of uranium, fluorine and mercury.
Ti-Tree Basin	✓	✓	✓	Drinking water exceedances of total dissolved solids, chlorine, sodium, uranium and nitrate. Irrigation exceedances of boron, uranium and fluorine.
Southern Basins (Basement)	✓			Stock water exceedances of uranium, fluorine, sulphate, selenium and total dissolve solids.
Southern Basins (Alluvial and Calcrete)	✓	✓		Drinking water exceedances of total dissolved solids, high pH, chlorine, sodium, uranium, sulphate, manganese, aluminium, nitrate, fluoride and selenium.
Southern Basins (Rheapook Channel)	✓	✓		Stock water exceedances of fluorine and selenium. Drinking water exceedances of total dissolved solids, high pH, chlorine, sodium, uranium, iron, sulphate, lead, antimony, nitrogen dioxide, fluoride and selenium.

Note: [1] ANZECC & ARCANZ (2000) Stock Watering Trigger Values.
[2] Australian Drinking Water Guidelines (ADWG 2011) Aesthetic and Health guideline.
[3] ANZECC & ARCANZ (2000) Irrigation - Long-term Trigger Values.



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0 5 10 15 20

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Electrical Conductivity (uS/cm)

- 0 - 1500
- 1501 - 3000
- 3001 - 4500
- 4501 - 6000
- 6001 - 7500
- 7501 - 13500
- Gas Pipeline
- Major Roads
- Project Areas
- Borefield Area
- Waterbodies

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Date 05 May 2016

Electrical Conductivity (Min) of Groundwater Samples

Figure 4-2

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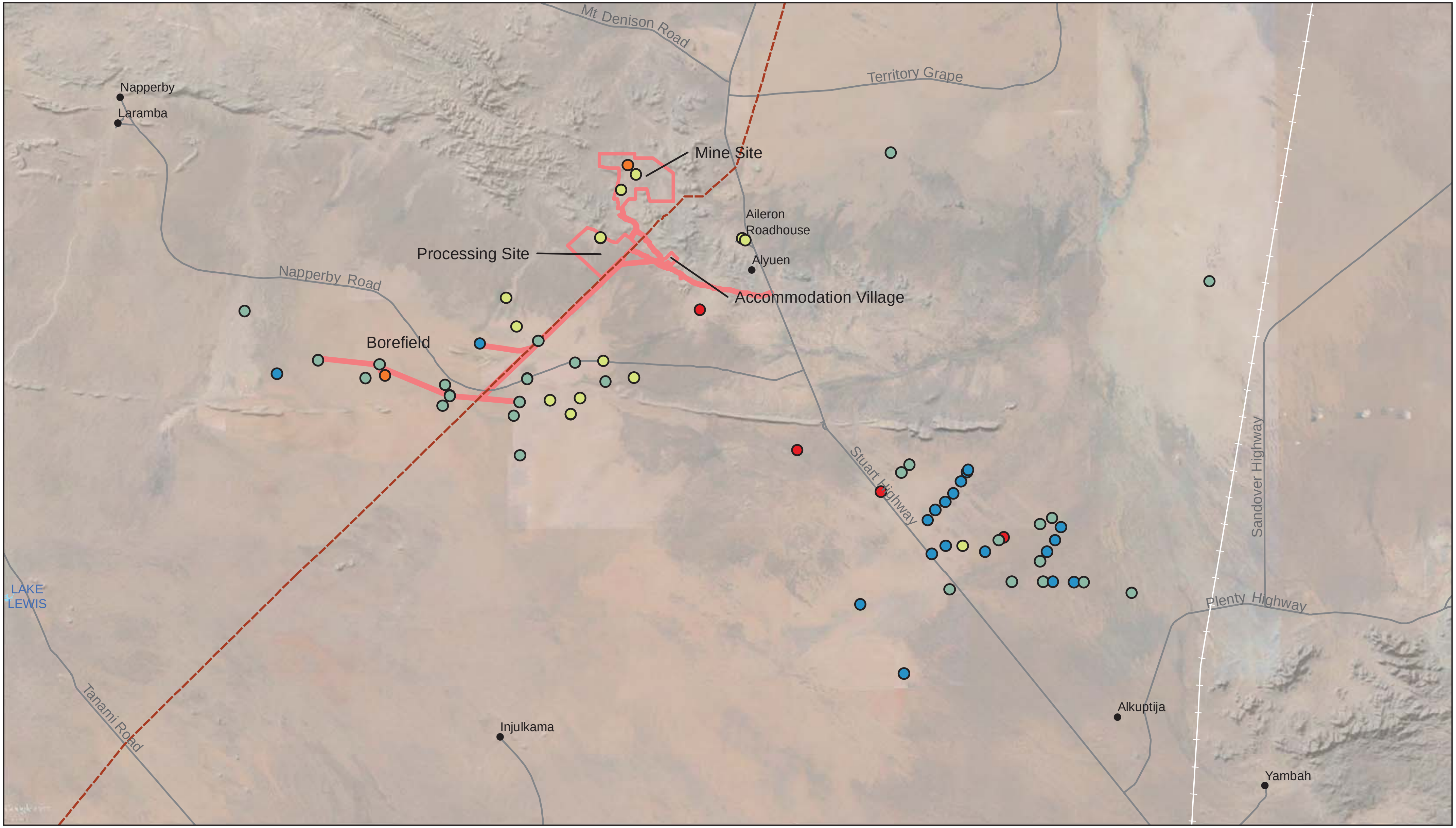
Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 04/02/2015). Ride - Groundwater Data (2015). ARL - Project Areas (2015). GA - Placenames, Railways, Gas Pipeline, Major Roads, Waterbodies (2015). Created by: CM



1:500,000 @ A4

0 5 10 15 20

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Electrical Conductivity (uS/cm)

- 0 - 1500
- 1501 - 3000
- 3001 - 4500
- 4501 - 6000
- 6001 - 7500
- 7501 - 13500
- Gas Pipeline
- Major Roads
- Project Areas
- Waterbodies

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Job Number	4322301
Revision	0
Date	29 Apr 2016

Electrical Conductivity (Max) of Groundwater Samples

Figure 4-3

G:\43\22301\GIS\Maps\4322301_1015_GroundSamplesElectricalConductivityMax.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 04/02/2015). Ride - Groundwater Data (2015). ARL - Project Areas (2015). GA - Placenames, Railways, Gas Pipeline, Major Roads, Waterbodies (2015). Created by: CM

5. Preliminary Conceptual Site Model

5.1 General

A Conceptual Site Model (CSM) is a representation of site-related information regarding potential surface and groundwater impacts, receptors and potential exposure pathways.

The development of a preliminary CSM provides the framework of identifying potential source-pathway-receptor linkages and associated monitoring techniques. Once detailed site specific information (monitoring data) is evaluated, the CSM will be refined and used as a decision tool to identify requirements for contingency management measures.

5.2 Key Aspects

5.2.1 Surface Watercourses

Watercourses are generally dry and do no exhibit flows for the majority of the year. Flows only occur during exceptional rainfall events and can flood existing watercourse banks. No watercourses are present within 1 km of the processing site or accommodation village.

5.2.2 Monitoring Benchmarks

Groundwater chemistry generally exceeds assigned environmental values (stock water, irrigation water and drinking water ANZECC values). Site Specific Groundwater Trigger Values (SSGTV) will be established throughout the construction phase (24 months) at nested well sites at the mine site and the processing site. The SSGTV will be used to provide a definitive dataset to be assessed against during operation, care and maintenance and/or rehabilitation.

5.2.3 Mine Pit Groundwater Inflow

The excavation of the pit below the groundwater table will commence the reversal of the groundwater flow direction causing it to report into the pit. The extent of the pit inflow contour laterally extends beyond all LOM mine site infrastructure 100 years post closure and continues to laterally extend to approximately 4 km radially from the pit 1000 years post closure. However, it should be noted that at any time leading up to the end of the 55 year operational life of the Project, there is potential for any seepage from the TSF and/or WRDs to discharge away from the mine site.

Post closure the pit will act as a terminal groundwater sink (evaporation losses exceed inputs from runoff, precipitation and groundwater inflows). As a result, the pit water is expected to show continual increases in metals and salt concentrations over time through accumulation of solutes introduced via groundwater inflows, run-off and precipitation.

5.2.4 Nil Discharge

The mine site and processing site have been designed as a no discharge site, however during heavy rainfall events and under exceptional circumstances there is the potential for stormwater basins discharging. No mine process water will be discharged off site. AMD potential is considered low and during these events the considerable dilution within adjacent creeks will substantially reduce potential contaminant concentrations. Sampling would be undertaken in accordance with the Discharges / Emergency Overflows procedure within the Surface Water Sampling Procedure in Appendix A. The sampling data will be used to assess if any additional management measures are required.

5.2.5 Borefield

The processing site is considered to pose a risk to groundwater contamination. During operation of the borefield, drawdown has the potential to impact local groundwater flow direction. It is hypothesised that groundwater beneath the processing site could ultimately end up within the borefield area. However, following closure and recovery of the borefield the potential fate of groundwater from the processing site will be validated following recalibration of the model using monitoring data from operations. Given the distance of the borefield from the processing site it is predicted that any potential impacts would be very gradual. Monitoring near the processing site will allow early detection and mitigation measures to minimise potential impacts.

Infrastructure at the processing site with the potential of being a groundwater contamination source includes seepage collection systems and impermeable bases.

5.3 Potential Water Impacts

5.3.1 Contamination Sources

The Project has four key areas including the mine site, processing site, borefield and accommodation village of which two are considered as potential contamination sources. The CSM has been developed based on known and potential contamination sources during operation (i.e. the highest risk period).

Table 5-1 Potential Sources of Contamination

Source / Area	Contaminant of Potential Concern (CoPC)
Mine Site	
Mine Pit Walls	Metals, radioactive and rare earth elements, pH, electrical conductivity and sulfate.
ROM Pad	
Long Term Ore Stockpile	
WRDs	
TSF	
Fuel storage (diesel / petrol storage)	Metals (including cadmium, chromium, copper, lead and nickel) and hydrocarbons (BTEX, BaP, total PAH and TRH).
Landfill	Metals (including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc).
Processing Site	
Evaporation Ponds	Metals, radioactive and rare earth elements, pH, electrical conductivity and sulfate.
Residue Storage Facility	
Fuel storage	Metals (including cadmium, chromium, copper, lead and nickel) and hydrocarbons (BTEX, BaP, total PAH and TRH).
Hazardous Substance Storage	Sulphuric acid, hydrochloric acid, sodium hydroxide (caustic soda), sodium carbonate, carbonate, lime, barium chloride and hydrocarbons (BTEX, BaP, total PAH and TRH).

Note: BaP: Benzo[a]pyrene
BTEX: Benzene, Toluene, Ethylbenzene and Xylenes
TRH: Total Recoverable Hydrocarbon
PAH: Polycyclic Aromatic hydrocarbons

5.4 Potential Receptors

5.4.1 Current Land Use

The Project is currently utilised as a pastoral lease for cattle grazing with stockwater bores installed across the area. The mine site is situated within the Ti-Tree Water Control District which is used for irrigation, stockwater and drinking water. Power and Water Corporation (PWC) drinking water supply for the Laramba community and Napperby Station is located west of the of the Project's borefield within the Southern Basins. Therefore, the current receptors are considered to be:

- Human Health:
  - Drinking water from Ti-Tree and Southern Basins.
- Environment:
  - Irrigation and stockwater within the Ti-Tree and Southern Basins, groundwater recharge of Lake Lewis and overland flows into the Woodford River; and

- Potential Groundwater Dependent Ecosystems (GDE) at Napperby Creek, Day Creek and Woodforde River.

5.4.2 Proposed Land Use

The proposed use of the site is to construct and operate a mine and processing site. The mine will involve the mining of an open pit and construction of associated infrastructure. The processing site will require the construction of RSFs, EPs and a power station. The potential receptors during the operation will be generally consistent with the current land use:

- Human Health:
  - Drinking water from Ti-Tree and Southern Basins.
- Environment:
  - Irrigation and stockwater within the Ti-Tree and Southern Basins, groundwater recharge of Lake Lewis and overland flows into the Woodford River; and
  - Potential GDE at Napperby Creek, Day Creek and Woodforde River.

5.4.3 Future Land Use

Following the 2 year construction and 55 years of operation, the Project area will be rehabilitated and closed. At closure the Project area is considered likely to return to the original land use as a pastoral lease for cattle production. Water use at, and surrounding, the Project is likely to continue to be required for use as drinking water, irrigation and stockwater.

5.5 Potential Operation Source-Pathway-Receptor Linkages

Preliminary source, pathway and receptor linkages have been developed to establish potential linkages. A summary is provided in Table 5-2. Monitoring will be undertaken to assess potential linkages and to inform additional management measures. The monitoring plan is provided in Section 6.

Table 5-2 Conceptual Site Model Summary

Source	Pathway	Receptor	Possible Link and Associated Management Measure(s)	Monitoring
Mine Site				
Open Pit	Vertical migration of pit lake water into saturated zone and horizontal migration.	Woodforde River (via Nolans Creek, Schafer Creek or Hunt Creek) Ti-Tree Basin Pastoral Bores	Unlikely The pit will develop a cone of depression through operations, pit groundwater inflow and surface water captured in the pit will not be able to migrate. In addition, water contained within the pit will be pumped to be used within the Processing water circuit or to the TSF. Post closure the pit will act as a terminal groundwater sink (evaporation losses exceed inputs from runoff, precipitation and groundwater inflows) which will ultimately collect any seepage from mine site infrastructure. In this situation, groundwater will not migrate from the pit.	Nested monitoring bores with quarterly sampling to assess potential impact against the groundwater baseline and up-gradient monitoring wells.
ROM Pad Long Term Ore Stockpile	Overland flow from stockpile bases entering Nolans Creek and ultimately infiltrating into the aquifer. Vertical migration through unsaturated zone into saturated zone and horizontal migration.	Woodforde River (via Nolans Creek), Ti-Tree Basin	Unlikely The ROM Pad and Stockpile Pad will be constructed with impermeable bases ($1x10^{-8}$ m/s) with surface drainage captured within stormwater retention ponds. ROM Pad and Stockpile seepage to groundwater will be collected into the pit following approximately 15 years of operation (Figure 4-1).	Surface water sampling within watercourses during flow events. Sampling of discharges in accordance with the Emergency Overflow Procedure.
TSF	Overflow from structure and entering Nolans Creek and ultimately infiltrating into the aquifer. Vertical migration through unsaturated zone into saturated zone and horizontal migration.		Unlikely TSF constructed with a capacity to capture a 100 year 72 hour ARI plus PMP 72 hour event. Contingency measures will be available to transfer excess water to alternative storage/pit. TSF constructed with low permeability soil liner and seepage collection system. TSF seepage to groundwater will be collected into the pit following approximately 100 years post closure (Figure 4-1).	Surface water sampling within watercourses during flow events. Sampling of discharges in accordance with the Emergency Overflow Procedure. Nested monitoring bores surrounding the TSF with quarterly sampling to assess potential impact against the groundwater baseline and up-gradient monitoring wells.

Source	Pathway	Receptor	Possible Link and Associated Management Measure(s)	Monitoring
WRDs	Surface flow from bases entering adjacent creek system and ultimately infiltrating into the aquifer. Vertical migration through unsaturated zone into saturated zone and horizontal migration.		Possible Excess surface flows to report to stormwater retention ponds. It is unlikely that the WRDs will seep to groundwater because of the climatic conditions at site. If seepage does occur it will flow into the pit following approximately 30 years of operation.	Surface water sampling within watercourses during flow events. Sampling of discharges in accordance with the Emergency Overflow Procedure. Nested monitoring bores near WRDs with quarterly sampling to assess potential impact against the groundwater baseline and up-gradient monitoring wells.
Refuelling area	Vertical migration through unsaturated zone into saturated zone and horizontal migration.		Improbable Fuel stored in self-bunded Above Ground Storage Tanks (ASTs) and Fuel Inventory (Loss Management) monitoring in accordance with the Hazardous Substances Management Plan.	Spills or sabotage will be managed in accordance with the ERMP including the Environmental Investigation Procedure.
Landfill	Seepage through the landfill vertically migrating through the unsaturated zone into the saturated zone and horizontal migration.		Unlikely No hazardous or toxic substances will be landfilled at the Project.	Monitoring bores near landfill with quarterly sampling to assess potential impact against the groundwater baseline and up-gradient monitoring wells.
Processing Site				
Evaporation Ponds Residue Storage Facility	Overflow flowing south and ultimately infiltrating into the aquifer. Vertical migration through unsaturated zone into saturated zone and horizontal migration.	Southern Basins Napperby Creek, Day Creek Lake Lewis (recharge)	Unlikely RSF to have a high density polyethylene (HDPE)/low permeability soil liner system, combined with basin drainage and a leakage collection and recovery system. EPs to have a HDPE liner. RSF and EPs constructed with a capacity to capture a 100 year 72 hour event. Contingency measures will be available to transfer excess water to alternative storage/pit.	Nested monitoring bores near the processing site including up-gradient, adjacent and down-gradient bores with quarterly sampling to assess potential impact against the groundwater baseline and up-gradient monitoring wells.
Fuel storage	Spill or leak from structure flowing off site and ultimately infiltrating into the aquifer. Vertical migration through unsaturated zone into saturated zone and horizontal migration.		Improbable Fuel stored in self-bunded ASTs and Fuel Inventory (Loss Management) monitoring in accordance with the Hazardous Substances Management Plan.	Spills or sabotage will be managed in accordance with the ERMP including the Environmental Investigation Procedure.
Hazardous Substance Storage			Unlikely Hazardous substances stored in a Chemical Storage Shed with internal bunding.	

Note: Scales of Likelihood include improbable, unlikely, possible and probable.

6. Monitoring Program

6.1 Multiple Before-After Control-Impact

Monitoring will be undertaken in accordance with the Multiple Before-After Control-Impact (MBACI) approach due to the large scale and potential for permanent and/or long term water related environmental impacts. The monitoring program has been designed to include:

- Control Sites: upstream / up gradient monitoring sites which monitor background concentrations. Multiple control sites will be utilised.
- Adjacent: monitoring points situated adjacent to potential point sources of contamination (i.e. locations storing Impacted Water, Processing Water), often called ‘point of discharge’.
- Impact Site: downstream / down-gradient monitoring sites. Multiple impact sites will be utilised.

All monitoring sites will be located and installed in locations where the future Project footprint will enable monitoring consistency throughout the Project life.

6.1.1 Sampling Periods

Water quality monitoring combines surface water, sediment and groundwater which will occur upstream/up gradient, adjacent and downstream/down gradient of the Project. The construction period will be used as the baseline period to capture a robust groundwater, sediment and surface water (where available) dataset.

The basis of each phase of monitoring is provided in Table 6-1.

Table 6-1 Sampling Period and Basis

Sampling Period	Duration	Basis
Baseline	24 month	Establish existing conditions at the Project for surface water, sediment and groundwater. Baseline period monitoring will be used to establish a definitive dataset from which potential impacts can be assessed during operation, care and maintenance and/or rehabilitation.
Operation	55 years	Assess monitoring data against baseline to determine if an impact has or is occurring. If significant differences between baseline and operation monitoring periods occur further management measures will be investigated and implemented as required.
Care and Maintenance	-	Assess Project impact to the surrounding environment through care and maintenance activities (i.e. minimal activities and/or management occurring). If significant differences between baseline and care and maintenance monitoring periods occur further management measures will be investigated and implemented as required.
Rehabilitation	-	Utilise baseline sampling data as the ultimate rehabilitation goal for groundwater, sediment and surface water.

6.1 Monitoring Summary

The monitoring program has been designed to capture both baseline conditions and assess potential impacts from the operation. Monitoring will ultimately be utilised to assess if the Project is impacting the surrounding environment and to inform rehabilitation goals. A summary of the monitoring program is provided in Table 6-2 and Table 6-3.

The monitoring sites will be updated following finalisation of the Mine, processing site and Borefield design.

Table 6-2 Baseline Monitoring

Monitoring	Number of Locations	Frequency / Date	
		Field Measurements	Field and Laboratory
Mine Site			
Surface Water	15	-	Early flows and late flows#
Groundwater	48	Biannual	Quarterly
Groundwater – up-gradient boundary bores MB101A and MB101B*	2	Monthly	Monthly
Sediment	15	-	Biannual
Photopoint Monitoring	15	Biannual	-
Processing Site			
Groundwater	42	Biannual	Quarterly
Groundwater – up-gradient boundary bores MB201A and MB201B*	2	Monthly (baseline period) Biannual (operations)	Monthly (baseline period) Quarterly (operations)
Borefield			
Groundwater	12	Quarterly	Biannual
Production Wells	5	Quarterly	Biannual

Note: # Due to the flow characteristics of the adjacent waterways sampling has been scheduled to be undertaken during flow events where a minimum of 0.1 m flowing water is present.
* The groundwater up-gradient boundary bore will be monitored monthly throughout the 24 month baseline period to collate sufficient data to determine site specific trigger values for the mine site and processing site.

Table 6-3 Operational Monitoring

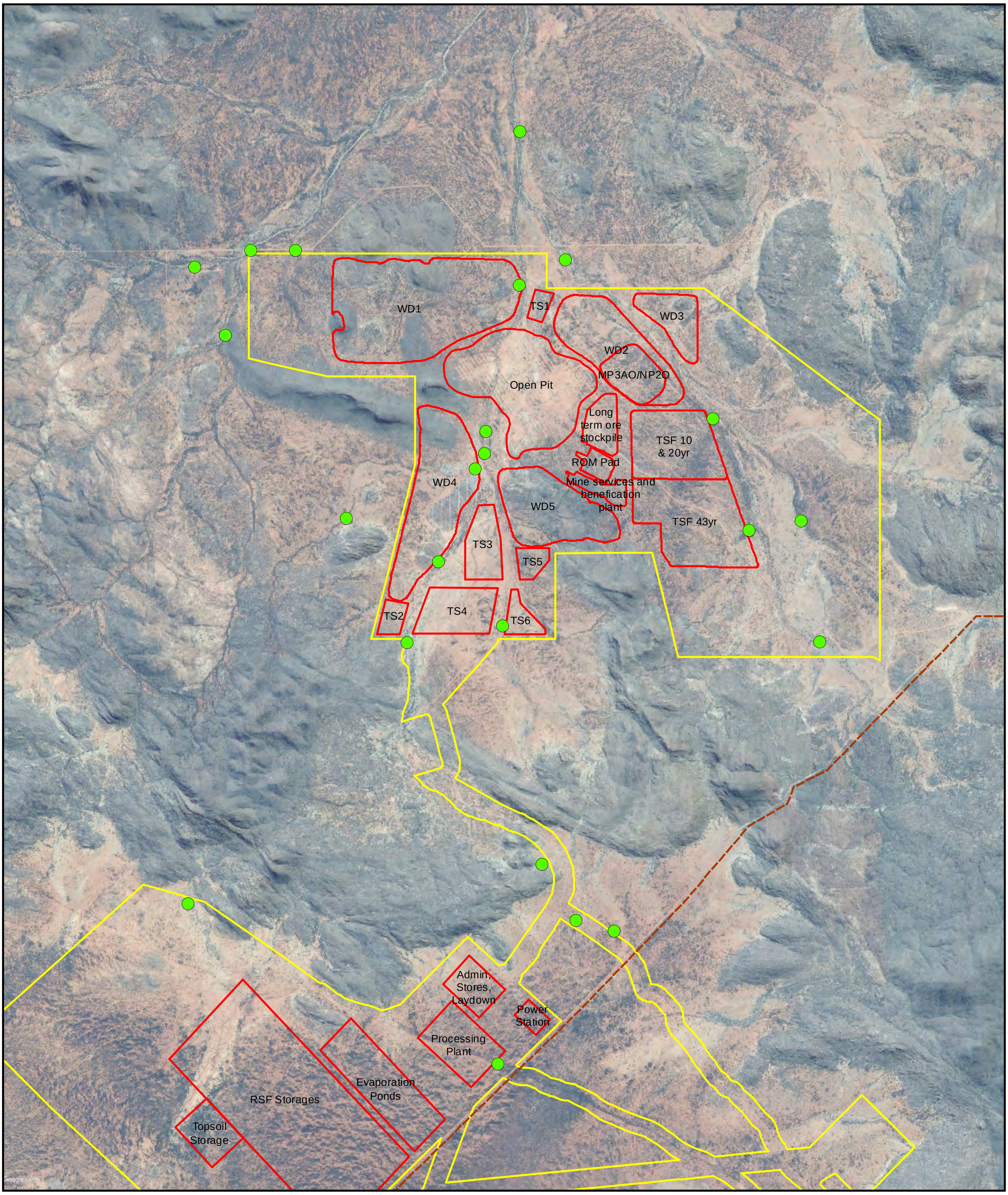
Monitoring	Number of Locations	Frequency / Date	
		Field Measurements	Field and Laboratory
Mine Site			
Surface Water	15	-	Early flows and late flows#
Stormwater Retention Ponds	14	Fortnightly	Quarterly
Groundwater	50	Quarterly	Quarterly
Sediment	15	-	Annually
Photopoint Monitoring	15	Annual	-
Open Pit	1	Monthly	Quarterly
Flotation Tailings Storage Facility	1*	Monthly	Quarterly
Processing Site			
Groundwater	44	Quarterly	Quarterly
Stormwater Retention Ponds	2	Fortnightly	Quarterly
Residue Storage Facilities	2*	Monthly	Quarterly
Evaporation Ponds	3*	Monthly	Quarterly
Borefield			
Groundwater	17	Monthly	Quarterly
Accommodation Village			
Stormwater Retention Ponds	1	During discharge events	Biannual

Note: # Due to the flow characteristics of the adjacent waterways sampling has been scheduled to be undertaken during flow events where a minimum of 0.1m flowing water is present.
***** Current design is being finalised, sampling will include one sample per cell.

6.2 Surface Water

6.2.1 Hydrostations

Twenty three (23) Arafura hydrographic stations have been constructed in the Nolans Region on Kerosene Camp Creek and at the site of the proposed Arafura beneficial treatment plant near Old Albs Bore. The hydrographic stations include 20 three stage automatic water samplers and 11 seven stage automatic water samplers (Figure 6-1). The hydrostation monitoring includes automatic creek flow water samplers and basic maximum flow height gauges, It is planned to increase the number of hydrographic stations in the NE Southern Basins and its catchment area, upgrade the sophistication of key hydrostations (hydrograph data loggers, sampling water for chemical analysis) and commence sediment and bed load sampling.



LEGEND

- Hydrostations
- Gas pipeline
- Proposed infrastructure
- Site boundary

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0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number	43-22529
Revision	0
Date	20 Oct 2017

Hydrostation locations

Figure 6-1

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Level 5, 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: ESRI - Shaded Relief (2009). Google Earth Pro - Imagery (Date extracted: 20/10/2017). ARL - Site boundary (2015). GHD - Proposed infrastructure, Hydrostations (2017). Created by: CM

6.2.2 Sampling / Monitoring Locations

The Project has been designed as a nil discharge site with any potential discharge from the Project considered to stay within the local vicinity of the Project footprint and infiltrating to groundwater.

There are a total of seven surface water sampling locations across the mine site. The surface water monitoring locations are situated within pre-existing waterways with the exception of SW04 which is located within the creek realignment. The other surface water monitoring locations include seven control sites and six impact sites (i.e. downstream of any potential discharge into the adjacent waterways).

The processing site is located on an alluvial fan in the upper catchment of the north eastern section of the Southern Basins and as such there are limited watercourses that can be monitored.

Stormwater sediment retention basins will be installed across all Project areas, the potential locations of stormwater basins are provided with in the ESCP. However, this is subject to change through the detailed design phase.

Samples will also be collected from the pit, TSF, RSF and EPs. These samples will be used to characterise the water quality from these facilities and will be used as reference when assessing potential impacts to groundwater and/or unexpected overflows.

A summary of surface water sampling locations and sampling frequencies are provided in Table 6-4. The mine site surface water sampling locations are illustrated on Figure 6-2 and Figure 6-3. The surface water sampling procedures including sampling to be undertaken in the case of an uncontrolled discharge are provided in the Surface Water Sampling Procedure (Appendix A).

Table 6-4 Surface Water Monitoring Locations

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Surface Water						
SW01	322051	7499080	Control	Nolans Creek Upstream of the TSF.	Early and late flows with a minimum of 0.1 m flowing water.	
SW02	317602	7499000		Unnamed Creek Upstream of TSF and TS2 and TS4.		
SW03	320920	7501690	Adjacent	Nolans Creek Downstream of TSF and upstream of WRD 2.		
SW04	317700	7501770	Impact	Creek Realignment Downstream of WRD 4, 5 and TS2, 3, 4 within the inlet to the creek realignment.		
SW05	316311	7503570	Impact	Creek Realignment Downstream of WRD 1 and prior to the outlet of the realignment.		
SW06	319408	7503360		Nolans Creek Downstream of TSF, WRD 2 and 3.		
SW07	318901	7503400		Kerosene Camp Creek Downstream of WRD 1, 2 and Pit.		
Stormwater sediment retention ponds						
SB01	316811	7503270	-	WRD 1	-	Field measurements fortnightly. Field and laboratory sample assay suite quarterly.
SB02	318920	7502980	-	WRD 1		
SB03	319775	7502920	-	WRD 2		
SB04	320206	7502940	-	WRD 4		
SB05	318807	7500960	-	WRD 4		
SB06	318414	7500830	-	WRD 5		
SB07	317753	7500990	-	WRD 5		
SB08	318816	7499560	-	TS4		
SB09	319997	7500240	-	WRD 3		
SB10	319426	7500890	-	ROM Pad		
SB11	319671	7501120	-	Mining Services		
SB12	320023	7500810	-	ROM Pad		
SB13	319659	7501470	-	Mining Services		
SB14	319613	7501000	-	Stockpile		
SB15	318941	7494550	-	RE Plant Compound		
SB16	318815	7494600	-	Power Station		
SB17	322497	7492990	-	Accommodation Village		

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Mine Pit and Processing Infrastructure						
Mine Pit Sump	*tbc*	*tbc*	-	Mine Pit sump water (i.e. groundwater inflow).	-	Field measurements monthly. Field and laboratory sample assay suite quarterly.
TSF	320125	7501040	-	TSF ponded water.		
RSF 1	*tbc*	*tbc*	-	RSF ponded water.		
RSF 2	*tbc*	*tbc*	-	RSF ponded water.		
EP 1	*tbc*	*tbc*	-	EP water.		
EP 2	*tbc*	*tbc*	-	EP water.		
EP 3	*tbc*	*tbc*	-	EP water.		

6.2.3 Sample Assay Suites

The sampling suite for surface water quality includes either field measurement or field and laboratory measurements. The suites are summarised as follows:

- Field Measurements

  Temperature, pH, Electrical Conductivity, Total Dissolved Solids, Turbidity and Oxidation Reduction Potential. Depth at location and photopoint monitoring (photos of sample location, upstream and downstream).

- Field and Laboratory Measurements

  In field: Temperature, pH, Electrical Conductivity, Total Dissolved Solids, Turbidity and Oxidation Reduction Potential. Depth at location and photopoint monitoring (photos of sample location, upstream and downstream).

  Laboratory Analysis

  – Total suspended solids (TSS)
  – Total hardness
  – Total acidity and alkalinity;
  – Major ions ($CaCO_3$, CO_3, HCO_3, Ca, Mg, K, Na, Cl, SO_4, NO_3)
  – Metals total and dissolved[2]: Al, As, B, Ba, Cd, Co, Cu, Fe, Li, Pb, P, Mn, Hg, Mo, Ni, Rb, Se, Sr, Ag, U, Th and Zn

Note – these are indicative analytes. The final suite of analytes will be determined following review of existing baseline data.

6.2.4 Surface Water Trigger Values

Surface water trigger values are unable to be determined for the Project at this time due to the ephemeral nature of the creeks. Due to limited flow events to date, limited baseline data has been collected and trigger values will be determined as sufficient data becomes available.

Stormwater sediment retention ponds and processing infrastructure have been designed to capture and contain precipitation across the project site. The stormwater sediment retention basin capacities will be designed in the detailed project design phase. However, in the unlikely event of an uncontrolled discharge from the site, sediment in addition to surface water sampling (where available) will be undertaken. This will be assessed against any baseline data collected and same day control site samples.

6.2.5 Seepages

Water retention structures including stormwater sediment retention ponds, will be installed across the site to reduce potential impacts on the receiving environment from TSF, RSF and EP. If seepage is identified during routine inspections the following will be undertaken:

1. Location and Extent: a summary of the location of the seep will be recorded and indicated on a map. The extent of the seep will be recorded including visible on the ground and surface water influence.
2. Volume: the volume of seepage will be recorded as an estimate in (L/minute or L/day).
3. Duration: the duration including commencement and ceasing date will be recorded.
4. Photographs: a photographic log will be taken to visualise the seep.

[2] Samples for dissolved metals are field filtered using 0.45 µm Stericup filter or similar.

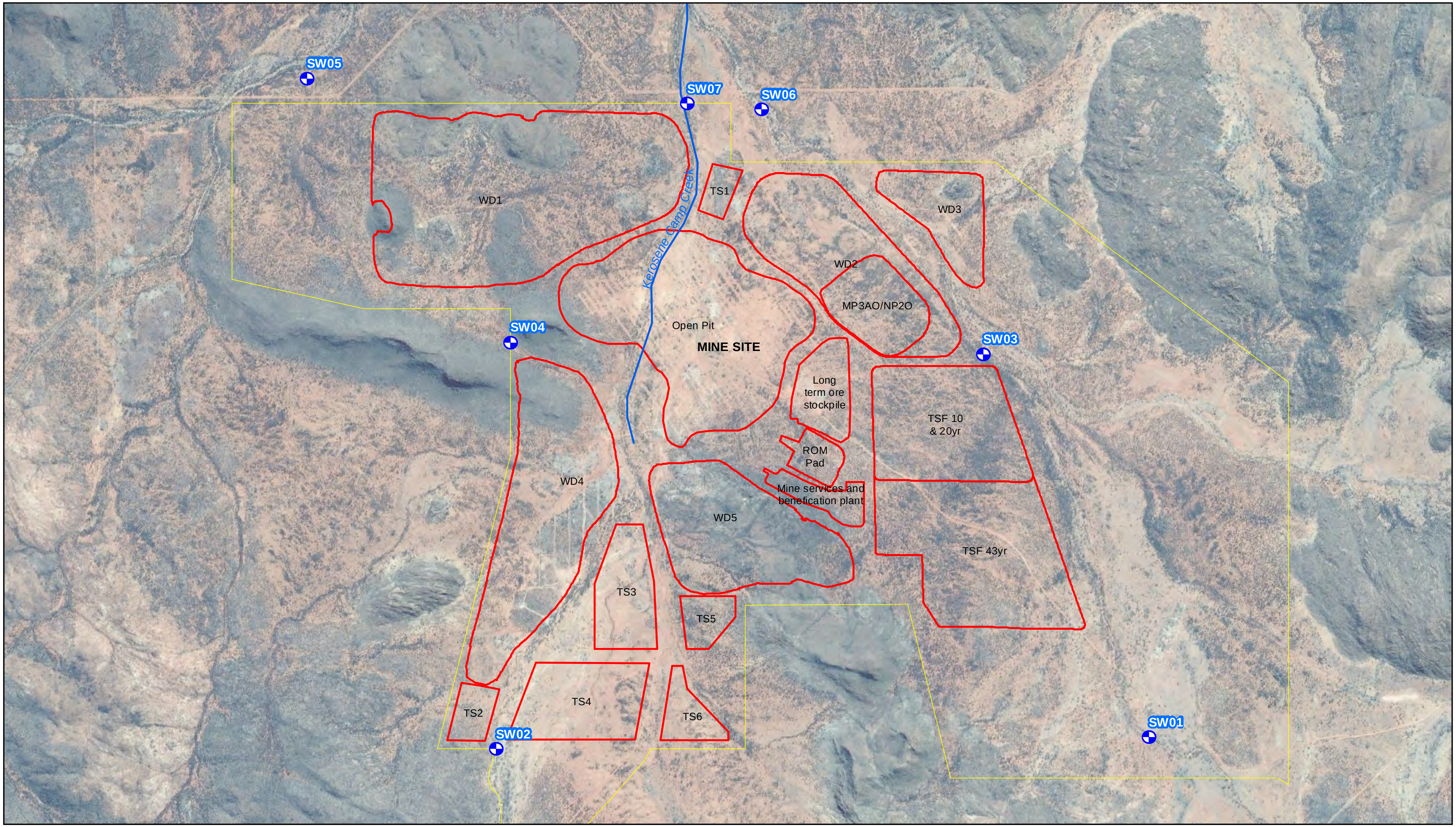
5. Sampling – Field: field water quality of the seep will be undertaken.
6. Sampling – Laboratory: if sufficient water can be collected and/or the seep continues for three consecutive days a laboratory sample will be collected.

6.2.6 Discharges / Emergency Overflows

Mine site infrastructure has the potential to overflow during significant rainfall events. In the event of a discharge (stormwater overflowing basins), the discharge water and receiving waterbodies will be sampled. Sampling will be undertaken daily during discharges including field and laboratory suites.

The standard surface water sampling procedures will be followed in addition to the following:

1. Location and Extent: a summary of the location of the discharge will be recorded and indicated on map including estimation of its extent.
2. Volume: the volume of discharge will be recorded daily as an estimate in L/minute.
3. Duration: the duration including commencement and ceasing date will be recorded.
4. Photographs: a photographic log will be taken at the Sample locations (discharge location, upstream and downstream).
5. Sampling – Field: daily field water quality of the discharge will be undertaken.
6. Sampling – Laboratory: daily laboratory sampling of discharge, upstream and downstream receiving environment locations.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Surface water

Proposed infrastructure

Site boundary

Borefield area

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number 43-225929
Revision 0
Date 20 Oct 2017

Monitoring Locations Surface Water

Figure 6-2

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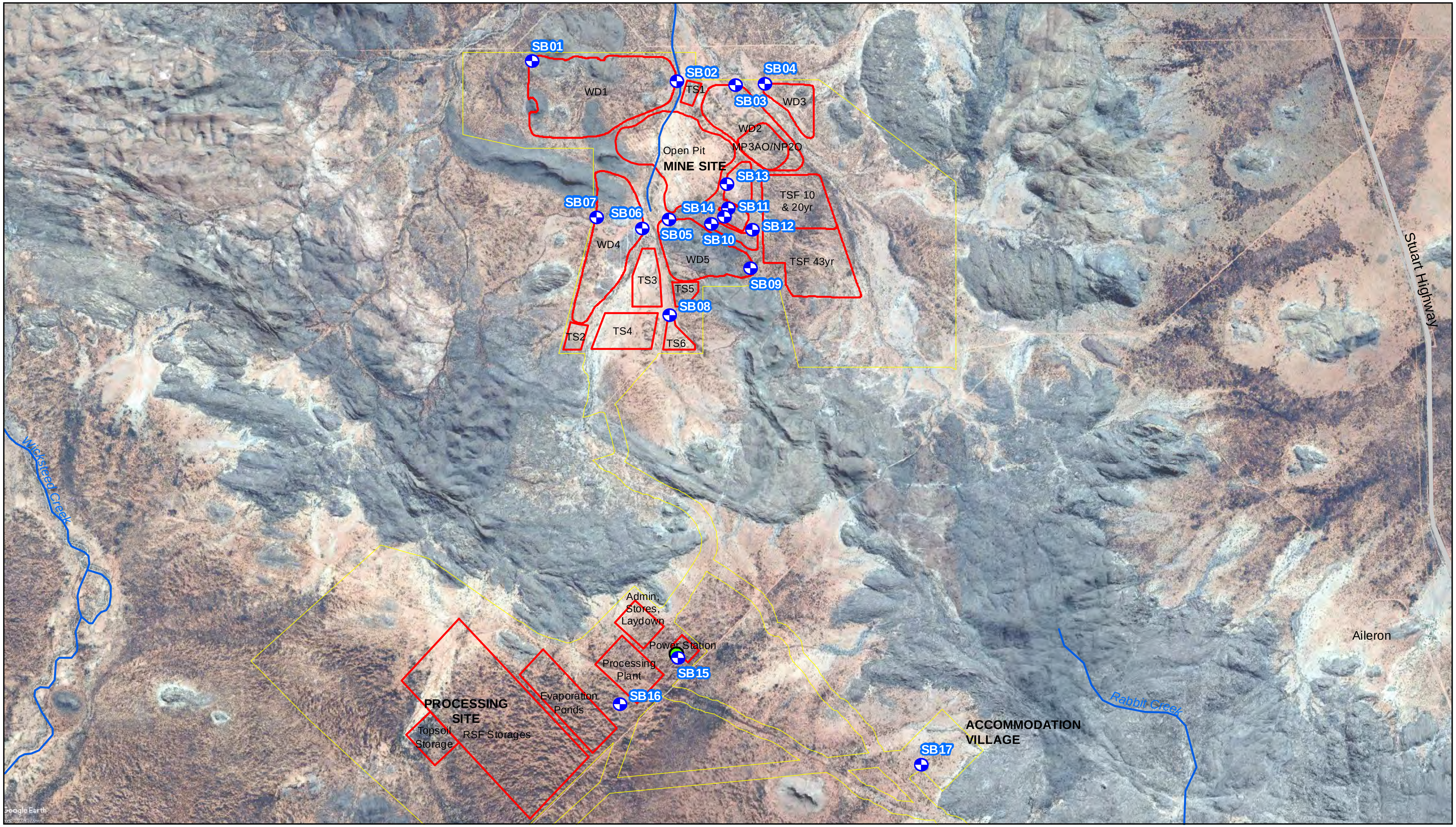
Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 25/07/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Stormwater sediment retention ponds
- Power Station
- Waterways
- Proposed infrastructure
- Study boundary

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number	43-225929
Revision	0
Date	19 Oct 2017

Monitoring Locations
Stormwater Sediment Retention Ponds

Figure 6-3

G:\43\22301\GIS\Maps\4322529_005.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

6.3 Groundwater

6.3.1 Sampling / Monitoring Locations

Mine Site and Processing Site

Groundwater contamination has the potential to cause long term impacts. The distance between potential contamination sources such as the TSF, RSF, ROM Pad and long term ore stockpiles and monitoring locations potentially influences contaminant concentrations. Monitoring will be undertaken adjacent to the point of potential contaminant discharge and at boundary locations.

The mine site will include an array of nested monitoring bore locations across the mine site at selected sites to monitor potential contaminant sources. Monitoring will also occur at or near the mining lease boundary. The monitoring bores will be utilised to assess potential impact to groundwater quality and assist in validating the groundwater model.

The processing site will also include an array of monitoring locations near potential contaminant sources at the lease boundary. These monitoring bores will be used to confirm groundwater flow direction and monitor groundwater quality.

Site Specific Groundwater Trigger Values (SSGTVs) will be determined from up-gradient monitoring bores. The location of these monitoring bores will be finalised once detailed design of project infrastructure is complete.

A monitoring network will be established across the borefield to confirm and monitor aquifer performance. The network will act to safeguard the water supply for the life of the Project whilst ensuring that impacts are minimised. The monitoring bores will be utilised to assess potential impact to groundwater quality, to assist in validating the groundwater model and developing a class 2 or 3 groundwater model.

A summary of sampling locations are provided in Table 6-5 and illustrated on Figure 6-4 to Figure 6-6. The groundwater sampling methodology is provided within the Groundwater Sampling Procedure (Appendix C).

Table 6-5 Preliminary Groundwater Monitoring Locations

Note - Table to revised in line with completed detailed designs. Locations and sample frequencies to be revised accordingly.

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
Mine Site								
MB101A	317968	7498230	Boundary (up-gradient)	1 km south of TS4.	Automatic Logger	Quarterly	Automatic Logger	Quarterly
MB101B						Monthly		
MB102A	316379	7500460	Boundary	1 km west (up-gradient) of WRD 4.	Quarterly	Biannual	Quarterly	Quarterly
MB102B								
MB103A	322474	7498280		1 km southeast (up-gradient) of TSF.	Automatic Logger		Automatic Logger	
MB103B								
MB104A	319090	7503560		Initially downgradient becoming up-gradient during mining. North of the Mine Site prior to the confluence of Kerosene Camp Creek and Nolans Creek.	Quarterly		Quarterly	
MB104B								
MB105A	318964	7504440		1 km north of the Mine Site, initially downgradient becoming up-gradient during mining.	Quarterly		Quarterly	
MB105B								
MB106A	318925	7505550		2 km north of the Mine Site, initially downgradient becoming up-gradient during mining.	Automatic Logger		Quarterly	
MB106B								
MB107A	321727	7504000		1 km northeast of the Mine Site within a potential preferential pathway. Initially downgradient becoming up-gradient during mining.	Quarterly		Quarterly	
MB107B								
MB108A	318450	7499020	Adjacent	South of TS4.	Automatic Logger	Biannual	Automatic Logger	Quarterly
MB108B								
MB109A	319603	7500020		South of WRD 5.	Quarterly		Quarterly	
MB109B								
MB110A	317682	7500910		East of WRD 4.	Quarterly		Quarterly	
MB110B								
MB111A	318631	7501490		Northeast of WRD 4, adjacent to southwest LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB111B								
MB112A	317496	7502120		South of WRD 1.	Quarterly		Quarterly	
MB112B								

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB113A	316606	7502810		West of WRD 1.	Automatic Logger		Automatic Logger	
MB113B								
MB114A	318323	7503380		North of WRD 1.	Quarterly		Quarterly	
MB114B								
MB115A	319250	7502500		West of WRD 2 and adjacent to north of LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB115B								
MB116A	320639	7503000		North of WRD 3.	Automatic Logger		Automatic Logger	
MB116B								
MB117A	321012	7502580		East of WRD 3.	Quarterly		Quarterly	
MB117B								
MB118A	320076	7501700		South of WRD 2 and north of TSF.	Quarterly		Quarterly	
MB118B								
MB119A	320798	7501680		North of TSF.	Quarterly		Quarterly	
MB119B								
MB120A	321330	7500900		East of TSF.	Quarterly		Quarterly	
MB120B								
MB121A	321647	7499990		East of TSF.	Quarterly		Quarterly	
MB121B								
MB122A	321384	7499230		South of TSF.	Automatic Logger		Automatic Logger	
MB122B								
MB123A	320575	7499700		West of TSF.	Quarterly		Quarterly	
MB123B								
MB124A	320059	7500890		West of TSF.	Quarterly		Quarterly	
MB124B								
MB125A	319494	7501200		West of ROM Pad and adjacent to southeast LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB125B								
Processing Site								
MB201A	315982	7495630	Boundary (up-gradient)	500 m north (up-gradient) of Processing Site.	Automatic Logger	Monthly	Automatic Logger	Quarterly
MB201B							Quarterly	
MB202A	317592	7495430	Boundary (up-gradient)	1 km north (up-gradient) of Processing Site.	Quarterly	Biannual	Quarterly	Quarterly
MB202B								
MB203A	315364	7495500	Adjacent	North of RSF.				
MB203B								

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB204A	314179	7495310		West of RSF.				
MB204B								
MB205A	314023	7494290		South of RSF.				
MB205B								
MB206A	316275	7494580		North of RSF.				
MB206B								
MB207A	315104	7493821		South of RSF.				
MB207B								
MB208A	315959	7492984		South of RSF.				
MB208B								
MB209A	316409	742509		South of RSF.				
MB209B								
MB210A	317538	7493261		East of RSF.				
MB210B								
MB211A	317604	7493990		North of RSF and south of the Processing plant.				
MB211B								
MB212A	317910	7494160		North of Processing plant.				
MB212B								
MB213A	318209	7494000		East of the Processing plant.				
MB213B								
MB214A	317941	7493800		South of the Processing plant.				
MB214B								
MB215A	318815	7494600		East of the Power Station.				
MB215B								
MB216A	318921	7494500		South of the Power Station.				
MB216B								
MB217A	319262	7494814		East of the Power Station.				
MB217B								
MB218A	319149	7494894		North of the Power Station.				
MB218B								
MB219A	314541	7492830	Down gradient	1 km south of Processing Site.				
MB219B								
MB220A	312476	7492290		2 km south of Processing Site.				
MB220B								

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB221A	316148	7492017	Up gradient	North of the landfill	Quarterly	Biannual	Quarterly	Quarterly
MB221B								
MB222A	315856	7491668	Down gradient	South of the landfill				
MB222B								
Borefield								
MB301	307737	7486578	Monitoring Bores		Automatic Logger	Biannual	Automatic Logger	Biannual
MB302	306717	7489358		Near approximate north boundary of borefield area, near Wicksteed Creek	Quarterly		Quarterly	
MB303	308810	7481514			Quarterly		Quarterly	
MB304	316208	7483218		Napperby Road, east of approximate borefield area	Quarterly		Quarterly	
MB305	310994	7479431			Quarterly		Quarterly	
MB306	308085	7474047		Near approximate south east boundary of borefield area	Automatic Logger		Automatic Logger	
MB307	307503	7477907			Quarterly		Quarterly	
MB308	300813	7480880			Automatic Logger		Automatic Logger	
MB309	300539	7478871			Quarterly		Quarterly	
MB310	284436	7481989			Automatic Logger		Automatic Logger	
MB311	281277	7488098		Western boundary of approximate borefield	Automatic Logger		Automatic Logger	
MB312	325620	7488200		Rabbit Creek	Quarterly		Quarterly	
SB008	308109	7479250	Production Bore	Borefield access track	Quarterly	Biannual	Quarterly	Biannual
SB015	301290	7479850		Borefield access track				
SB021	294454	7482340		Borefield access track				
SB025	288460	7483290		Borefield access track				
SB027	304196	7484910		Borefield access track				

Note: A = shallow monitoring well.
B = deep monitoring well.
Not all sites allocated A and B bores will require nested or adjacent deep and shallow bores. Hydrogeological conditions should assessed during drilling to determine this. Likewise, site specific conditions may negate the need to drill all of the aforementioned bores and should be reassessed based on local hydrogeological conditions.

6.3.2 Sample Assay Suites

The sampling suite for surface water quality includes either field measurement or field and laboratory measurements. The suites are summarised as follows:

- Field measurement:
  - Standing water level
  - Standing water level and laboratory measurements
  - Standing water level and purged water quality characteristics including temperature, pH, electrical conductivity, total dissolved solids, turbidity and oxidation reduction potential.
- Laboratory analysis:
  - Total Suspended Solids, Total Hardness and Total Acidity and Alkalinity
  - Major ions ($CaCO_3$, CO_3, HCO_3, Ca, Mg, K, Na, Cl, SO_4, NO_3)
  - Metals total and dissolved (0.45 µm field filtered[3]): Al, As, B, Ba, Cd, Co, Cu, Fe, Li, Pb, P, Mn, Hg, Mo, Ni, Rb, Se, Sr, Ag, U, Th and Zn
  - Radionuclides (U-238, U-234, Th-230, Ra-226, Rn-222, Pb-210, Po-210, Th-232, Ra-228, Th-228). Radionuclides will be tested annually at representative bores only.

Note – these are indicative an analyte suite and the final suite will be determined following review of baseline data. Sub-suites are also highly likely to be established following this baseline assessment with metals and radionuclides being highly likely to be removed from the majority of background and borefield locations.

6.3.3 Groundwater Trigger Values

The Project is situated in a predominately undeveloped area, natural variation in groundwater quality exists and will be further established through a baseline assessment in order to understand the Project potential impact over its lifetime, in accordance with ANZEC/ARMCANZ (2013). The current level of understanding of groundwater properties does not allow the adoption or determination of appropriate trigger values such as ANZECC/ARMCANZ, as illustrated summarised in Section 4.2.8.

Additional baseline data is required to inform an effective monitoring program and to establish site specific trigger values. The length of baseline monitoring will be sufficient to establish natural variability of groundwater quality in the area. The baseline at the mine site and processing site will be established over a two year period (i.e. the construction phase). The data will be collected from up-gradient and boundary bores at both sites which will be monitored on a quarterly basis. The 80th percentile values will be utilised to develop Site Specific Groundwater Trigger Values (SSGTVs).

Adjacent land use and the ultimate end land use of the Project is likely to be a pastoral lease (cattle grazing), therefore in addition to the SSGTVs, groundwater monitoring data will be reviewed against ANZECC Stock Watering for closure and rehabilitation purposes.

Trigger Value Assessment

Groundwater monitoring results will be assessed against SSGTVs during operation as follows:

- Toxicants (Metals) – 95th percentile of concentration values across a quarter will be assessed against trigger values and reference site; and
- Physical and Chemical Stressor – median concentration values across a quarter will be assessed against the 80th percentile at the reference site.

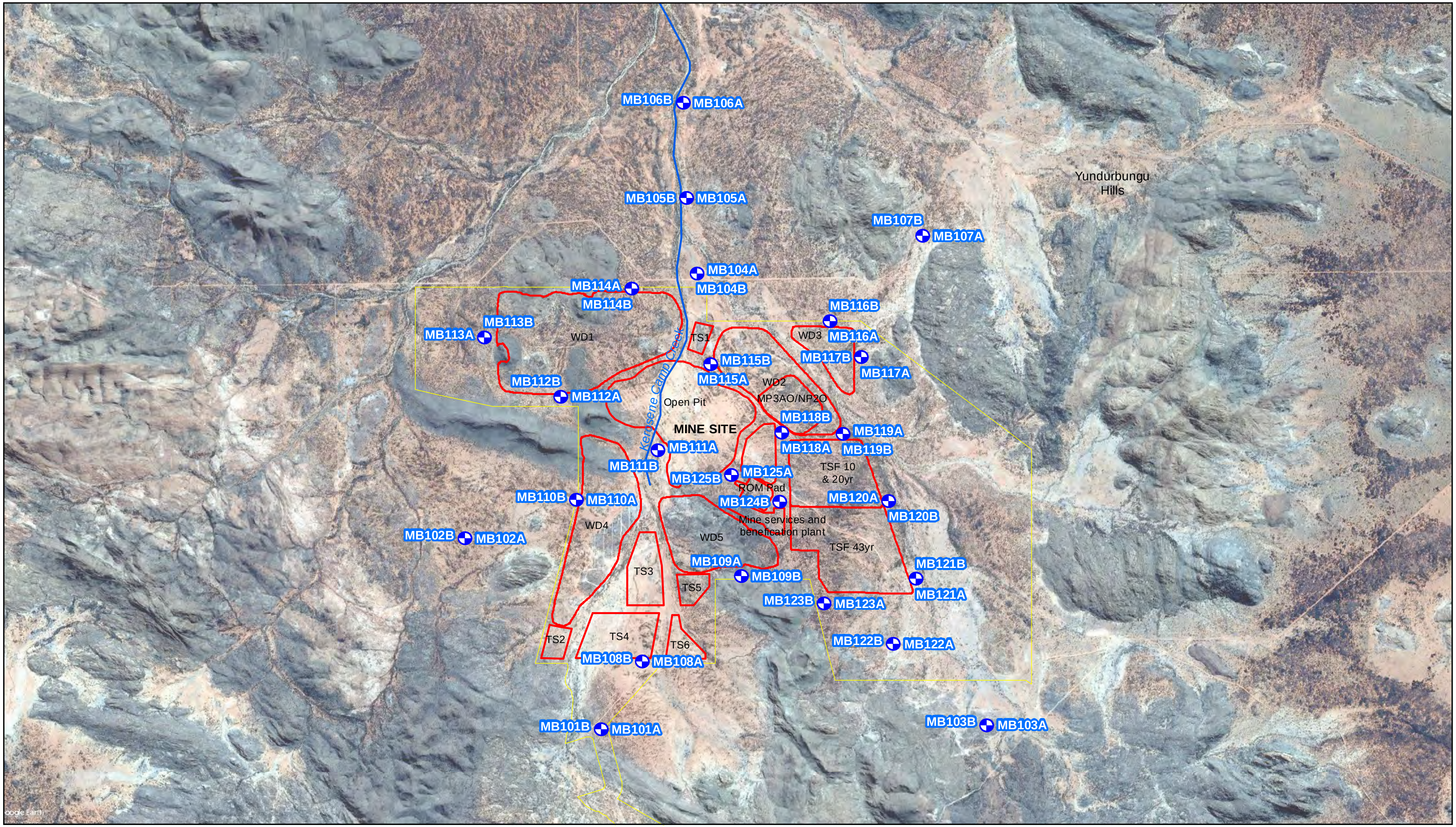
[3] Samples for dissolved metals are field filtered using 0.45 µm Stericup filter.

If concentrations exceed trigger values as defined by the above criteria, investigations will be undertaken to identify management measures to be implemented if risks are considered to be significant.

Contingency plans specific to Acid Metalliferous Drainage (AMD) management at the site would need to be implemented if any AMD issues result in an exceedance of ground or surface water quality when assessed against site-specific trigger values. This approach would involve undertaking an investigation to identify ‘root cause’ whereby the causal link for the water quality exceedance would be determined. Adaptive management would then seek to implement an appropriate alternate management strategy to eliminate any future risk of a repeat, given the nature of the incident.

Trend Assessment

The principal objective of the monitoring programs will be to assess change over time. A trend analysis will be utilised to determine potential impact to groundwater and assess if the impact is increasing, decreasing or constant.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Groundwater monitoring locations
- Proposed infrastructure
- Waterways
- Study boundary

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Environmental Impact Statement

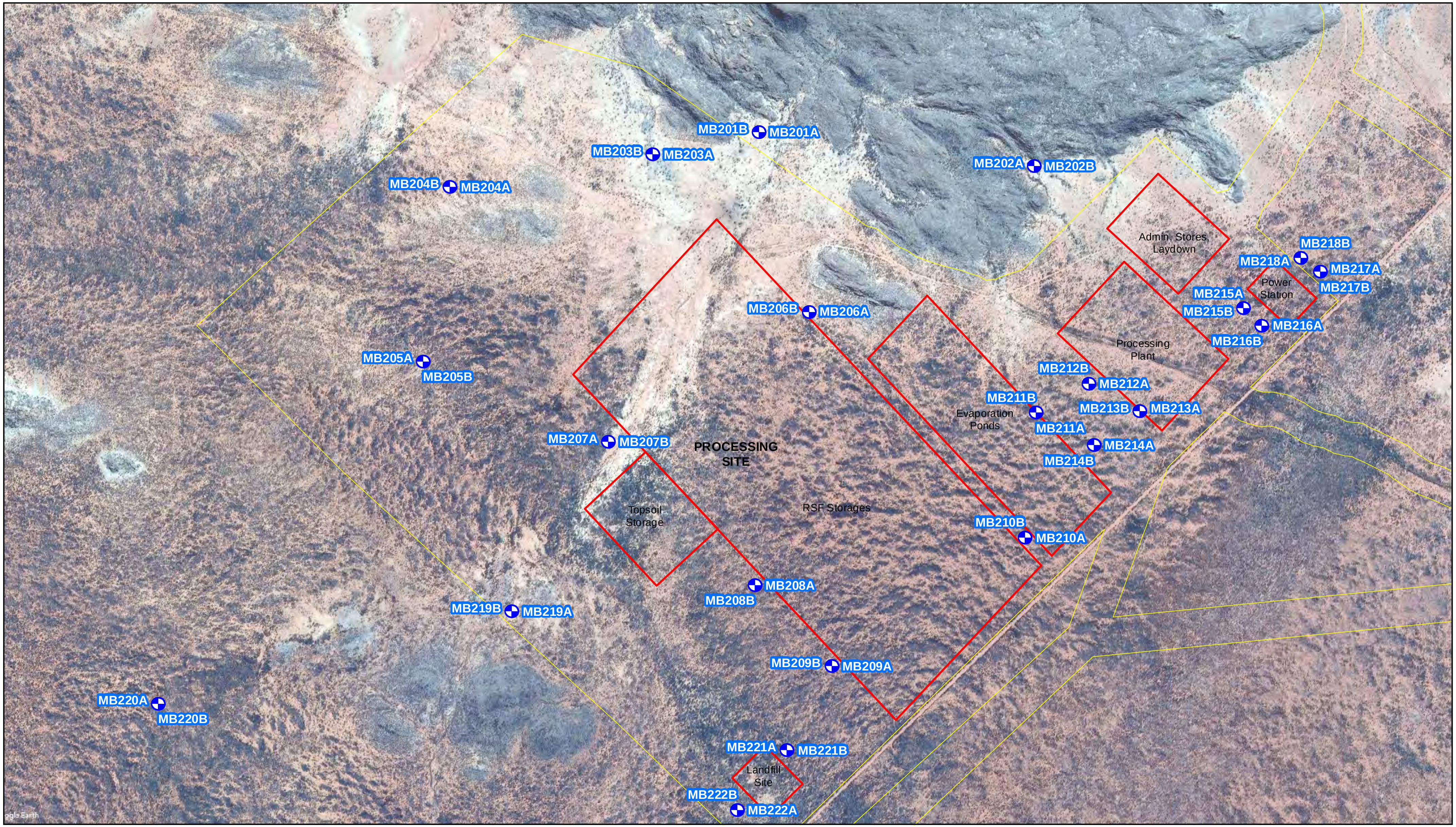
Job Number	43-225929
Revision	0
Date	19 Oct 2017

Groundwater monitoring locations

Figure 6-4

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Groundwater monitoring locations
- Waterways
- Proposed infrastructure
- Study boundary

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Environmental Impact Statement

Job Number	43-225929
Revision	0
Date	20 Oct 2017

Groundwater monitoring locations

Figure 6-5

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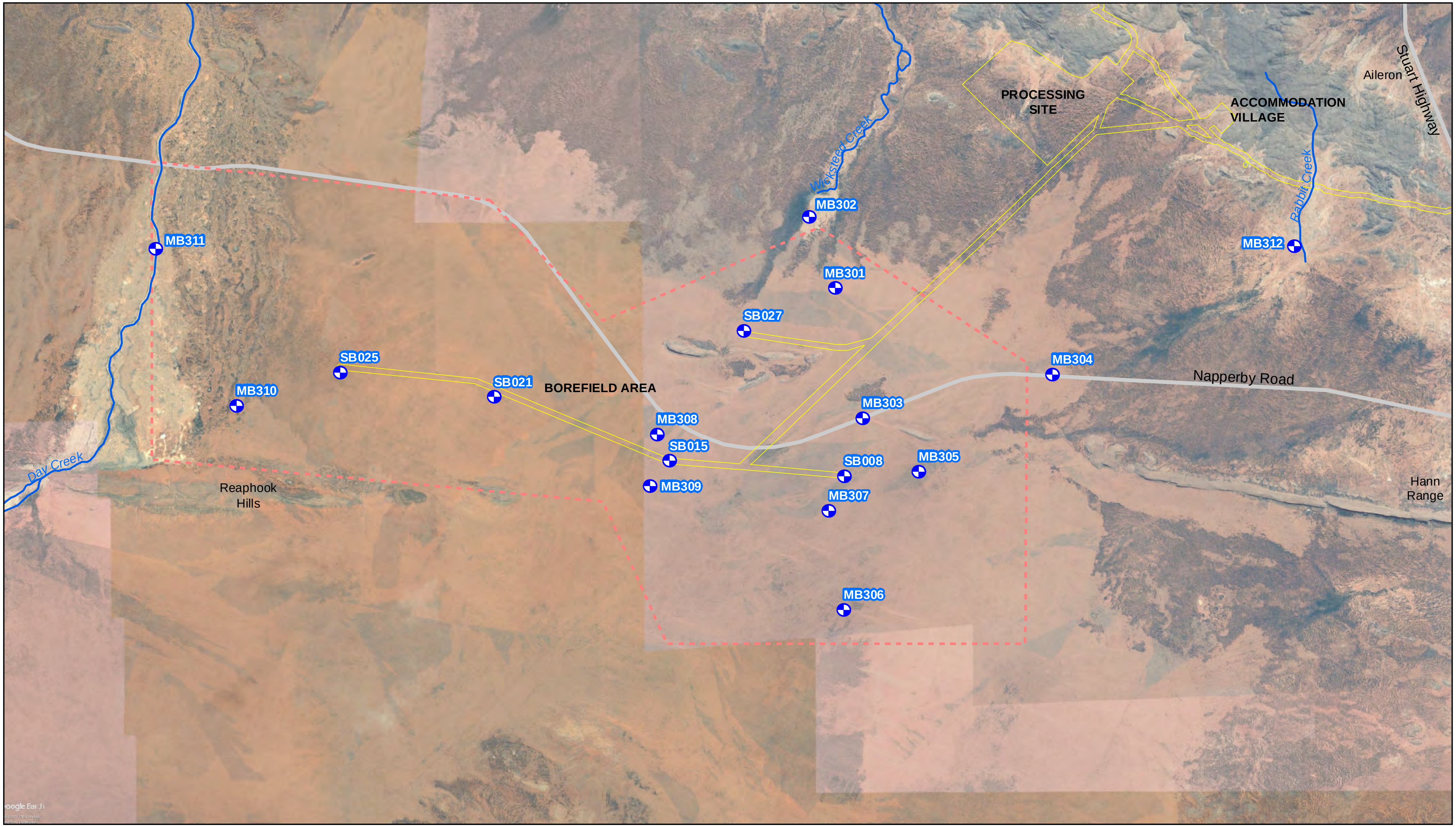
Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

Borefield
Borefield Area
Waterways
Study Area

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number 43-22529
Revision 0
Date 19 Oct 2017

Monitoring Locations Borefield

Figure 6-6

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Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 25/07/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

6.4 Sediment

6.4.1 Monitoring Locations

Sediment sampling will be undertaken when samples are available to augment the water quality sampling. The purpose of sediment sampling will be to characterise the quality of sediments within the flow channels. Sediment sampling locations are proposed to coincide with the above-mentioned surface water monitoring locations at the mine site.

A summary of sampling locations and suites are provided in Table 6-4 and illustrated on Figure 6-2 and Figure 6-3. Biannual baseline and annual operational sediment sampling at each site is recommended. The sediment sampling procedures are provided in the Sediment Sampling Procedure (Appendix B).

6.4.2 Sampling Assay Suite

The sampling suite for sediment includes photopoint monitoring and laboratory measurements as follows:

- Photopoint Monitoring; and
- Laboratory Analysis:
  - Metals, U, Th, P and Sr
  - Rare Earths element suite.

Note – the Nolans deposit has a unique geochemical signature and the above analytes will enable early detection within sediments.

6.4.1 Sediment Trigger Values

Sediment has the potential to be a source for dissolved contaminants. In general, sediments represent a source of bioavailable contaminants to benthic biota and are therefore a threat to the aquatic food chain. However, the Projects location and the aforementioned limited aquatic fauna makes the use of ANZECC Interim Sediment Quality Guidelines (ISQG) inappropriate.

In some instances there are no guidelines for a specific contaminant due to an absence of baseline data. The recommended interim approach is to derive a value on the basis of natural background (control) concentration multiplied by an appropriate factor (ANZECC 2000a recommends a factor of 2).

Baseline Assessment

Sediment monitoring results will be assessed against baseline and reference sites to determine if there is a significant increase. A minimum of three baseline samples will be collected.

Trend Assessment

The principal objective of the monitoring programs will be to assess change over time. A trend analysis will be utilised to determine potential impact to groundwater and assess if the impact is increasing, decreasing or constant.

7. Monitoring Program - Quality Assurance and Quality Control

Quality Assurance (QA) involves all of the actions, procedures, checks and decisions, undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results (National Environmental Protection Council, 1999). Quality Control (QC) involves protocols to monitor and measure the effectiveness of QA procedures.

The QA/QC procedures outlined in the following Sections are based on AS 5567.1 – 1998 and will be implemented during sampling.

7.1 Data Quality Indicators

To minimise the potential for unrepresentative data, the following Data Quality Indicators (DQIs) will be used to evaluate sampling techniques and laboratory analysis of collected samples:

- **Data representativeness** - expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples in an appropriate pattern across the Project, and by using an adequate number of sample locations to characterise the site. Consistent and repeatable sampling techniques and methods are utilised throughout the sampling program.
- **Completeness** - defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set as being sufficient valid data generated during the monitoring program. If there is insufficient valid data, then additional data are required to be collected.
- **Comparability** - is a qualitative parameter expressing the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the data is assessed by calculating the Relative Percent Difference (RPD) between duplicate sample pairs.

  $$RPD(\%) = \frac{|C_o - C_d|}{C_o + C_d} \times 200$$

  Where C_o = Analyte concentration of the original sample

  C_d = Analyte concentration of the duplicate sample

  A nominal acceptance criteria of 30% RPD for field duplicates and splits for inorganics will be adopted, however it is noted that this will not always be achieved, particularly at low analyte concentrations.

- **Accuracy** - measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes, laboratory blanks and analyses against reference standards. The nominal "acceptance limits" on laboratory control samples are defined as follows:

– Laboratory spikes – 70-130% for metals/inorganics, 60-140% for organics;

– Laboratory duplicates – <30% for metals/inorganics, <50% for organics; and

– Laboratory blanks – <practical quantitation limit.

Accuracy of field works is assessed by examining the level of contamination detected in field and equipment blanks. Blanks should return concentrations of all organic analytes as being less than the practical quantitation limit of the testing laboratory.

The individual testing laboratories will conduct an internal assessment of the laboratory QC program; however the results will also be independently reviewed and assessed.

7.2 Summary of Data Quality Acceptance Criteria

Data quality acceptance criteria adopted for this Project are set out in Table 7-1. These are generally based on the minimum requirements detailed in the Australian Standard AS4482.1-2005.

Table 7-1 Data Quality Acceptance Criteria

Measurement	Sediment	Water	Frequency	Acceptance Criteria	
				RPD (%)	Recovery (%)
Quality control samples to be prepared or taken on site (field)					
Blind field duplicate (BFD) samples (primary laboratory)	Yes	Yes	1 in 20 samples collected or 1 per batch	30 or 50	-
Quality control samples to be prepared by laboratory					
Laboratory blanks	Yes	Yes	1 per batch	-	-
Laboratory duplicates	Yes		1 in 10 samples collected or 1 per batch (whichever is smaller)	30	-
Matrix spike recoveries	Yes		1 per batch	-	70 to 130
Laboratory control sample spike recoveries	Yes		1 per batch	-	70 to 130
Surrogate spikes	Yes	Yes	Each analysis done by GC-MS (all organics except $TPH_{C>10}$)		

Note: water includes surface and groundwater.

7.3 Field Program

All field work will be conducted with reference to the advisory note of the Department of Resources (2009) for the sampling of surface waters and groundwater. Key requirements of these procedures are as follows:

- Decontamination procedures - including the use of new disposable gloves for the collection of each sample, decontamination of all multiple use sampling equipment between each sampling location (using a phosphate free detergent and potable water) and the use of dedicated sampling containers provided by the laboratory;
- Sample identification procedures - collected samples will be immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers to be clearly labelled with a sample number, sample location, sample depth (for groundwater) and sample date. The sample containers are then transferred to an ice filled cooler for sample preservation prior to and during shipment to the testing laboratory;
- Chain of custody protocols - a chain-of-custody form is to be completed and forwarded to the testing laboratory with each discrete batch of samples; and

- Sample duplicate frequency - field duplicates (blind) to be collected and analysed at a rate not less than ten per cent (i.e. not less than one duplicate per ten primary samples).

7.3.1 Field Quality Control

Field quality control procedures will include the collection and analysis of the following:

- **Blind field duplicates (BFDs):** Comprise a single sample that is divided into two separate sampling containers. Both samples are sent anonymously to the primary Project laboratory. Blind duplicates provide an indication of the analytical precision of the laboratory, but are inherently influenced by other factors such as sampling techniques and sample media heterogeneity.

8. Site Water Management

8.1 Water Use

Groundwater extraction will occur at the Project via two methods including groundwater extraction from multiple production bores (4-5 bores) within the Reaphook Hills borefield within the Southern Basins and pit sump dewatering in the Ti-Tree Basin. The water supply will be utilised throughout the life of the Project (approximately 55 years) and following the closure of the Project pumping will cease. The pit will remain open and act as groundwater sink in perpetuity (evaporation losses exceed inputs from runoff, precipitation and groundwater inflows).

The peak raw water demand is projected to be 2,700 ML/y consisting of 2,200 ML/y, 50 ML/y and 120-150 ML/y for Processing water, potable water and dust suppression respectively. The demand for raw water will steadily ramp up over the construction and operations phase of the mine and is expected to peak in mine development stage 6. The demands are illustrated in Figure 8-1.

8.1.1 Water Sources

The majority of water for the Project will be sourced from the Borefield situated approximately 25 km south west of the processing plant. The Borefield is located within the Southern Basins and will contain a number of production bores pumping approximately 2,700 ML/yr which matches the water use requirements detailed in Figure 8-1.

Groundwater modelling of the mining operation indicates peak groundwater inflows at final depth. Any groundwater inflow to the mine pit water will be opportunistically collected in a sump and pumped for use at the crusher, dust suppression and the processing plant.

8.1.2 Potable Water Supply

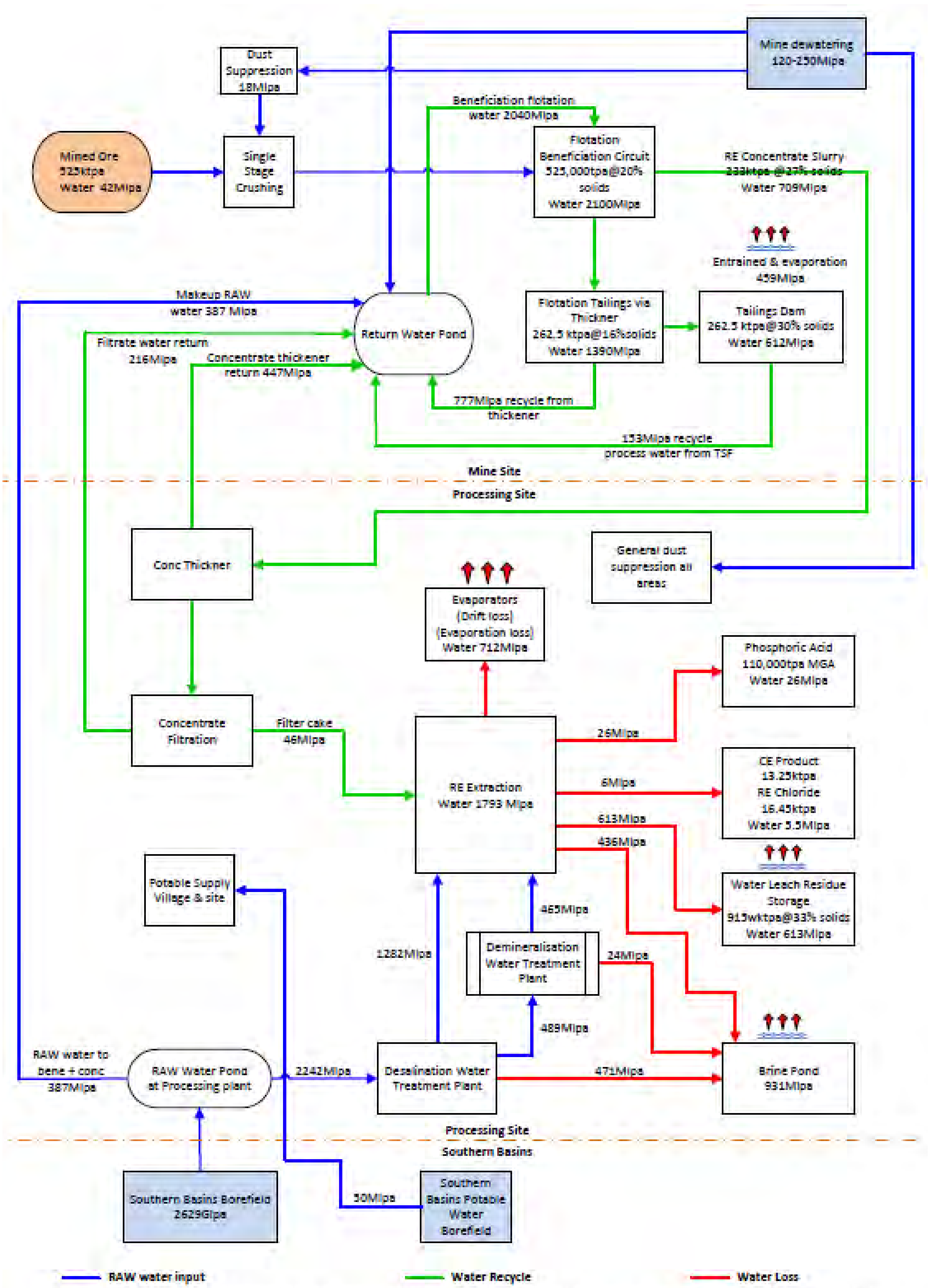
Potable water will be sourced from the Borefield then treated (filtered and chlorinated) at the processing plant and distributed across the Project as required. At the accommodation village where a high demand is anticipated the water supply will be stored within an onsite tank with sufficient capacity to store two days' supply.

A temporary water supply will be established as an interim measure until the permanent potable water treatment plant is commissioned.

8.1.3 Dust suppression

Water sourced from mine dewatering will be utilised for dust suppression. Roads requiring regular watering are limited to mine haul roads, pit ramps, floor, and the ROM pad and access road from the mine to the processing site.

Runoff from these areas is managed by the sediment management system, therefore, any contaminants (including radionuclides) will be contained within the dirty water management system during storm events up to the 100 year 72-hour design storm event.



Note: Until final engineering is completed the water balance is as shown. There are opportunities to reduce consumption but additional test work and engineering solutions have to be investigated and evaluated. Water from mine dewatering will be used for dust suppression and as make up water in the beneficiation plant. As the quantity of water used for dust suppression will vary because of climatic conditions only a small provision of this water has been included in this balance. Any available water from dewatering in excess of dust suppression requirements will be used in the beneficiation process and will displace water shown coming from the Southern Basins Borefield.

Figure 8-1 Schematic of Water Demands

8.2 Water Management Systems

The water management system at the Nolans Project would include separate water management areas for:

- **Clean water** – runoff generated by catchments areas outside of the mine affected areas;
- **Sediment water** – runoff generated by disturbed catchment areas, principally including waste rock dumps;
- **Ore contact** – runoff generated within the open pit, stockpile and TSF areas;
- **Process water** – water utilised in the processing plant and water generated by and stored within infrastructure associated with the process plant;
- **Domestic waste water** – grey waste water sewage from staff facilities; and

Design standards for water management infrastructure is specific to each of these water management systems.

8.2.1 Clean water

The clean water system manages runoff generated by catchment areas outside of mine affected areas, and generally includes:

- Natural watercourses and drainage lines outside of operational mining areas; and
- Flood protection levees and clean water diversions (including the proposed Kerosene Camp Creek diversion.

Flow diversion banks will be installed across the Mine to divert clean water away from disturbed areas.

Clean water diversions and flood protection levees are generally designed to safely manage the 100 year ARI flood event, particularly above open cut mining areas. 100 year ARI flooding modelling indicates that a number of flood levees will be required to protect the open pit area from flooding. One of these levees is associated with the proposed Kerosene Camp Creek diversion. Initial modelling indicates that a 1 m high flood protection bund is likely to be sufficient to separate the open cut pits from floodwater ingress during the 1000-year ARI flood event.

The regular inspection of the clean water diversions and flood protection levees should be included in the routine monitoring program, with repairs undertaken as necessary in accordance with a suitable response plan.

Culverts will be installed in roads to facilitate overland flow through the site and to facilitate diversion of flows (from within the catchment) into the Creek diversion.

8.2.2 Sediment water

The sediment water system manages runoff generated by areas disturbed by mining activities, but outside of the process water system. Dirty water generally includes runoff from haul roads and waste rock dumps.

Sediment water management infrastructure typically consists of dirty water catch drains and sediment basins. Dirty water catch drains intercept sediment-laden runoff and direct it to the sediment basins, where the suspended sediment can settle prior to the water being discharged off site or reused on site.

The sediment water management system would operate separately from the ore contact and process water management system, in order to minimise the potential contamination of water that could be discharged off site during large storm events.

8.2.3 Ore contact water

The ore contact water system manages runoff water generated within the open pit, stockpile and TSF. As a result ore contact water typically includes elevated pollutant levels that should not be discharged into the downstream environment without suitable treatment.

To minimise the risk of uncontrolled discharges the TSFs are to be constructed as “turkeys nest” dams, and will be managed to maintain a minimum freeboard capacity equivalent to the inflows expected from the 100 year ARI (equivalent to the 1% AEP) 72 hour design storm event. During extreme rainfall events beyond this design limit, overflows from the TSF will be directed via an emergency overflow weir to the open pit to minimise the discharge of untreated mine water.

Within the open pit, a pit sump will be used to manage most runoff generated within the pit area. During periods of extended or extreme rainfall, it is expected that the pit sump will be overtopped, flooding the pit floor and potentially some lower benches. During these periods, mining operations will be moved to upper benches (if safe to do so) whilst the pit is dewatered.

The TSFs will be dewatered into the process water dam for reuse in the processing plant or onto the evaporation ponds within the process water system.

The pit will be dewatered into water storage areas (turkeys nest) for use in dust suppression or will be directed into the process water dam for use in the processing plant.

8.2.4 Process water

Concentrate slurry from the concentrator will be pumped approximately 8 km to the processing site. The pipeline will run above ground within a bunded corridor. In the event of leaks or pipe failure, slurry will be captured within the bunded corridor and within event ponds located at significant low points along the 8 km alignment.

The processing plant and its associated residue storage facilities, namely Phosphate Residue, Impurity Removal Residue, Water Leach Residue and Sodium Sulphate are located west of the gas pipeline and on the south facing slopes above the Southern Basins.

The process water system manages water within the plant and RSF facilities. As a result process water typically includes elevated pollutant levels that should not be discharged into the downstream environment without suitable treatment.

To minimise the risk of uncontrolled discharges, process water storages and RSFs are typically constructed as “turkeys nest” dams. These storages will be managed to maintain a minimum freeboard capacity equivalent to the inflows expected from the 100 year ARI (equivalent to the 1% AEP) 72 hour design storm event.

The RSFs will be dewatered by pumping to the process water dam for reuse in the processing plant or disposed of via the evaporation ponds. If necessary, water treatment measures such as reverse osmosis may be utilised to allow for discharge of excess water.

8.2.5 Domestic waste water

Wastewater from the accommodation village and non-processing wastewater from the processing site and mine site will either be pumped to a common sewage treatment plant located adjacent to the processing plant or to a second small treatment facility installed at the mine site. The pipelines will be located within defined road service corridors.

The Sewage Treatment Plant (STP) will be a package type unit providing the appropriate level of treatment. Treated effluent will be disposed of within the EPs and sludge will be pumped out and disposed of by a local (Alice Springs) contractor on a regular basis.

9. References

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NHMRC/ARMCANZ (2004) Australian Drinking Water Guidelines. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand.

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Appendices

Appendix A – Surface Water Sampling Procedure

Arafura Resources Limited

Nolans Project

Surface Water Sampling Procedure

October 2017

Document Status

Version	Author	Reviewer	Approved by	Date	Status

Amendments

Section	Details

Audit Summary

Section	Details

Table of contents

Table index

Figure index

Appendices

1. Introduction

The Water Management Plan (WMP) for the Nolans Project (Project) provides a framework for the management of sampling requirements at the site. The WMP has been designed to collect data throughout the construction and operations phase to assess the performance of water management onsite. In order to facilitate consistency in sampling, and comply with quality assurance and control methodologies, a series of sampling procedures have been established including:

- Surface Water Sampling Procedure (this procedure);
- Groundwater Sampling Procedure; and
- Sediment Sampling Procedure.

1.1 Purpose

The primary objective of the Surface Water Sampling Procedure is to prevent contamination or alteration in water chemistry during sample collection. The collected sample should represent the physical, chemical and biological characteristics of surface water in the targeted water body as closely as possible.

1.2 Planning and Equipment

A number of factors must be considered during the field planning phase, prior to surface water sampling. These include consideration of ground condition at targeted locations and safety requirements. A summary of equipment and associated suppliers are provided in Table 1-1. All equipment in relation to surface water sampling should be ordered a minimum of four weeks prior to sampling.

Table 1-1 Summary of Planning

Timing	Details	Supplier
At least 4 weeks prior to sampling	**Order Lab Bottles** Laboratory bottles Eskies and Cool Bricks	*tbc*
	Hire / Maintenance Check Long arm sampler	Eco Environmental 6/509-511 South Rd, Ashford SA 5031 08 8293 3355 adelaide@ecoenvironmental.com.au Thermo Fisher Scientific 5 Caribbean Dv, Scoresby Vic 3179 03 9757 4377 RentalsAU@thermofisher.com
	Purchase 0.45µm Stericup filters Stericup vacuum pump Nitrile gloves Decon N	Eco Environmental 6/509-511 South Rd, Ashford SA 5031 08 8293 3355 adelaide@ecoenvironmental.com.au Thermo Fisher Scientific 5 Caribbean Dv, Scoresby Vic 3179 03 9757 4377 RentalsAU@thermofisher.com
1 day prior to sampling	**Calibrate** Water quality meter	-

2. Surface Water Sampling Procedure

2.1 Sampling Equipment

Surface water sampling requires the following:

- Surface Water Quality Sheet (Appendix A);
- Long arm sampler;
- Water quality meter (calibrated);
- 0.45µm water filters and suction pump;
- Eskies and Cool Bricks;
- Laboratory bottles;
- Nitrile Gloves;
- Decontaminated plastic or stainless steel bucket;
- Tool kit including screw drivers, tape measure and shovel; and
- Permeant marker.

2.2 Sampling Locations

There are a number of surface water sampling locations across the Project. These sampling locations are be positioned to assess upstream, onsite and downstream impacts from the Project. Rising stage samplers have been installed in the Kerosene Camp Creek, the Nolans Creek and the western tributary of the Kerosene Camp Creek where the intended diversion will flow to. These gauging stations are both up and downstream of the project and creek confluences. In addition gauging stations have been installed downstream of the processing site in drainage lines to try and capture run-off quality. This area is difficult to sample because of the very poorly defined drainage. The area typically only has sheet flow with minor drainage gutters intermittently scattered across the area. These limited drainage lines ultimate fan out and disperse.

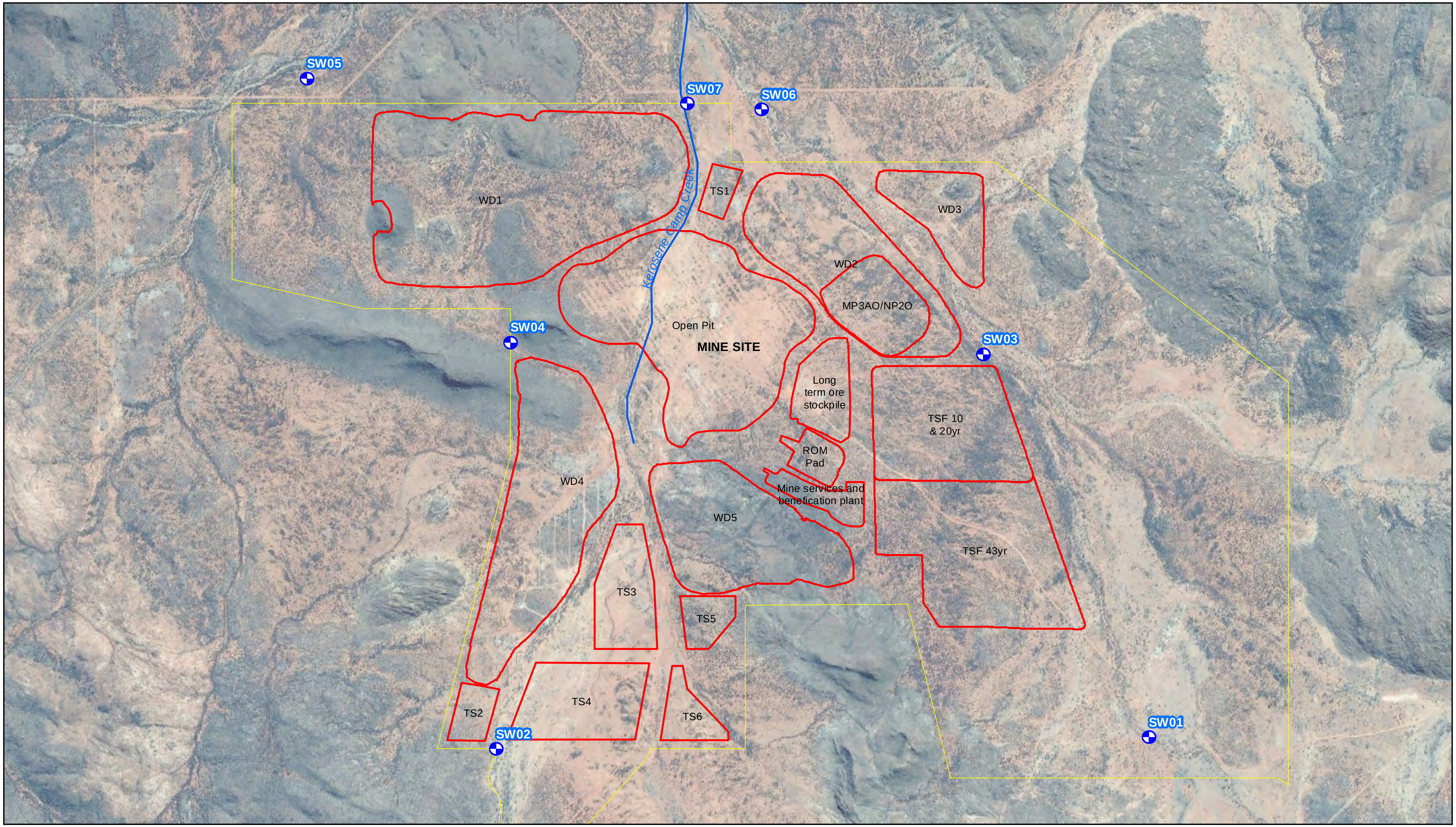
The sampling program has been designed to assess Nolans Creek, Kerosene Camp Creek, Kerosene Camp Creek western tributary and other minor drainage lines in and around the Project.

A summary of sampling locations, frequency and suites are provided in Table 2-1 and illustrated on Figure 2-1 and Figure 2-2.

Table 2-1 Surface Water Monitoring Locations

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Surface Water						
SW01	322051	7499080	Control	Nolans Creek Upstream of the TSF.	Early and late flows with a minimum of 0.1 m flowing water.	
SW02	317602	7499000		Unnamed Creek Upstream of TSF and TS2 and TS4.		
SW03	320920	7501690	Adjacent	Nolans Creek Downstream of TSF and upstream of WRD 2.		
SW04	317700	7501770	Impact	Creek Realignment Downstream of WRD 4, 5 and TS2, 3, 4 within the inlet to the creek realignment.		
SW05	316311	7503570	Impact	Creek Realignment Downstream of WRD 1 and prior to the outlet of the realignment.		
SW06	319408	7503360		Nolans Creek Downstream of TSF, WRD 2 and 3.		
SW07	318901	7503400		Kerosene Camp Creek Downstream of WRD 1, 2 and Pit.		
Stormwater sediment retention ponds						
SB01	316811	7503270	-	WRD 1	-	Field measurements fortnightly. Field and laboratory sample assay suite quarterly.
SB02	318920	7502980	-	WRD 1		
SB03	319775	7502920	-	WRD 2		
SB04	320206	7502940	-	WRD 4		
SB05	318807	7500960	-	WRD 4		
SB06	318414	7500830	-	WRD 5		
SB07	317753	7500990	-	WRD 5		
SB08	318816	7499560	-	TS4		
SB09	319997	7500240	-	WRD 3		
SB10	319426	7500890	-	ROM Pad		
SB11	319671	7501120	-	Mining Services		
SB12	320023	7500810	-	ROM Pad		
SB13	319659	7501470	-	Mining Services		
SB14	319613	7501000	-	Stockpile		
SB15	318941	7494550	-	RE Plant Compound		
SB16	318815	7494600	-	Power Station		
SB17	322497	7492990	-	Accommodation Village		

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Mine Pit and Processing Infrastructure						
Mine Pit Sump	*tbc*	*tbc*	-	Mine Pit sump water (i.e. groundwater inflow).	-	Field measurements monthly. Field and laboratory sample assay suite quarterly.
TSF	320125	7501040	-	TSF ponded water.		
RSF 1	*tbc*	*tbc*	-	RSF ponded water.		
RSF 2	*tbc*	*tbc*	-	RSF ponded water.		
EP 1	*tbc*	*tbc*	-	EP water.		
EP 2	*tbc*	*tbc*	-	EP water.		
EP 3	*tbc*	*tbc*	-	EP water.		



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Surface water
- Site boundary
- Borefield area
- Proposed infrastructure

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Revision | 0
Date | 20 Oct 2017

Monitoring Locations Surface Water

Figure 2-1

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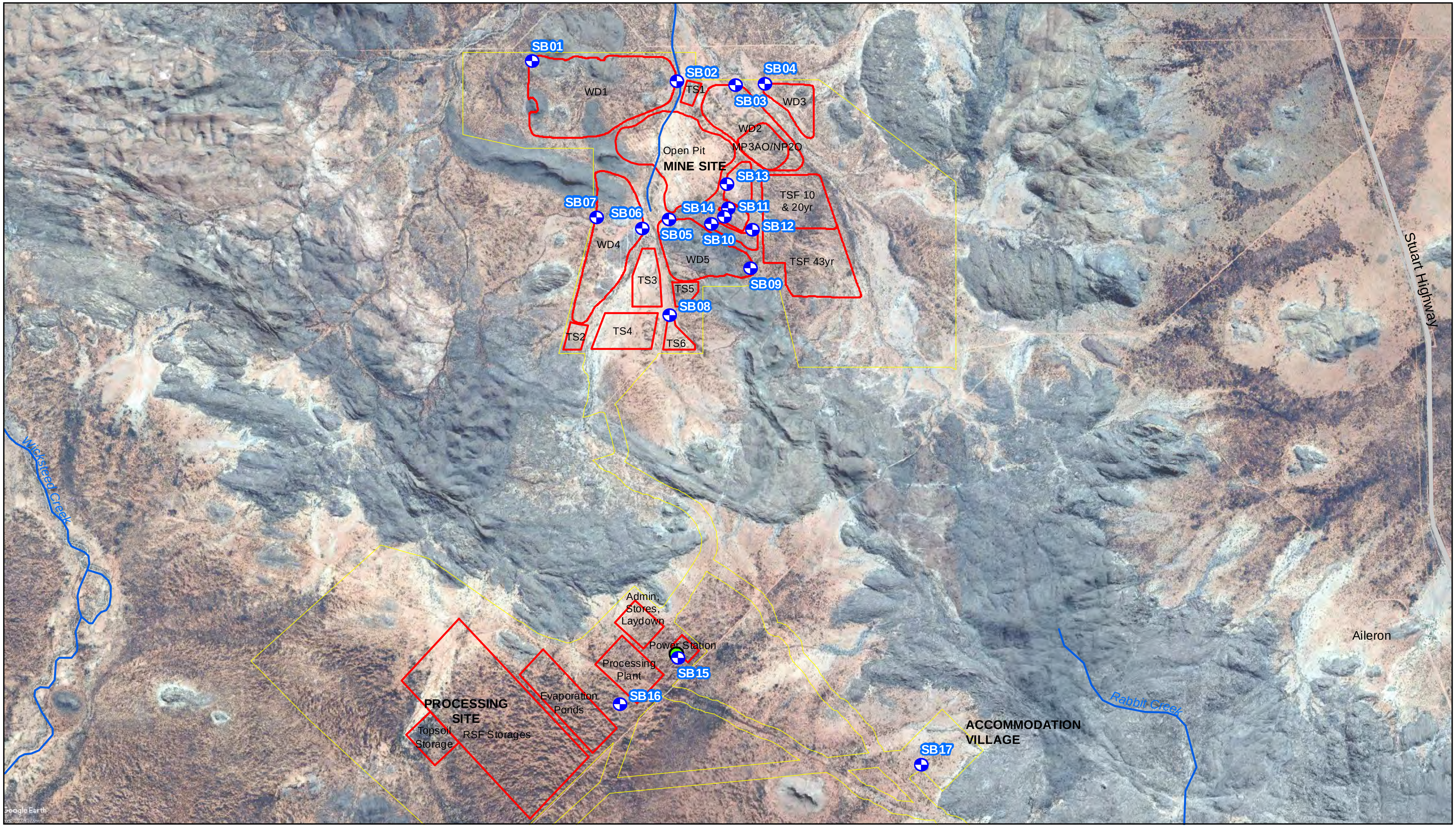
Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 25/07/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Stormwater sediment retention ponds
- Power Station
- Waterways
- Proposed infrastructure
- Study boundary

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Job Number	43-225929
Revision	0
Date	19 Oct 2017

Monitoring Locations
Stormwater Sediment Retention Ponds

Figure 2-2

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Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

2.2.1 Surface Water Sample Assay Suite

The sampling suite for surface water quality includes either field measurement or field and laboratory measurements. The suites are summarised as follows:

- Field Measurements

  Temperature, pH, Electrical Conductivity, Total Dissolved Solids, Turbidity and Oxidation Reduction Potential. Depth at location and photopoint monitoring (photos of sample location, upstream and downstream).

- Field and Laboratory Measurements

  In field: Temperature, pH, Electrical Conductivity, Total Dissolved Solids, Turbidity and Oxidation Reduction Potential. Depth at location and photopoint monitoring (photos of sample location, upstream and downstream).

  Laboratory Analysis

  - Total suspended solids (TSS)
  - Total hardness
  - Total acidity and alkalinity
  - Major ions ($CaCO_3$, CO_3, HCO_3, Ca, Mg, K, Na, Cl, SO_4, NO_3)
  - Metals total and dissolved[1]: Al, As, B, Ba, Cd, Co, Cu, Fe, Li, Pb, P, Mn, Hg, Mo, Ni, Rb, Se, Sr, Ag, U, Th and Zn

Note – these are indicative analytes. The final suite of analytes will be determined following review of existing baseline data.

Sampling is to be undertaken in accordance with the sampling procedure provided in Section 3.

2.3 Sampling Frequency

Sampling will be undertaken in accordance with the frequency identified in Table 2-1 when sufficient water is available to collect a sample without sediments being disturbed. Surface water sampling will only be undertaken during flow events where a minimum of 0.1m of flowing water is present.

2.3.1 Seepages

Water retention structures including stormwater sediment retention ponds will be installed across the site to reduce potential impacts on the receiving environment from FTSF, RSF and EV. If seepage is identified during routine inspections the following will be undertaken:

1. Location and Extent: a summary of the location of the seep will be recorded and indicated on map (Figure 2-1). The extent of the seep will be recorded including visible on the ground and surface water influence.
2. Volume: the volume of seepage will be recorded as an estimate in (L/minute or L/day).
3. Duration: the duration including commencement and ceasing date will be recorded.
4. Photographs: a photographic log will be taken to visualise the seep.
5. Sampling – Field: field water quality of the seep will be undertaken.
6. Sampling – Laboratory: if sufficient water can be collected and/or the seep continues for three consecutive days a laboratory sample will be collected.

[1] Samples for dissolved metals are field filtered using 0.45 µm Stericup filter or similar.

2.3.2 Discharges / Emergency Overflows

Mine site infrastructure has the potential to overflow during significant rainfall events. In the event of a discharge (stormwater overflowing basins), the discharge water and receiving waterbodies will be sampled. Sampling will be undertaken daily during discharges including field and laboratory suites.

The standard surface water sampling procedures will be followed in addition to the following:

1. Location and Extent: a summary of the location of the discharge will be recorded and indicated on map including estimation of its extent.
2. Volume: the volume of discharge will be recorded daily as an estimate in L/minute.
3. Duration: the duration including commencement and ceasing date will be recorded.
4. Photographs: a photographic log will be taken at the Sample locations (discharge location, upstream and downstream).
5. Sampling – Field: daily field water quality of the discharge will be undertaken.
6. Sampling – Laboratory: daily laboratory sampling of discharge, upstream and downstream receiving environment locations.

3. Surface Water Sampling Procedures

3.1 Field Measurements

Surface water gauging is to be undertaken in accordance with the following:

1. Complete surface water quality sheet for location (Appendix A)
2. Water Quality Parameters

   Record field water quality parameters by either suspending the water quality meter within the water body or collecting a sample and placing into a clean bucket for measurements to be taken
3. Photographs

   Photographs of the sample location should be taken include the sampling point, upstream and downstream. Photographs to be logged into a filing system indicating site location and date.

3.2 Field and Laboratory Measurements

Surface water sampling is only to be undertaken during periods of flow greater than 0.1m deep. The process is to be undertaken in accordance with the following:

1. Complete surface water quality sheet for location (Appendix A)
2. Water Quality Parameters

   Record field water quality parameters by either suspending the water quality meter within the water body or collecting a sample and placing into a clean bucket for measurements to be taken
3. Photographs

   Photographs of the sample location should be taken include the sampling point, upstream and downstream. Photographs to be logged into a filing system indicating site location and date;
4. Grab Sample

   Rinse long arm sampler container in the water body to be sampled three times. Place long arm sampler directly into water body, open end vertically down and fill with an arc motion with the bottle mouth facing upstream. Take care to avoid collecting surface films.

   For waters less than half a metre in depth, collect a grab sample at half the water depth. For waters greater than half a metre in depth, a grab sample should be taken at 20 to 30 cm below the surface water.
5. Field Filtering

   A total metals sample (not filtered) and a dissolved metal sample should be collected. The dissolved metal sample requires field filtration through a disposable 0.45 µm filter.
6. Waste Disposal

   Excess surface water is to be returned to ground and all disposable sampling equipment used should be stored for disposal at the Process Site including filters.
7. Electronic Transfer

   All water quality results, duplicate locations and Chain of Custody (CoC) are to be scanned and kept on file. The purging results are to be entered into the surface water database.

3.3 Sample Dispatch

Water samples have a high potential to deteriorate following collection. Samples are to be placed into an onsite fridge pending dispatch to laboratory. At completion of the sampling round, bottles are to be packed into eskys and ice bricks placed on top of samples and transferred to Alice Springs haulage depot. Samplers are to contact the haulage companies and the laboratory to inform them of sample delivery and requirements to keep refrigerated.

The sampler is to inform the laboratory of sample postage and provide a completed Chain of Custody (CoC). A blank CoC is provided in Appendix A.

4. Discharge Notifications

Discharges from the Site will be assessed on a case by case basis to determine if formal notifications to the DME and NT EPA are required. All external communication of incidents will be signed and approved by Arafura Resources Management Team.

In general, if there is a discharge of contained/managed water from the Project (i.e. collapse of flood levees or overflow of stormwater basins) the DME and NT EPA will be notified. A summary of the notification requirements is provided in Table 4-1.

Table 4-1 Formal Notification Requirements

Entity	Trigger	Timeframe and Contact Details	Incident Reporting Details
Department of Mines and Energy (DME)	Incident which causes minor environmental impact with some minor actual or potential hard to the environment.	As soon as practicable. Mineral.Info@nt.gov.au	The Section 29 Notification of Environmental Incident Form requires the following details: • Site and operator details. • Location occurred and area impacted (GPS coordinates); • Date and time; • Description of incident • Emergency and remedial actions taken. • Nature of impact and severity; • Current situation; • Details of sampling undertaken; and • Notification status internally and externally. The form is to be signed by the HSEC Manager and/or General Manager. A blank form is provided in Appendix C.
Northern Territory Environmental Protection Authority (NT EPA)	Incident which causes, or is threatening or may threaten to cause pollution resulting in material environmental harm or serious harm. Qualifying triggers requiring submittal of Section 14 Incident Report to NT EPA are any of the following: • is not trivial or negligible in nature; or • consists of an environmental nuisance of a high impact or on a wide scale; or • results, or is likely to result in $50,000 or more in taking action to prevent or minimise environmental harm or rehabilitate the environment; or results in actual or potential loss or damage to value of $50,000 or more of the prescribed amount (whichever is the greater).	< 24 hrs post incident ntepa@nt.gov.au pollution@nt.gov.au	The Section 14 Incident Report Form requires the following details: • Incident causing or threatening to cause pollution; • Location occurred and area impacted; • Date and time; • How the pollution has occurred, is occurring or may occur; • Attempts made to prevent, reduce, control, rectify, investigation and/or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and • Operator details. The form is to be signed by the HSEC Manager and/or General Manager. A blank form is provided in Appendix D.

Appendices

Appendix A – Surface Water Quality Sheet

SURFACE WATER QUALITY FIELD SHEET

Date:	Sampler:

FIELD PARAMETERS

Location ID	Time	pH	D.O (%)	ORP (mV)	E.C (µS/cm)	TDS (mg/L)	Temp (^{0}C)	Turbidity (NTU)	Salinity (ppt)	Comments (water flow, colour, suspended sediments)

Additional Comments

Appendix B – Chain of Custody Form

Notification of an Environmental Incident

Section 29 of the Mining Management Act

**Forward completed form to: Mining Compliance Division,
Department of Mines and Energy**

Email: mineral.info@nt.gov.au (preferred) or Fax: (08) 89996527

PLEASE TYPE OR PRINT CLEARLY

Please ensure that you have read the Draft Guideline - Environmental incident reporting under Section 29 of the Mining Management Act (July 2012) [167kb]]

NAME OF MINING SITE		
NAME OF OPERATOR		
DATE & TIME OF INCIDENT		
NAME OF PERSON NOTIFYING		
POSITION/TITLE		
CONTACT PERSON		
CONTACT DETAILS	Business:	Mobile
	Fax:	E-mail:
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc as appropriate)		
DESCRIPTION OF INCIDENT		
EMERGENCY & REMEDIAL ACTIONS TAKEN		

Appendix C – DME Section 29 Notification of Environmental Incident

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

❑NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 024423 2063 E: nowra@alsglobal.com

❑PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT:	**TURNAROUND REQUIREMENTS :**	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE:	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT:	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		**COC:** 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: ˚C
PROJECT MANAGER:	**CONTACT PH:**	**OF:** 1 2 3 4 5 6 7	Other comment:

SAMPLER:	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**				
Email Reports to (will default to PM if no other addresses are listed):		DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS									Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
				TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ENVIRONMENTAL DETAILS

NATURE OF IMPACT AND SEVERITY (Volume/ of spillage, area impacted, wildlife/vegetation/ erosion, etc) DME severity classification: 1 2 3 4 *Refer to pages 3 to 5 of the Draft Guideline - Environmental incident reporting under Section 29 of the Mining Management Act (July 2012) [167kb]]*	
CURRENT SITUATION (Potential / ongoing / ceased / etc)	
DETAILS OF ANY SAMPLES TAKEN (when / where / type / number / time for results /etc)	

OPERATOR INTERNAL REPORTING

Has the incident been reported internally? **YES / NO** If so, to whom	Name: Position:
Operator reference number (where applicable/available)	

HAS THE DEPARTMENT BEEN NOTIFIED EARLIER?	☐**YES** ☐ **NO**
WHO WAS NOTIFIED	
HOW (phone/email/fax)	
WHEN (date & time)	
BY WHOM	

Signed: ___________________________________ *Date:* _______________

NAME*:* ___________________________________

POSITION: ______________________________

OFFICE USE ONLY	
RECEIVED BY	
DATE	TIME

Appendix D – NT EPA Section 14 Incident Report

ntepa Northern Territory Environment Protection Authority

SECTION 14 INCIDENT REPORT (*Waste Management and Pollution Control Act*)

Date and Time of Notification:	
Person / Company:	
Incident:	

(a) the incident causing or threatening to cause pollution	
(b) the place where the incident occurred	
(c) the date and time of the incident	
(d) how the pollution has occurred, is occurring or may occur	
(e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident	
(f) the identity of the person notifying the NT EPA	

GHD

GPO Box 351 Darwin NT 0801
T: (08) 8982 0100   F: (08) 8981 1075   E: drwmail@ghd.com.au

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	A Koscielski	N Conroy	NC	N Conroy	NC	10/03/16
Draft B	K. Marmion	K Fitzpatrick	KF	K Fitzpatrick	KF	20/10/17

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Appendix B – Sediment Sampling Procedure

Arafura Resources Limited

Nolans Project

Sediment Sampling Procedure

October 2017

Document Status

Version	Author	Reviewer	Approved by	Date	Status

Amendments

Section	Details

Audit Summary

Section	Details

Table of contents

Table index

Figure index

Appendices

1. Introduction

The Water Management Plan (WMP) for the Nolans Project (Project) provides a framework for the management of sampling requirements at the site. The WMP has been designed to collect data throughout the construction and operations phase to assess the performance of water management onsite. In order to facilitate consistency in sampling, and comply with quality assurance and control methodologies, a series of sampling procedures have been established including:

- Surface Water Sampling Procedure;
- Groundwater Sampling Procedure; and
- Sediment Sampling Procedure (this procedure).

1.1 Purpose

Sediment sampling will be undertaken as a proxy for water quality due to the limited flows experienced at and surrounding the Project.

The primary objective of the Sediment Sampling Procedure is to obtain a sample with minimal significant alteration in sediment chemistry during sample collection. The collected sample should represent the physical, chemical and biological characteristics of sediment in the targeted drainage system as closely as possible.

1.2 Planning and Equipment

A number of factors must be considered during the field planning phase prior to sediment sampling. These include consideration of ground condition at targeted locations and safety requirements. A summary of gear and associated supplier are provided in Table 1-1. All equipment in relation to sediment sampling should be ordered a minimum of four weeks prior to sampling.

Table 1-1 Summary of Planning

Timing	Details	Supplier
>4 weeks prior to sampling	**Order Lab Bottles** Laboratory jars and large zip lock bags Eskies and Cool Bricks	tbc
	Purchase Nitrile gloves Decon N	tbc Eco Environmental 6/509-511 South Rd, Ashford SA 5031 08 8293 3355 adelaide@ecoenvironmental.com.au tbc Thermo Fisher Scientific 5 Caribbean Dv, Scoresby Vic 3179 03 9757 4377 RentalsAU@thermofisher.com

2. Sediment Sampling Procedure

2.1 Sampling Equipment

Sediment sampling requires the following:

- Chain of Custody (Appendix A);
- Stainless steel or plastic bucket and spade;
- 3 mm stainless steel sieve;
- 80 mesh sieve;
- Calico sample bags, zip lock bags paper soil sample bags(capable of storing 500 gms of fine sediments);
- Nitrile Gloves; and
- Permeant marker.

2.2 Sampling Locations

There are a number of sediment sampling locations across the Project. The sediment sampling locations coincide with surface water sampling locations at the Mine Site. The sampling locations are positioned to assess upstream, onsite and downstream impacts from the Project.

A summary of sampling locations, frequency and suites are provided in Table 2-1 and illustrated on Figure 2-1 and Figure 2-2.

2.2.1 Sediment Sample Assay Suite

The sampling suite for sediment includes:

- Photopoint Monitoring; and
- Laboratory Analysis:
  - Metals, U, Th, P and Sr
  - Rare Earths element suite.

Note – the Nolans deposit has a unique geochemical signature and the above analytes will enable early detection within sediments.

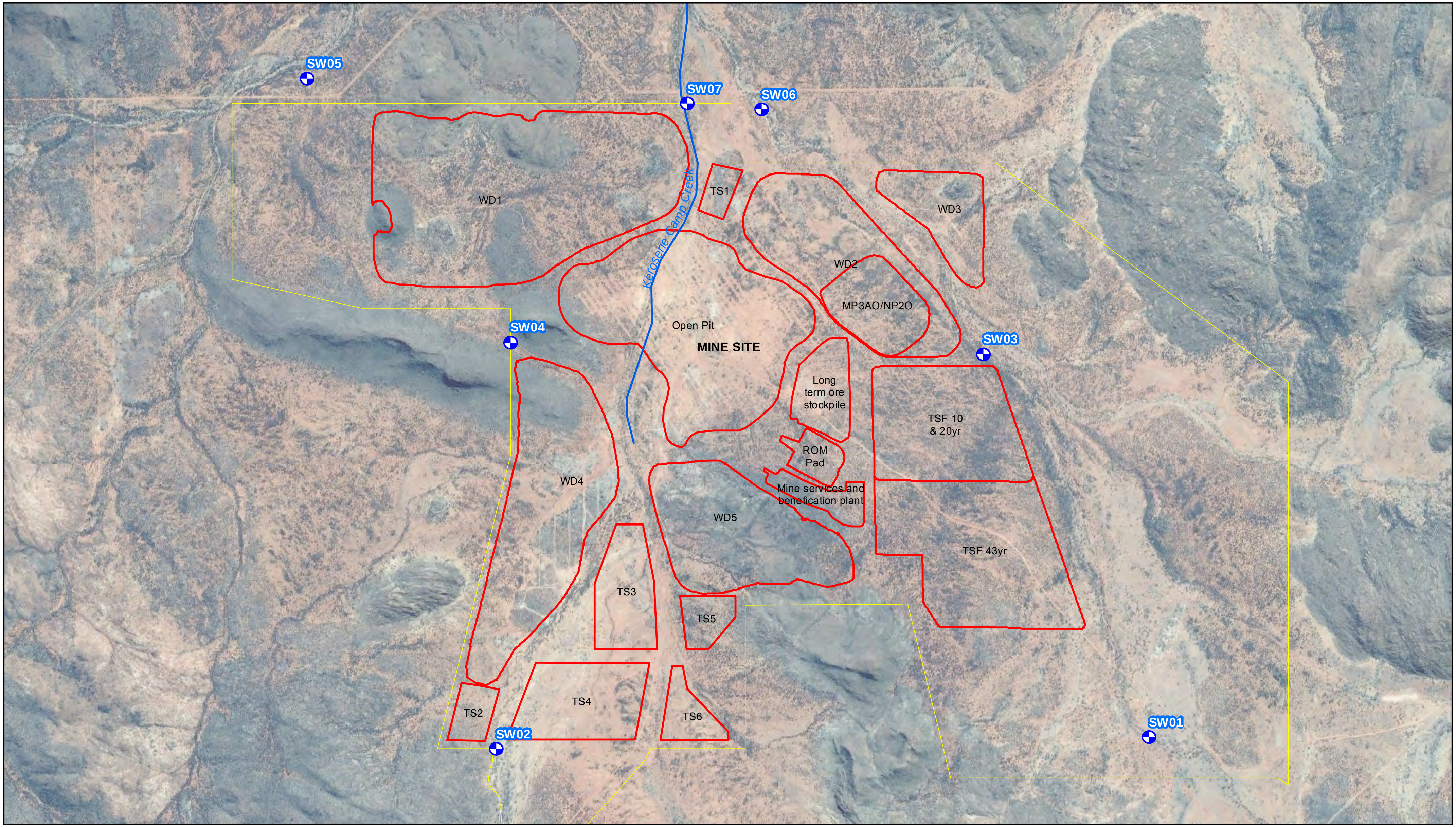
2.3 Sampling Frequency

Sampling will be undertaken in accordance with the frequency identified in Table 2-1.

Table 2-1 Sediment Sampling Locations

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Surface Water						
SW01	322051	7499080	Control	Nolans Creek Upstream of the TSF.	Early and late flows with a minimum of 0.1 m flowing water.	
SW02	317602	7499000		Unnamed Creek Upstream of TSF and TS2 and TS4.		
SW03	320920	7501690	Adjacent	Nolans Creek Downstream of TSF and upstream of WRD 2.		
SW04	317700	7501770	Impact	Creek Realignment Downstream of WRD 4, 5 and TS2, 3, 4 within the inlet to the creek realignment.		
SW05	316311	7503570	Impact	Creek Realignment Downstream of WRD 1 and prior to the outlet of the realignment.		
SW06	319408	7503360		Nolans Creek Downstream of TSF, WRD 2 and 3.		
SW07	318901	7503400		Kerosene Camp Creek Downstream of WRD 1, 2 and Pit.		
Stormwater sediment retention ponds						
SB01	316811	7503270	-	WRD 1	-	Field measurements fortnightly. Field and laboratory sample assay suite quarterly.
SB02	318920	7502980	-	WRD 1		
SB03	319775	7502920	-	WRD 2		
SB04	320206	7502940	-	WRD 4		
SB05	318807	7500960	-	WRD 4		
SB06	318414	7500830	-	WRD 5		
SB07	317753	7500990	-	WRD 5		
SB08	318816	7499560	-	TS4		
SB09	319997	7500240	-	WRD 3		
SB10	319426	7500890	-	ROM Pad		
SB11	319671	7501120	-	Mining Services		
SB12	320023	7500810	-	ROM Pad		
SB13	319659	7501470	-	Mining Services		
SB14	319613	7501000	-	Stockpile		
SB15	318941	7494550	-	RE Plant Compound		
SB16	318815	7494600	-	Power Station		
SB17	322497	7492990	-	Accommodation Village		

Site ID	Coordinates		Type	Description	Sample Frequency	
	Easting	Northing			Baseline	Operation
Mine Pit and Processing Infrastructure						
Mine Pit Sump	*tbc*	*tbc*	-	Mine Pit sump water (i.e. groundwater inflow).	-	Field measurements monthly. Field and laboratory sample assay suite quarterly.
TSF	320125	7501040	-	TSF ponded water.		
RSF 1	*tbc*	*tbc*	-	RSF ponded water.		
RSF 2	*tbc*	*tbc*	-	RSF ponded water.		
EP 1	*tbc*	*tbc*	-	EP water.		
EP 2	*tbc*	*tbc*	-	EP water.		
EP 3	*tbc*	*tbc*	-	EP water.		



1:35,000 @ A4

0 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Surface water
- Proposed infrastructure
- Site boundary
- Borefield area

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

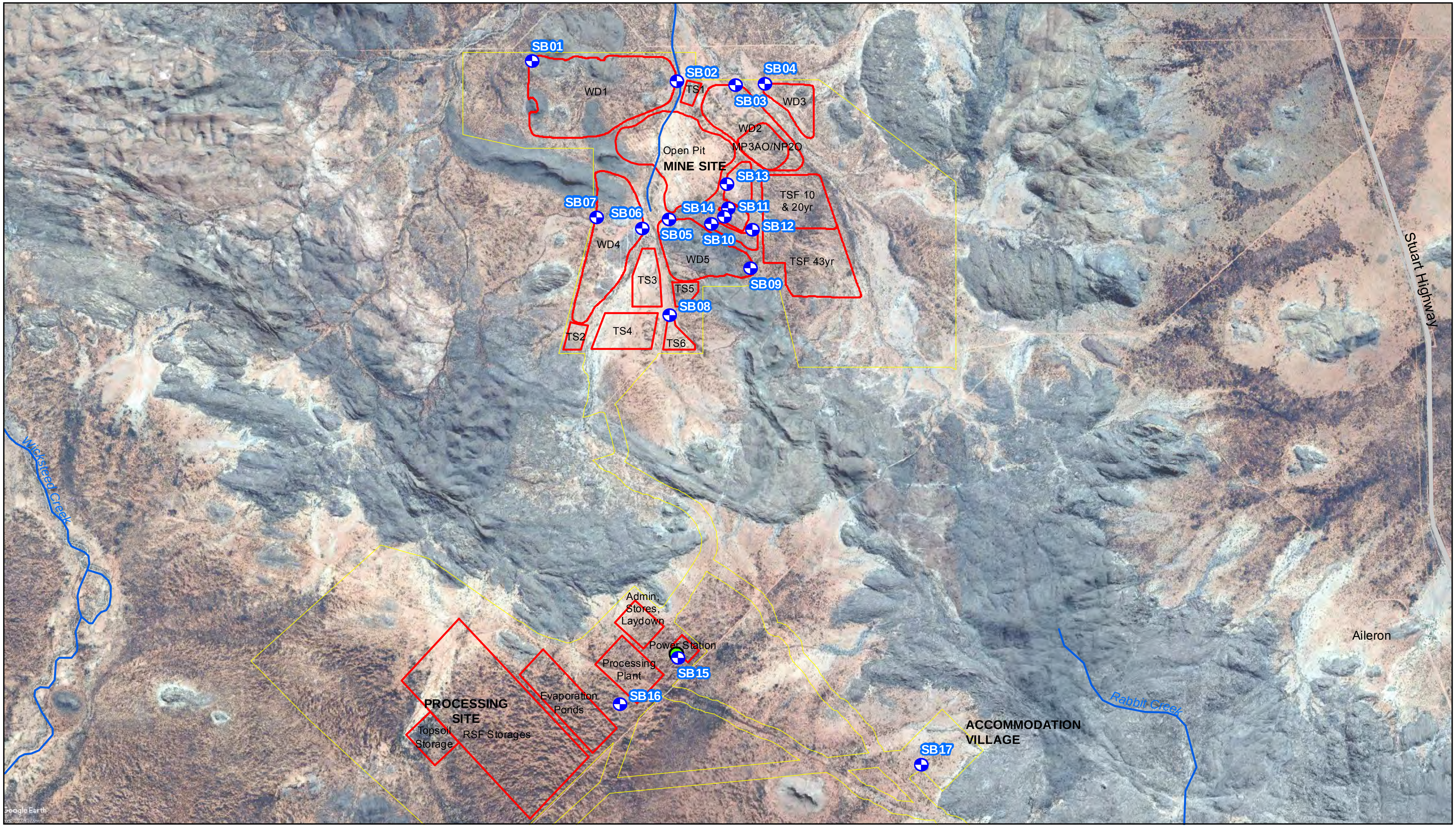
Job Number	43-225929
Revision	0
Date	20 Oct 2017

Monitoring Locations
Surface Water

Figure 2-1

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 25/07/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



1:75,000 @ A4

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Stormwater sediment retention ponds
- Power Station
- Waterways
- Proposed infrastructure
- Study boundary

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number	43-225929
Revision	0
Date	19 Oct 2017

Monitoring Locations
Stormwater Sediment Retention Ponds

Figure 2-2

G:\43\22301\GIS\Maps\4322529_005.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

3. Sediment Sampling Procedure

3.1 Field Measurements

Sediment sampling is to be undertaken in accordance with the following:

1. Photographs

   Photographs of the sample location, upstream and downstream should be taken. Photographs to be logged into a filing system indicating site location and date.

2. Ground Conditions

   Summarise all ground conditions at the sampling location including the presence or absence of water, direction and volume of flow.

   Areas of discoloured sediments, polluted water, affected plant growth and animal populations (aquatic) and odours should be identified and mapped.

   Undertake a qualitative assessment of sediment loss or deposition that has occurred since the previous sampling event.

3.2 Sample Collection

Sediment samples are composite samples including five sub samples across the primary drainage channel. The collection of sediment samples will be undertaken in accordance with the following:

1. Rinse spade and mixing bucket with Decon N to decontaminate;
2. Scrap away any organic surface matter
3. Sample Collection

   Apply nitrile gloves and collect five 2 kg subsamples across the primary drainage channel. The sample should be collected from surface to a maximum depth of 150 mm.

   Combine and mix the subsamples thoroughly within the decontaminated bucket and sieve through a 3 mm stainless steel sieve into a second bucket:

   – If sample is dry, sieve through a -80 mesh (180μ) sieve and collect about 200-500 gms of fine material. If sample is damp it may need to go to site laboratory for drying prior to final -80 mesh sieve.
   – Place sieved sediment into sample bag, record details on bag etc. for dispatch.

4. Waste Disposal

   Excess sediment will be returned to ground at the side of the creek and all used disposable sampling equipment should be stored for disposal at the Processing Site.

5. Electronic Transfer

   All sediment quality results, duplicate locations and Chain of Custody (CoC) are to be scanned and kept on file.

3.3 Sample Dispatch

Sediment samples have potential to deteriorate following collection. Samples are to be placed into an onsite fridge pending dispatch to laboratory. At completion of the sampling round, samples are to be packaged and transferred to Alice Springs haulage depot. Samplers are to contact the haulage companies and laboratory to inform them of sample delivery.

The sampler is to inform the laboratory of sample detail and provide a completed CoC (example provided in Appendix A).

Appendices

Appendix A – Chain of Custody Form

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

❑NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 024423 2063 E: nowra@alsglobal.com

❑PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT:	**TURNAROUND REQUIREMENTS :**	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE:	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT:	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		**COC:** 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: ˚C
PROJECT MANAGER: **CONTACT PH:**		**OF:** 1 2 3 4 5 6 7	Other comment:

SAMPLER: **SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES / NO) **EDD FORMAT (or default):**				
Email Reports to (will default to PM if no other addresses are listed):	DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS									Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
				TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

GHD

GPO Box 351 Darwin NT 0801
T: (08) 8982 0100   F: (08) 8981 1075   E: drwmail@ghd.com.au

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	A Koscielski	N Conroy	NC	N Conroy	NC	10/03/16
Draft B		K Fitzpatrick	KF	K Fitzpatrick	KF	20/10/17

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Appendix C – Groundwater Sampling Procedure

Arafura Resources Limited

Nolans Project

Groundwater Sampling Procedure

October 2017

Document Status

Version	Author	Reviewer	Approved by	Date	Status

Amendments

Section	Details

Audit Summary

Section	Details

Table of contents

Table index

Figure index

Appendices

1. Introduction

The Water Management Plan (WMP) for the Nolans Project (Project) provides a framework for the management of sampling requirements at the site. The WMP has been designed to collect data throughout the construction and operations phase to assess the performance of water management onsite. In order to facilitate consistency in sampling, and comply with quality assurance and control methodologies, a series of sampling procedures have been established including:

- Surface Water Sampling Procedure;
- Groundwater Sampling Procedure (this procedure); and
- Sediment Sampling Procedure.

1.1 Purpose

The primary objective of the Groundwater Sampling Procedure is to obtain a representative water sample with minimal significant alteration in water chemistry. The collected sample should represent the physical, chemical and biological characteristics of groundwater in the target unit as closely as possible.

1.2 Planning and Equipment

A number of factors must be considered during the field planning phase prior to groundwater sampling. These include consideration of access road conditions, safety requirements, the depth of groundwater and well construction (internal diameter and gravel pack). A summary of equipment and associated suppliers are provided in Table 1-1. All equipment in relation to groundwater sampling should be ordered a minimum of four weeks prior to sampling.

Table 1-1 Summary of Planning

Timing	Details	Supplier
>4 weeks prior to sampling	**Order Lab Bottles** Laboratory bottles Eskies and Cool Bricks	tbc
	Hire / Maintenance Check Low-flow pump Water level gauge or interface probe	Eco Environmental 6/509-511 South Rd, Ashford SA 5031 08 8293 3355 adelaide@ecoenvironmental.com.au Thermo Fisher Scientific 5 Caribbean Dv, Scoresby Vic 3179 03 9757 4377 RentalsAU@thermofisher.com
	Purchase 0.45µm Stericup filters Stericup vacuum pump Low-flow tubing Nitrile gloves Decon N	Eco Environmental 6/509-511 South Rd, Ashford SA 5031 08 8293 3355 adelaide@ecoenvironmental.com.au Thermo Fisher Scientific 5 Caribbean Dv, Scoresby Vic 3179 03 9757 4377 RentalsAU@thermofisher.com
1 day prior to sampling	**Calibrate** Water quality meter	-

2. Groundwater Sampling Procedure

2.1 Groundwater Sampling Events

The monitoring of groundwater at the Project is split into two types as detailed below:

- Standing Water Level Gauging

  Measurement of the standing water level relative to the internal well casings. A groundwater gauging field sheet is provided in Appendix A.

- Groundwater Sampling

  Measurement of the standing water level, purging, recording water quality data and sampling. A groundwater purging sheet and Chain of Custody (CoC) sheet is provided in Appendix B and Appendix C respectively.

2.2 Sampling Equipment

Groundwater sampling requires the following:

- Groundwater Gauging Sheet (Appendix A), Groundwater Purging Sheet (Appendix B) and Chain of Custody sheet (Appendix C);
- Water level gauge or interface probe;
- Water quality meter (calibrated);
- Low-flow sampling pump/equipment;
- Disposable low-flow sampling tubes;
- 0.45µm water filters and suction pump;
- Eskies and Cool Bricks;
- Laboratory bottles;
- Nitrile Gloves;
- Decontaminated plastic or stainless steel bucket;
- Padlock keys and tools to remove well caps; and
- Permeant marker.

2.3 Sampling Locations

The sampling events and frequencies at each groundwater well are provided in Table 2-1. The groundwater well locations are provided in Figure 2-1 to Figure 2-3.

Table 2-1 Preliminary Groundwater Monitoring Locations

Note - Table to revised in line with completed detailed designs. Locations and sample frequencies to be revised accordingly.

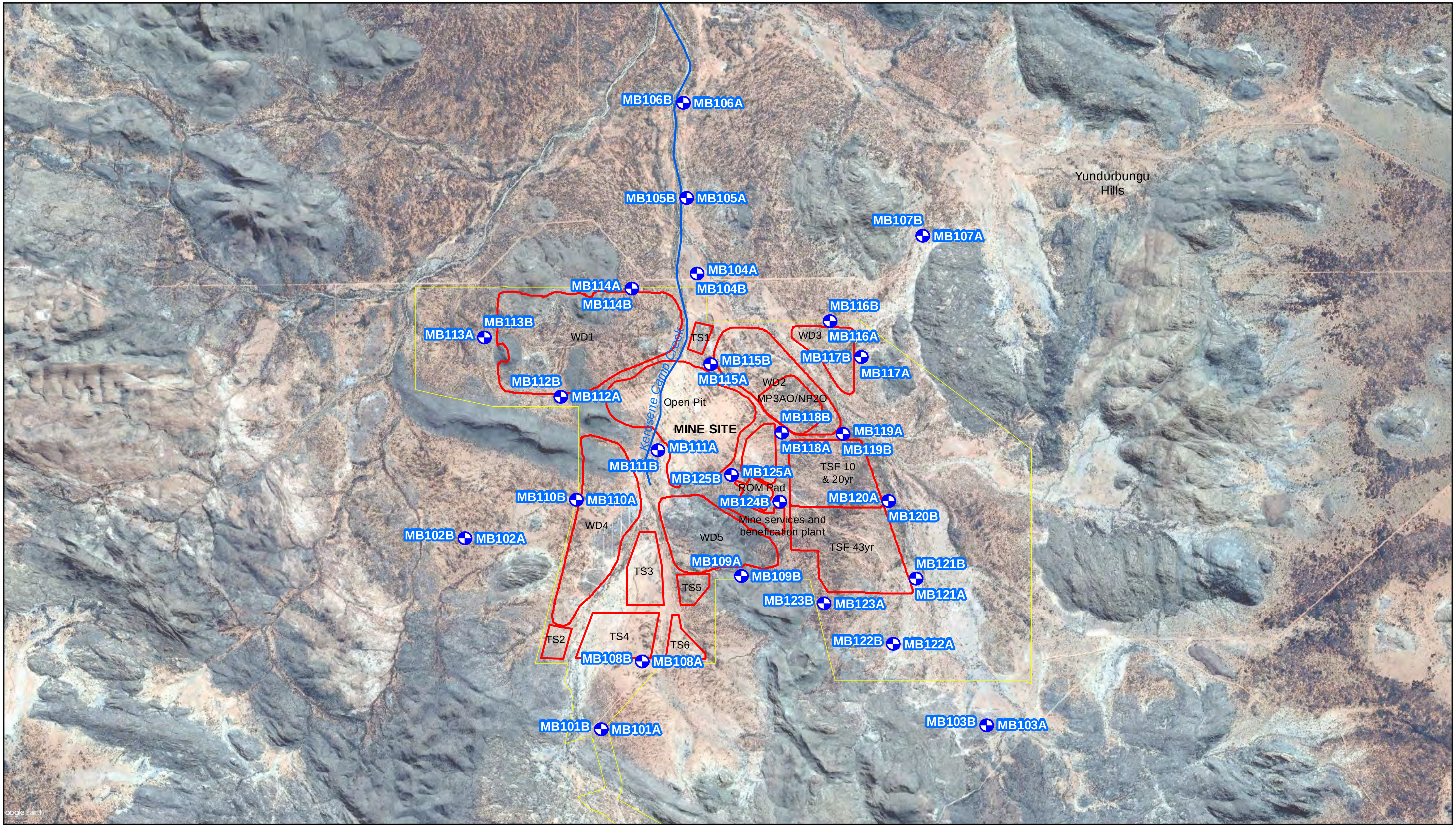
Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
Mine Site								
MB101A	317968	7498230	Boundary (up-gradient)	1 km south of TS4.	Automatic Logger	Quarterly	Automatic Logger	Quarterly
MB101B						Monthly		
MB102A	316379	7500460	Boundary	1 km west (up-gradient) of WRD 4.	Quarterly	Biannual	Quarterly	Quarterly
MB102B								
MB103A	322474	7498280		1 km southeast (up-gradient) of TSF.	Automatic Logger		Automatic Logger	
MB103B								
MB104A	319090	7503560		Initially downgradient becoming up-gradient during mining. North of the Mine Site prior to the confluence of Kerosene Camp Creek and Nolans Creek.	Quarterly		Quarterly	
MB104B								
MB105A	318964	7504440		1 km north of the Mine Site, initially downgradient becoming up-gradient during mining.	Quarterly		Quarterly	
MB105B								
MB106A	318925	7505550		2 km north of the Mine Site, initially downgradient becoming up-gradient during mining.	Automatic Logger		Quarterly	
MB106B								
MB107A	321727	7504000		1 km northeast of the Mine Site within a potential preferential pathway. Initially downgradient becoming up-gradient during mining.	Quarterly		Quarterly	
MB107B								
MB108A	318450	7499020	Adjacent	South of TS4.	Automatic Logger	Biannual	Automatic Logger	Quarterly
MB108B								
MB109A	319603	7500020		South of WRD 5.	Quarterly		Quarterly	
MB109B								
MB110A	317682	7500910		East of WRD 4.	Quarterly		Quarterly	
MB110B								
MB111A	318631	7501490		Northeast of WRD 4, adjacent to southwest LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB111B								
MB112A	317496	7502120		South of WRD 1.	Quarterly		Quarterly	
MB112B								
MB113A	316606	7502810		West of WRD 1.				

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB113B					Automatic Logger		Automatic Logger	
MB114A	318323	7503380		North of WRD 1.	Quarterly		Quarterly	
MB114B								
MB115A	319250	7502500		West of WRD 2 and adjacent to north of LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB115B								
MB116A	320639	7503000		North of WRD 3.	Automatic Logger		Automatic Logger	
MB116B								
MB117A	321012	7502580		East of WRD 3.	Quarterly		Quarterly	
MB117B								
MB118A	320076	7501700		South of WRD 2 and north of TSF.	Quarterly		Quarterly	
MB118B								
MB119A	320798	7501680		North of TSF.	Quarterly		Quarterly	
MB119B								
MB120A	321330	7500900		East of TSF.	Quarterly		Quarterly	
MB120B								
MB121A	321647	7499990		East of TSF.	Quarterly		Quarterly	
MB121B								
MB122A	321384	7499230		South of TSF.	Automatic Logger		Automatic Logger	
MB122B								
MB123A	320575	7499700		West of TSF.	Quarterly		Quarterly	
MB123B								
MB124A	320059	7500890		West of TSF.	Quarterly		Quarterly	
MB124B								
MB125A	319494	7501200		West of ROM Pad and adjacent to southeast LOM Mine Pit shell.	Automatic Logger		Automatic Logger	
MB125B								
Processing Site								
MB201A	315982	7495630	Boundary (up-gradient)	500 m north (up-gradient) of Processing Site.	Automatic Logger	Monthly	Automatic Logger	Quarterly
MB201B							Quarterly	
MB202A	317592	7495430	Boundary (up-gradient)	1 km north (up-gradient) of Processing Site.	Quarterly	Biannual	Quarterly	Quarterly
MB202B								
MB203A	315364	7495500	Adjacent	North of RSF.				
MB203B								
MB204A	314179	7495310		West of RSF.				

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB204B								
MB205A	314023	7494290		South of RSF.				
MB205B								
MB206A	316275	7494580		North of RSF.				
MB206B								
MB207A	315104	7493821		South of RSF.				
MB207B								
MB208A	315959	7492984		South of RSF.				
MB208B								
MB209A	316409	742509		South of RSF.				
MB209B								
MB210A	317538	7493261		East of RSF.				
MB210B								
MB211A	317604	7493990		North of RSF and south of the Processing plant.				
MB211B								
MB212A	317910	7494160		North of Processing plant.				
MB212B								
MB213A	318209	7494000		East of the Processing plant.				
MB213B								
MB214A	317941	7493800		South of the Processing plant.				
MB214B								
MB215A	318815	7494600		East of the Power Station.				
MB215B								
MB216A	318921	7494500		South of the Power Station.				
MB216B								
MB217A	319262	7494814		East of the Power Station.				
MB217B								
MB218A	319149	7494894		North of the Power Station.				
MB218B								
MB219A	314541	7492830	Down gradient	1 km south of Processing Site.				
MB219B								
MB220A	312476	7492290		2 km south of Processing Site.				
MB220B								
MB221A	316148	7492017	Up gradient	North of the landfill	Quarterly	Biannual	Quarterly	Quarterly
MB221B								

Site ID	Coordinates		Type	Description	Sample Frequency			
					Baseline		Operation	
	Easting	Northing			SWL	SWL and Laboratory	SWL	SWL and Laboratory
MB222A	315856	7491668	Down gradient	South of the landfill				
MB222B								
Borefield								
MB301	307737	7486578	Monitoring Bores		Automatic Logger	Biannual	Automatic Logger	Biannual
MB302	306717	7489358		Near approximate north boundary of borefield area, near Wicksteed Creek	Quarterly		Quarterly	
MB303	308810	7481514			Quarterly		Quarterly	
MB304	316208	7483218		Napperby Road, east of approximate borefield area	Quarterly		Quarterly	
MB305	310994	7479431			Quarterly		Quarterly	
MB306	308085	7474047		Near approximate south east boundary of borefield area	Automatic Logger		Automatic Logger	
MB307	307503	7477907			Quarterly		Quarterly	
MB308	300813	7480880			Automatic Logger		Automatic Logger	
MB309	300539	7478871			Quarterly		Quarterly	
MB310	284436	7481989			Automatic Logger		Automatic Logger	
MB311	281277	7488098		Western boundary of approximate borefield	Automatic Logger		Automatic Logger	
MB312	325620	7488200		Rabbit Creek	Quarterly		Quarterly	
SB008	308109	7479250	Production Bore	Borefield access track	Quarterly	Biannual	Quarterly	Biannual
SB015	301290	7479850		Borefield access track				
SB021	294454	7482340		Borefield access track				
SB025	288460	7483290		Borefield access track				
SB027	304196	7484910		Borefield access track				

Note: A = shallow monitoring well.
B = deep monitoring well.



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0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Groundwater monitoring locations
- Waterways
- Study boundary
- Proposed infrastructure

Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number	43-225929
Revision	0
Date	19 Oct 2017

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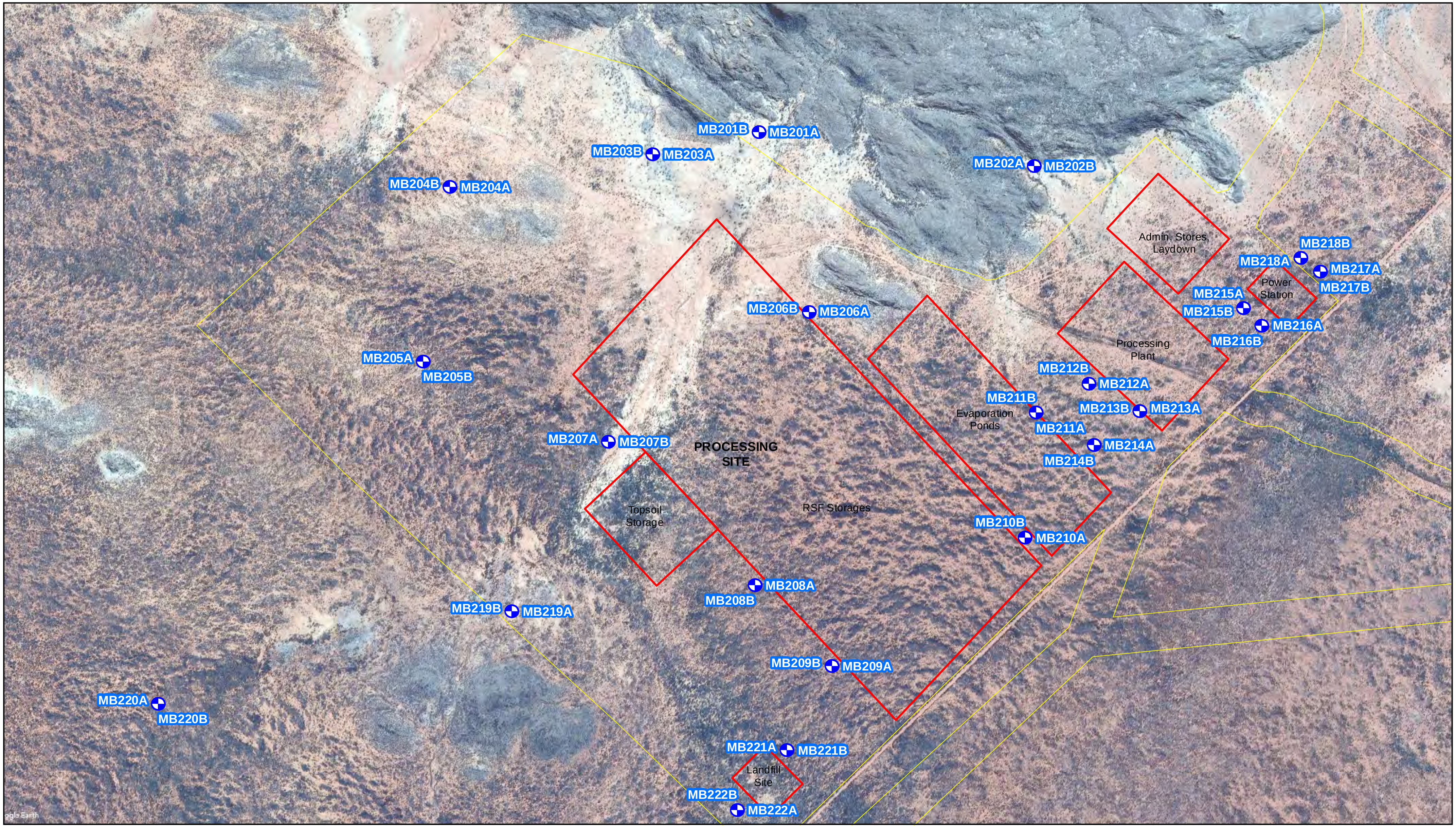
Groundwater monitoring locations

Figure 2-1

G:\43\22301\GIS\Maps\4322529_006.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



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0 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Groundwater monitoring locations
- Waterways
- Proposed infrastructure
- Study boundary

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Revision	0
Date	20 Oct 2017

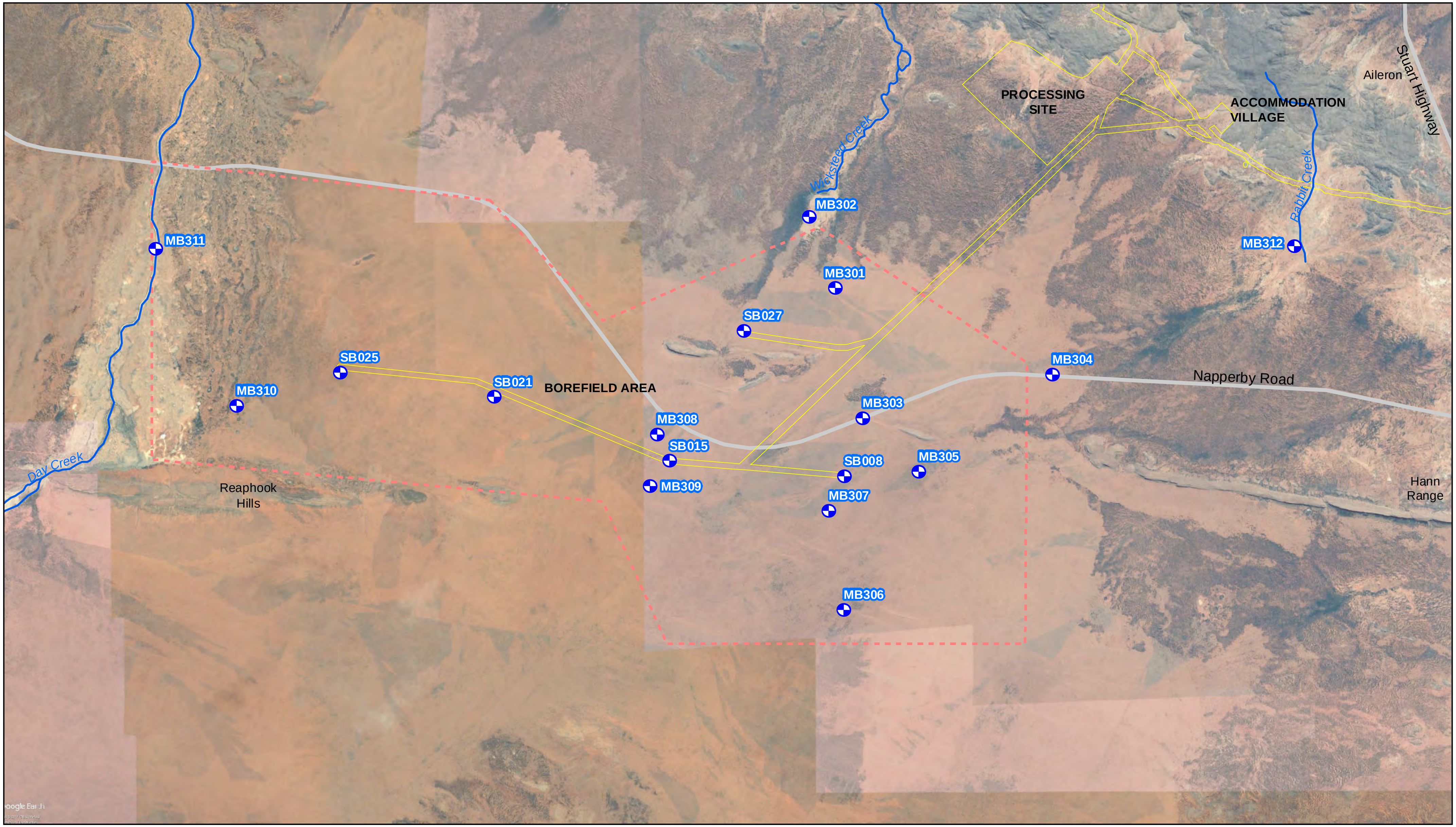
Groundwater monitoring locations

Figure 2-2

G:\43\22301\GIS\Maps\4322529_007.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 30/08/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM



1:200,000 @ A4

0 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

LEGEND

- Borefield
- Borefield Area
- Waterways
- Study Area

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Environmental Impact Statement

Job Number 43-22529
Revision 0
Date 19 Oct 2017

Monitoring Locations Borefield

Figure 2-3

G:\43\22301\GIS\Maps\4322529_008.mxd

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com

Data source: Google Earth Pro - Imagery (Date extracted: 25/07/2017). GA - Roads, Waterways, Placenames (2015). ESRI - Shaded Relief (2009). ARL - Water Bores, Proposed Pipelines, Borefield Area, Proposed Mine Site, Treatment Plant and Accommodation Village (2015). Created by: CW, CM

2.3.1 Groundwater Sample Assay Suite

Field measurements are to be collected using the water quality meter during the purging process. Following stabilisation of water quality parameters (see Section 3.1.2), laboratory samples are to be collected. The groundwater sampling assay suite is provided below:

- Standing water level
- Standing water level and laboratory measurements

  Standing water level and purged water quality characteristics including temperature, pH, electrical conductivity, total dissolved solids, turbidity and oxidation reduction potential.

  Laboratory analysis:

  – Total Suspended Solids, Total Hardness and Total Acidity and Alkalinity
  – Major ions ($CaCO_3$, CO_3, HCO_3, Ca, Mg, K, Na, Cl, SO_4, NO_3)
  – Metals total and dissolved (0.45 µm field filtered[1]): Al, As, B, Ba, Cd, Co, Cu, Fe, Li, Pb, P, Mn, Hg, Mo, Ni, Rb, Se, Sr, Ag, U, Th and Zn
  – Radionuclides (U-238, U-234, Th-230, Ra-226, Rn-222, Pb-210, Po-210, Th-232, Ra-228, Th-228). Radionuclides will be tested annually at representative bores only.

Note – these are indicative an analyte suite and the final suite will be determined following review of baseline data.

2.4 Sampling Frequency

Sampling frequency will be determined following installation of bores. Some will be quarterly and others may be 6 monthly or opportunistically following rain fall. Based on significant drilling data we know that the occurrence of groundwater away for the Nolans deposit is very limited. An indicative frequency is provided in Table 2-1.

2.4.1 Environmental Incident Sampling

In the event that an incident occurs where a hazardous substance or chemical is discharged to the environment the HSEC Manager will determine if an investigation is warranted based on severity level of the incident, the requirements of the Hazardous Substance Management Plan and Emergency Response Plan.

[1] Samples for dissolved metals are field filtered using 0.45 µm Stericup filter.

3. Groundwater Sampling Procedures

3.1.1 Standing Water Level Gauging

Groundwater gauging is to be undertaken in accordance with the following:

1. Complete groundwater gauging sheet for each sample location
2. Gauging

   Gauge water level relative to Top of Casing (TOC) using an electronic interface meter or dip tape. The well cap should be removed and the well allowed to stabilise before measurements are made. Where possible, depth measurements should be recorded to the nearest 1 mm (i.e. 0.001 m).

   A groundwater gauging sheet is provided in Appendix A.

3.1.2 Groundwater Sampling Methodology

Groundwater sampling is to be conducted in accordance with the following:

1. Complete groundwater gauging sheet for location.
2. Gauging

   Gauge water level relative to Top of Casing (TOC) using an electronic interface meter or dip tape. The well cap should be removed and the well allowed to stabilise before measurements are made. Where possible, depth measurements should be recorded to the nearest 1 mm (i.e. 0.001 m).
3. Decontamination

   Reusable sampling equipment such as the pump and cables should be decontaminated prior to and at the completion of sampling each sample location. Decontamination can be undertaken by submerging the pump and cables in a mixture of Decon N / Decon 90 and water.
4. Pump Installation

   Insert pump into well with care to avoid excessive disturbance and re-suspension of sediment within the well. The pump intake should be suspended inside the well screen so as to minimise the volume of stagnant groundwater required to be purged and intercept the inflowing groundwater from the target formation.
5. Purging

   Commence purging of well, the aim of this process is to remove 'stagnant' groundwater from the well so that groundwater is representative of the surrounding unit. Water quality parameters should be recorded at regular intervals (i.e. every 2 to 5 minutes or every 2 to 5 litres) on the groundwater gauging sheet (Appendix B).

   Parameters are to stabilise prior to sampling, they are considered stabilised when three consecutive readings are within the following limits:

   – 10% for Dissolved Oxygen;
   – ± 3% Electrical Conductivity;
   – 0.05 pH units for pH;
   – ± 0.2 °C for Temperature; and
   – ± 10 mV Redox.

Contingency – No Parameter Stabilisation

If after prolonged purging the parameters do not stabilise to within the specified limits, the original well and gravel pack volume should be calculated and ensure at least 3 well volumes of groundwater has been purged.

Contingency – Pumped Dry

Low yielding wells that are purged dry should be left to recover. Following recovery of groundwater levels in the well, sampling can proceed on the assumption that the groundwater represents inflow from the unit screened by the well. In this instance, measurement of stabilisation parameters should record a minimum of three consecutive readings prior to sampling.

6. Groundwater Sampling

   A groundwater sample should be collected after the measured parameters have stabilised. Commonly the purging device is used to sample the groundwater. Sampling should be undertaken so as to minimise the entry of air into the sample – run the outflow from the sampling device down the side of the container, rather than allowing it to cascade into the container.

   Once collected, groundwater samples should be labelled and stored in ice chilled cooler boxes. Samples should be kept out of the sun. Samples should be returned to the laboratory under Chain of Custody (COC) documentation as detailed in Section 3.2.

7. Field Filtering

   A total metals sample (not filtered) and a dissolved metals sample should be collected. The dissolved metals sample requires field filtration through a disposable 0.45 µm filter.

8. Waste Disposal

   Purged groundwater is to be pumped onto the ground and all used disposable sampling equipment should be stored for disposal at the process site including filters, tubing and bladders.

9. Electronic Transfer

   All purging results, duplicate locations and CoC are to be scanned and kept on file. The purging results are to be entered into the groundwater database.

3.2 Sample Dispatch

Sediment samples have potential to deteriorate following collection. Samples are to be placed into onsite fridge pending dispatch to laboratory. At completion of the sampling round bottles are to be packed into eskys and ice bricks placed on top of samples and transferred to Alice Springs haulage depot. Samplers are to contact the haulage companies and laboratory to inform of sample delivery and requirements to keep refrigerated.

The sampler is to inform the laboratory of sample postage and provide a completed Chain of Custody (CoC). An example CoC is provided in Appendix C.

4. Discharge Notifications

Discharges from the Site will be assessed on a case by case basis to determine if formal notifications to the DME and NT EPA are required. All external communication of incidents will be signed and approved by EHS Manager and/or General Manager.

In general, if there is a discharge of contained/managed water from the project (i.e. collapse of flood levees or overflow of stormwater basins) the DME and NT EPA will be notified. A summary of the notification requirements is provided in Table 4-1.

Table 4-1 Formal Notification Requirements

Entity	Trigger	Timeframe and Contact Details	Incident Reporting Details
Department of Mines and Energy (DME)	Incident which causes minor environmental impact with some minor actual or potential hard to the environment.	As soon as practicable. Mineral.Info@nt.gov.au	The Section 29 Notification of Environmental Incident Form requires the following details: • Site and operator details. • Location occurred and area impacted (GPS coordinates); • Date and time; • Description of incident • Emergency and remedial actions taken. • Nature of impact and severity; • Current situation; • Details of sampling undertaken; and • Notification status internally and externally. The form is to be signed by the HSEC Manager and/or General Manager. A blank form is provided in Appendix D
Northern Territory Environmental Protection Authority (NT EPA)	Incident which causes, or is threatening or may threaten to cause pollution resulting in material environmental harm or serious harm. Qualifying triggers requiring submittal of Section 14 Incident Report to NT EPA are any of the following: • is not trivial or negligible in nature; or • consists of an environmental nuisance of a high impact or on a wide scale; or results, or is likely to result in $50,000 or more in taking action to prevent or minimise environmental harm or rehabilitate the environment; or results in actual or potential loss or damage to value of $50,000 or more of the prescribed amount (whichever is the greater).	< 24 hrs post incident ntepa@nt.gov.au pollution@nt.gov.au	The Section 14 Incident Report Form requires the following details: • Incident causing or threatening to cause pollution; • Location occurred and area impacted; • Date and time; • How the pollution has occurred, is occurring or may occur; • Attempts made to prevent, reduce, control, rectify, investigation and/or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and • Operator details. The form is to be signed by the HSEC Manager and/or General Manager. A blank form is provided in Appendix E.

Qualifying triggers requiring submittal of Section 14 Incident Report to NT EPA are any of the following:

- is not trivial or negligible in nature; or
- consists of an environmental nuisance of a high impact or on a wide scale; or
- results, or is likely to result in $50,000 or more in taking action to prevent or minimise environmental harm or rehabilitate the environment; or results in actual or potential loss or damage to value of $50,000 or more of the prescribed amount (whichever is the greater).

Appendices

Appendix A – Groundwater Gauging Sheet

GROUNDWATER GAUGING FIELD SHEET

Date:	Sampler:

GROUNDWATER LEVELS

Standing water level is measured from the top of internal casing (TOIC).

Groundwater Well	Easting	Northing	Top of Internal Casing (m AHD)	Standing Water Level (m BTOIC)	Standing Water Level (m AHD)	Comments

Additional Comments

Appendix B – Groundwater Purging Sheet

GROUNDWATER PURGING AND SAMPLING FIELD SHEET

PROJECT DETAILS

Depth to Water Table Before Sampling (m TOC):	**Borehole ID:**
Depth to Bottom of Casing (m TOC):	**Date:**
Depth to Water Table After Sampling (m TOC):	**QA Collected:**
Sampler:	**Sample Method:**

FIELD PARAMETERS (minimum of five)

Time	Volume (L)	D.O (%)	D.O (mg/L)	TDS (mg/L)	Turbidity (NTU)	E.C (us/cm)	pH	Eh (mV)	Temp (^{0}C)	Comments

Post Sample Parameters

Number of Bottles:	Comments:

Appendix C – Chain of Custody Form

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

❑NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 024423 2063 E: nowra@alsglobal.com

❑PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT:

OFFICE:

PROJECT:

ORDER NUMBER:

PROJECT MANAGER: **CONTACT PH:**

SAMPLER: **SAMPLER MOBILE:**

COC emailed to ALS? (YES / NO) **EDD FORMAT (or default):**

Email Reports to (will default to PM if no other addresses are listed):

Email Invoice to (will default to PM if no other addresses are listed):

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)

☐ Standard TAT **(List due date):**

☐ Non Standard or urgent TAT **(List due date):**

ALS QUOTE NO.:

COC SEQUENCE NUMBER (Circle)

COC:	**1**	**2**	**3**	**4**	**5**	**6**	**7**
OF:	**1**	**2**	**3**	**4**	**5**	**6**	**7**

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		˚C	
Other comment:			

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	**SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)**			**CONTAINER INFORMATION**		**ANALYSIS REQUIRED including SUITES** (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								**Additional Information**
LAB ID	**SAMPLE ID**	**DATE / TIME**	**MATRIX**	**TYPE & PRESERVATIVE** *(refer to codes below)*	**TOTAL CONTAINERS**									Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
				TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Appendix D – DME Section 29 Notification of Environmental Incident

Notification of an Environmental Incident

Section 29 of the Mining Management Act

**Forward completed form to: Mining Compliance Division,
Department of Mines and Energy**

Email: mineral.info@nt.gov.au (preferred) or Fax: (08) 89996527

PLEASE TYPE OR PRINT CLEARLY

Please ensure that you have read the Draft Guideline - Environmental incident reporting under Section 29 of the Mining Management Act (July 2012) [167kb]]

NAME OF MINING SITE		
NAME OF OPERATOR		
DATE & TIME OF INCIDENT		
NAME OF PERSON NOTIFYING		
POSITION/TITLE		
CONTACT PERSON		
CONTACT DETAILS	Business:	Mobile
	Fax:	E-mail:
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc as appropriate)		
DESCRIPTION OF INCIDENT		
EMERGENCY & REMEDIAL ACTIONS TAKEN		

ENVIRONMENTAL DETAILS

NATURE OF IMPACT AND SEVERITY (Volume/ of spillage, area impacted, wildlife/vegetation/ erosion, etc) DME severity classification: 1 2 3 4 *Refer to pages 3 to 5 of the Draft Guideline - Environmental incident reporting under Section 29 of the Mining Management Act (July 2012) [167kb]]*	
CURRENT SITUATION (Potential / ongoing / ceased / etc)	
DETAILS OF ANY SAMPLES TAKEN (when / where / type / number / time for results /etc)	

OPERATOR INTERNAL REPORTING

Has the incident been reported internally? **YES / NO** If so, to whom	Name: Position:
Operator reference number (where applicable/available)	

HAS THE DEPARTMENT BEEN NOTIFIED EARLIER?	☐**YES** ☐ **NO**
WHO WAS NOTIFIED	
HOW (phone/email/fax)	
WHEN (date & time)	
BY WHOM	

Signed: ___________________________________ *Date:* _______________

NAME*:* __________________________________

POSITION: ______________________________

OFFICE USE ONLY	
RECEIVED BY	
DATE	TIME

Appendix E – NT EPA Section 14 Incident Report

Northern Territory Environment Protection Authority

SECTION 14 INCIDENT REPORT (*Waste Management and Pollution Control Act*)

Date and Time of Notification:	
Person / Company:	
Incident:	

(a) the incident causing or threatening to cause pollution	
(b) the place where the incident occurred	
(c) the date and time of the incident	
(d) how the pollution has occurred, is occurring or may occur	
(e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident	
(f) the identity of the person notifying the NT EPA	

GHD

GPO Box 351 Darwin NT 0801
T: (08) 8982 0100   F: (08) 8981 1075   E: drwmail@ghd.com.au

G:\43\22529\WP\Appendices\Water Management Plan\Groundwater Sampling Procedure_Rev B_201017.docx

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	A Koscielski	N Conroy	NC	N Conroy	NC	10/03/16
Draft B		K Fitzgerald	KF	K Fitzgerald	KF	20/10/17

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Appendix D – Erosion and Sediment Control Plan

Refer to Appendix D of the WMP included in the EIS at https://ntepa.nt.gov.au/__data/assets/pdf_file/0006/289779/nolans_rare_earth_draft_eis_appendixX_L_water_management_plan.pdf

The ESCP will be updated following detailed design, however the principles and guidelines apply.

Appendix E – Emergency Response Management Plan

Refer to Appendix F of the EMP included in the EIS at https://ntepa.nt.gov.au/environmental-assessments/register/nolans-rare-earth/draft-environmental-impact-statement-eis

The ERMP will be updated following detailed design, however the principles and guidelines apply.

GHD

GPO Box 351 Darwin NT 0801
T: (08) 8982 0100   F: (08) 8981 1075   E: drwmail@ghd.com.au

https://projects.ghd.com/oc/NorthernTerritory/nolansprojectenviron/Delivery/Documents/4322529_Water Management Plan.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	A Koscielski	P Dunn N Conroy	NC	N Conroy	NC	10/03/16
Draft B	A Wyatt	A Wyatt L Evans I McCartle	AW LE IMC	K Fitzpatrick	KF	20/10/17

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