Appendix A

Study Team

EIS Study Team

Project Input	Key staff and qualifications	Company
Project Manager	Ian McCardle BSc (Hons), MSc	GHD
EIS preparation	Ian McCardle BSc (Hons), MSc	GHD
	Drew Farrar BSc (Hons)	GHD
	Kylie Fitzpatrick BSc	GHD
	Kristina Downey BSc (Hons), MRes	GHD
Stakeholder engagement	Leanne Jefferys BE (Hons), BSc	GHD
	Ian McCardle BSc (Hons), MSc	GHD
Water resources	Wayne Schaffer MSc (Eng)	GHD
	Loong Yoong BE (Env)	GHD
	Joanne Stegena BE (Env)	GHD
	Adam Osbaldeston BSc (Hons)	GHD
	Bishnu Gautam BSc, MSc	GHD
Biodiversity	Arien Quin BSc (Botany), BA	GHD
	Peter Moonie BSc (Ecology), BAppSc, Grad Dip (Teach)	GHD
	Richard Retallick BSc (Hons), PhD	GHD
	Kelly Dalton BSc (Hons)	GHD
	Alex Kutt BSc (Hons), PhD	GHD
	Nicole Conroy BAppSc (Hons)	GHD
	Alex Holmes BSc (Hons)	GHD
	Glen Gaikhorst MSc	GHD
	Jo Kuiper BSc	GHD
Air and GHG	Laura Clayson BE (Env) (Hons), BSc (Chem) (Hons)	GHD
	Shane Woods BE (Env) (Hons), BA (Lang) (Hons)	GHD
Noise and vibration	James Forrest BEnvSc	GHD

Historic and Cultural Heritage	Jennie Lindbergh MHeritCons (Architecture), BA (Archaeology) (Hons), DipArts	Australian Museum
	Christopher Langeluddecke BA (Archaeology) (Hons)	Australian Museum
	Laressa Berehowyj BA (Archaeology)(Hons)	Australian Museum
Socio-economics	Pallavi Mandke PhD	GHD
	Jayne Mooney BA (Hons)	GHD
Rehabilitation and mine closure	Paul Rokich BSc (Biology), MBA	GHD
Environmental management	Alex Koscielski BSc (Hons)	GHD
GIS	Alex Feeney BSc	GHD
	Ryan Bannister BSc (Hons)	GHD

Appendix B

DotE and NT EPA Determination Letters

EPBC Ref: 2013/7027

Mr Paul Burton
Managing Director
TNG Limited
PO Box 1126
SUBIACO WA 6904

Dear Mr Burton

Decision on referral and assessment approach – accredited assessment
Mount Peake iron, vanadium and titanium mining project, Northern Territory (EPBC 2013/7027)

Thank you for submitting a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).This is to advise you of my decision about the proposed action to undertake the Mt Peake iron, vanadium and titanium mining project and associated infrastructure, 280 kilometres north-northwest of Alice Springs, Northern Territory.

As a delegate of the Minister for the Environment, I have decided that the proposed action is a controlled action and, as such, requires assessment and a decision on approval under the EPBC Act before it can proceed.

It appears that the proposed action is likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (sections 18 & 18A)

For example, based on the information available in the referral, the proposed action is likely to have a significant impact because:

- The proposed action will result in the clearance of 838.5 ha of native vegetation that may decrease the availability of habitat such that the listed vulnerable Dwarf Desert Spike-rush *(Eleocharis pappillosa)* is likely to decline;

- The clearance of potential habitat and risk of vehicle strike from increased truck movements may interfere with the recovery of the listed vulnerable Black-footed Rock-wallaby (MacDonnell Ranges race) *(Petrogale lateralis)*, Greater Bilby *(Macrotis lagotis)* and Crest-tailed Mulgara *(Dasycercus cristicauda)* species.

Please note that this decision only relates to the potential for significant impact on the specific matters protected by the Australian Government under Chapter 2 of the EPBC Act.

I have also decided that the proposed action will need to be assessed through accredited assessment with the Northern Territory under the Northern Territory *Environmental Assessment Act 1982* at the level of an Environmental Impact Statement.

Details on the assessment process and the responsibilities of the proponent are set out in the enclosed fact sheet. Further information is available from the department's website at http://www.environment.gov.au/epbc.

I have also written to the following parties to advise them of this decision:

Territory authority	Northern Territory Environment Protection Agency
Other relevant authority	Commonwealth Department of Industry

Copies of both the referral decision notification and the decision on assessment approach notifications are enclosed.

Please also note that once a proposal to take an action has been referred under the EPBC Act, it is an offence under Section 74AA to take the action while the decision making process is on-going (unless that action is specifically excluded from the referral or other exemptions apply). This provision of the EPBC Act carries a maximum penalty of $425,000. The EPBC Act is available on line at: http://www.environment.gov.au/epbc/about/index.html

The department has recently published an *Environmental Impact Assessment Client Service Charter* (the Charter) which outlines the department's commitments when undertaking environmental impact assessments under the EPBC Act. A copy of the Charter can be found at: http://www.environment.gov.au/epbc/publications/index.html.

If you have any questions about the assessment process or this decision, please contact the project manager, Rose Givens, by email to Rose.Givens@environment.gov.au, or telephone 02 6274 1840 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Tony Bigwood
A/g Assistant Secretary
North, West and Offshore Assessment Branch
18 November 2013

Australian Government

Department of the Environment

Notification of

REFERRAL DECISION AND DESIGNATED PROPONENT – controlled action

Mount Peake iron, vanadium and titanium mining project, Northern Territory (EPBC 2013/7027)

This decision is made under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

proposed action	To undertake the Mount Peake iron, vanadium and titanium mining project and associated infrastructure, 280 kilometres north-northwest of Alice Springs, Northern Territory [See EPBC Act referral 2013/7027].

decision on proposed action	The proposed action is a controlled action. The project will require assessment and approval under the EPBC Act before it can proceed.
relevant controlling provisions	• Listed threatened species and communities (sections 18 & 18A)
designated proponent	TNG Limited ACN: 000 817 023

assessment approach	To be advised.
Decision-maker	
name and position	Tony Bigwood A/g Assistant Secretary North, West and Offshore Assessment Branch
signature	
date of decision	13 November 2013

Australian Government
Department of the Environment

Notification of
DECISION ON ASSESSMENT APPROACH

Mount Peake iron, vanadium and titanium mining project, Northern Territory (EPBC 2013/7027)

This decision is made under Section 87 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

proposed action	To undertake the Mount Peake iron, vanadium and titanium mining project and associated infrastructure, 280 kilometres north-northwest of Alice Springs, Northern Territory [See EPBC Act referral 2013/7027]

Decision on assessment approach

assessment approach	The project will be assessed by accredited assessment at the level of Environmental Impact Statement under the Northern Territory *Environmental Assessment Act 1982.*

Person authorised to make decision

name and position	Tony Bigwood A/g Assistant Secretary North, West and Offshore Assessment Branch
signature	Tony B
date of decision	18 November 2013

EPBC Ref: 2013/7027

Mr Paul Burton
Managing Director
TNG Limited
PO Box 1126
SUBIACO WA 6904

Dear Mr Burton

Decision on variation request
Mount Peake Iron, Vanadium and Titanium Mining Project, Northern Territory (EPBC 2013/7027)

I refer to Mr Ian McCardle's letter of 11 March 2015 requesting a variation of the proposed Mount Peake Iron, Vanadium and Titanium Mining Project (EPBC 2013/7027), on your behalf.

After examination of all relevant and additional information, I have considered the request under section 156B of the EPBC Act.

As a delegate of the Minister for the Environment, I have decided to accept the variation to the proposal.

A copy of the notice recording this decision is enclosed. This document will be published on the Department's website.

I note that all provisions under the EPBC Act have ceased to apply to the original proposal and now apply to the varied proposal, and that for the purpose of the application of those provisions, anything done in relation to the original proposal is taken to have been done in relation to the varied proposal.

I have also written to the Northern Territory Environment Protection Authority to advise them of my decision.

If you have any questions about the referral process or this decision, please contact the project manager, Lauren Mackaway, by email to lauren.mackaway@environment.gov.au, or telephone (02) 6275 9790 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Simon Banks

Dr Simon Banks
Assistant Secretary
West Assessments Branch
8 April 2015

CC: Mr Ian McCardle
Principle Environmental Scientist
GHD Pty Limited

Australian Government

Department of the Environment

NOTIFICATION OF VARIATION OF PROPOSAL TO TAKE ACTION

Mt Peake Iron, Vanadium and Titanium Mining Project, Northern Territory (EPBC 2013/7027)

This decision to accept a variation to the proposal to take an action is made under section 156B of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Variation to proposal to take an action

Person proposing to take the action	TNG Limited ACN: 000 817 023
Original proposed action	To undertake the Mount Peake iron, vanadium and titanium mining project and associated infrastructure, 280 kilometres north-northwest of Alice Springs, Northern Territory [See EPBC Act referral 2013/7027].
Varied proposed action	The variation is to remove from the original proposed action: • the hydrometallurgical processing plant, • the gas/slurry pipeline infrastructure corridor linking the mine site with a rail siding at Adnera. The variation also alters the original proposed action by: • trucking of magnetite concentrate to the rail head rather than as a slurry via a pipeline, • delivery of gas to the mine site via a pipeline located within the transport corridor. [see EPBC Act referral 2013/7027 and request to vary the proposal dated 11 March 2015].
Date of effect	This variation has effect on the date the instrument is signed.

Person authorised to make this decision

Name and position	Dr Simon Banks Assistant Secretary West Assessment Branch
Signature	Simon Banks
date of decision	8 April 2015

ntepa Northern Territory Environment Protection Authority

Level 2, Darwin Plaza
41 Smith Street, The Mall

Postal address GPO Box 3675
Darwin NT 0801
Tel 08 8924 4136
Fax 08 8924 4053
Web www.ntepa.nt.gov.au

Our ref EN2013/0051

Mr Paul Burton
Managing Director
TNG Limited
PO Box 1126
Subiaco WA 6904

Dear Mr Burton,

RE: NOTICE OF INTENT – TNG LIMITED - MT PEAKE PROJECT

Thank you for submitting a Notice of Intent (NOI) for consideration under the NT *Environmental Assessment Act* (EA Act).

I am writing to inform you that the Northern Territory Environment Protection Authority (NT EPA) has decided that the above proposal put forward by TNG Ltd requires assessment under the EA Act at the level of an Environment Impact Statement (EIS). Enclosed is a Statement of Reasons supporting the decision.

Draft Terms of Reference for the project are being prepared by the NT EPA. The draft Terms of Reference will be advertised for public comment for 14 days. The Terms of Reference will be finalised and issued to you following full consideration of any comments raised during the exhibition period. The Terms of Reference will advise you of the information and matters that are required to be addressed in the EIS.

Any queries in relation to this matter should be directed to Ms Lisa Bradley, Manager Environmental Assessments, NT EPA on (08) 8924 4136 or Lisa.Bradley@nt.gov.au.

Yours sincerely

Gary Nairn

HON. GARY NAIRN
Member
Northern Territory Environment Protection Authority

13 November 2013

Attached: *Statement of Reasons*

ntepa Northern Territory Environment Protection Authority

Statement of Reasons

MT PEAKE PROJECT – TNG LIMITED

NOVEMBER 2013

PROJECT

ON 4 July 2013, TNG Limited (the Proponent) (of Enigma Mining Ltd) submitted a Notice of Intent (NOI) proposing to develop and operate the Mt Peake Project, 280 km north-northwest of Alice Springs and 60km west of the Stuart Highway. The NOI proposed:

- Mining of a poly-metallic ore body;
- Beneficiation and hydrometallurgical processing of the ore at the mine-site or offsite, to produce hematite powder (Fe_2O_3), vanadium pentoxide flake (V_2O_5) and titanium dioxide (TiO_2);
- Transport of the products via a slurry pipeline or trucks to a new rail siding near Adnera, beside the Alice Springs to Darwin Railway, followed by rail transport to East Arm Wharf for export.

The resource is estimated to be at least 160 Million tonnes, which would provide a mine-life of approximately 20 years. Workforce would peak at around 350 workers.

New infrastructure requirements include:

Mount Peake Mine Area

- 150m-deep pit;
- dry stacked tailings cell, or conventional Tailings storage facility;
- waste rock dump;
- gas-fired power station;
- run of mine (ROM) pad;
- mine access road;
- gas and water pipelines;
- beneficiation plant;
- hydrometallurgical plant including acid plant and oxygen generation facility (onsite or offsite, yet to be determined);
- concentrate stockpile;
- leach and salt residue storage cells;
- product stockpiles for titanium dioxide and hematite (or magnetite);
- water treatment ponds or tanks;
- water and waste water treatment plants;
- explosives and detonator magazines;
- construction camp and accommodation village;
- administrative, control, laboratory, workshop and storage buildings;
- gatehouse and weighbridge;
- bulk fuels storage area and water storage tanks;
- workshops and offices; and
- air strip.

Rail Siding (near Adnera):

- product rail load-out facility at Adnera including hard stand storage shed for containerised vanadium and product stockpiles for titanium dioxide and hematite (or magnetite); and
- If transport via slurry pipeline is selected additional new facilities required include:

- filtration area with:
  - thickeners;
  - pressure filters;
  - control room; and
  - buffer tanks.
- transfer pond or tank;
- slurry pipeline from the Project Mining Area to Adnera Rail Siding; and
- return water line.

Corridors
- Infrastructure pipeline corridor (gas, +/- slurry, +/- return water, <90km / 100.8 ha); and
- Road transport corridor (90km, 310 ha);

East Arm Wharf
- Stockpiles for Fe_2O_3 and TiO_2;
- Laydown area for containerised V_2O_5; and
- Reclaim hopper.

DECISION

The Northern Territory Environment Protection Authority (NT EPA) considers that there is a risk of significant impacts to the environment from this proposal. A number of the risks have not been adequately characterised and require further studies and a more comprehensive assessment. Therefore, the proposal requires assessment under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS).

JUSTIFICATION

A review of the NOI identified:
- Environmental risk and details of proposed risk reduction measures are yet to be defined with respect to:
  - Waste rock dump (WRD) and dry stacked tailings cell, or conventional Tailings Storage Facility (TSF);
  - Potential for Acidic and/or Metalliferous Drainage from the WRD, TSF and other mine infrastructure;
  - Handling, storage and transport of mineral products: hematite powder (Fe2O3), vanadium pentoxide flake (V2O5) and titanium dioxide (TiO2);
  - Product transport alternatives to the railhead, i.e. slurry pipeline vs. road train transport.
  - Potential for product concentrate spills, such as from ruptured pipelines, traffic and rail transport accidents, and wind and water erosion of product stockpiles;
  - Alternative hydrometallurgical plant locations;
  - Handling, storage and transport of reagents and/or hazardous materials, including: hydrochloric acid, organic solvent, sulphuric acid, sulphur, sodium hydroxide, sodium chloride, calcium carbonate, oxygen, sodium hypochlorite; flocculent; and fuels;
  - Storm surge (East Arm Wharf infrastructure); and
  - Closure and Rehabilitation.

- Potential for impacts may exist to:
  - Sites of biological conservation significance, including Mud Hut Swamp and Anmatyerr North, downstream of the Project Area;
  - Sites of Aboriginal heritage significance;
  - Sites of cultural heritage (Indigenous and non-Indigenous);
  - Flora and fauna species of conservation significance for the NT and nationally;

- Local communities;
- Workers, such as from inhalation of product dust; and
- Livestock at neighbouring pastoral properties.

- The Proponent has not yet demonstrated:
  - sufficient water will be available for the Project;
  - ground and surface water resources will be protected from contamination;
  - that Sensitive receptors to mine impacts have been identified. Impacts might include:
    - groundwater drawdown (cone of depression) associated with pit dewatering, potentially affecting groundwater dependent ecosystems, livestock; nearby communities or other users of shared potable aquifers;
    - dust (including product dust) at all Project locations;
    - power station emissions;
    - erosion and sedimentation; and
    - groundwater and surface water contamination.
  - negative social and economic impacts will be avoided, and benefits optimised;
  - breeding sites for biting insects will not be created; and
  - clearing of native vegetation will be minimised where possible.

The above information gaps and risks have not been adequately characterised or addressed in the NOI and require further studies and a more comprehensive assessment, to ensure environmental impacts from the proposal will be minimised.

CONSULTATION

On 5 July 2013, in accordance with the Environmental Assessment Administrative Procedures, the NOI was circulated to Northern Territory Government advisory agencies that have administrative responsibilities relating to this action.

Submissions were received from:

- Aboriginal Areas Protection Authority;
- Environmental Health Branch - Department of Health ;
- Department of Land Resource Management;
- Heritage Branch - Department of Lands, Planning and the Environment;
- Medical Entomology - Centre for Disease Control - Department of Health;
- Mining Environmental Compliance Division - Department of Mines and Energy; and
- Department of Primary Industry and Fisheries.

Gary Nairn

HON. GARY NAIRN
MEMBER
NORTHERN TERRITORY ENVIRONMENT PROTECTION AUTHORITY

13 NOVEMBER 2013

ntepa Northern Territory Environment Protection Authority

Level 2, Darwin Plaza
42 Smith Street, The Mall
Darwin NT 0800
Postal address: GPO Box 3675
Darwin NT 0801
Tel: 08 8924 4136
Fax: 08 8924 4053
Web: www.ntepa.nt.gov.au

Our ref: EN2013/0051-002

Paul Burton
Managing Director,
TNG Limited
PO Box 1126
SUBIACO WA 6904

Dear Mr Burton,

RE: Advice of changes to the TNG Limited Mount Peake Project

The Northern Territory Environment Protection Authority (NT EPA) acknowledges correspondence submitted by Ian McCardle, Principal Environmental Scientist, GHD Pty Ltd on 9 March 2015, notifying of changes to the Mount Peake Project. The Project amendments were described as:

The hydrometallurgical processing plant, that was to be located within the Mount Peake Mining Area, is now not being considered. Current planning is for this facility to be located offshore. This will result in the projects disturbance footprint reducing by approximately 80ha, a reduction in atmospheric emissions, reduced vehicle movements due to fewer consumable being required, and a reduced construction and operations workforce.

In addition, the infrastructure corridor linking the mine site with a new rail siding at Adnera will no longer be required. It is proposed to truck magnetite concentrate to the rail head rather than to slurry it via a pipeline. Gas to the mine site will now be delivered via a pipeline located within the transport corridor. The removal of the infrastructure corridor will reduce the projects disturbance footprint by approximately 100 ha.

In accordance with clause 14A of the *Environmental Assessment Administrative Procedures*, the NT EPA has decided that the above changes do not alter the environmental significance of the Project. The Project will continue to be assessed at the level of an Environmental Impact Statement, and the Terms of Reference issued 7 March 2014 will not be amended.

Any queries in relation to this matter should be directed to Ms Lisa Bradley, Manager Environmental Assessments, NT EPA on telephone (08) 8924 4136 or email lisa.bradley@nt.gov.au.

Yours sincerely

Gary Nairn

GARY NAIRN
Member
Northern Territory Environment Protection Authority

March 2015

TNG LIMITED

Appendix C

Draft EIS Terms of Reference

TERMS OF REFERENCE FOR THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT

MOUNT PEAKE PROJECT
TNG LIMITED

March 2014

Table of Contents

Acronymns and Abbreviations Used in this Document

AAPA	Aboriginal Areas Protection Authority
AMD	Acidic and/or Metalliferous Drainage
AS/NZS	Standards Australia / Standards New Zealand
CO	Carbon Monoxide
DoH	NT Department of Health
EA Act	NT *Environmental Assessment Act*
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Comm)
ESCP	Erosion and Sediment Control Plan
Fe_2O_3	Hematite
GIS	Geographic Information System
ha	hectares
JORC	Joint Ore Reserves Committee
JORC Code.	The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
km	kilometres
km^2	square kilometres
m	metres
MCP	Mine Closure Plan
NES	National Environmental Significance
NOI	Notice of Intent
NO_X	Nitrogen oxide
NT EPA	Northern Territory Environment Protection Authority
NT	Northern Territory
NNW	North-North-West
PAF	Potentially Acid Forming
PASS	Potential Acid Sulfate Soils
ROM	Run of mine
SO_2	Sulfur dioxide
SOX	Sulfur oxides
TDS	Total Dissolved Solids
the Project	The Mount Peake Vanadium-Iron-Titanium Project
the Proponent	TNG Limited
TiO_2	titanium dioxide
TIVAN	Proposed new processing technology trademarked by TNG
TPWC Act	*Territory Parks and Wildlife Conservation Act 2000* (NT)
TSF	Tailings Storage Facility
V_2O_5	Vanadium pentoxide
WRD	Waste Rock Dump

1 Introduction

TNG Limited (the Proponent) proposes to develop and operate the Mount Peake Vanadium-Iron-Titanium Project (the Project) at Mount Peake, 280km NNW of Alice Springs and 60km west of the Stuart Highway. The Project includes open-cut mining of a polymetallic ore body, followed by ore beneficiation to produce a magnetite concentrate and / or hydrometallurgical processing to extract vanadium pentoxide flake (V_2O_5), titanium dioxide (TiO_2) and hematite powder (Fe_2O_3). The Joint Ore Resource Committee (JORC) Mineral Resource is estimated at 160 Million tonnes providing for an initial mine-life of 20 years. Workforce would peak at around 350 workers. The configuration is yet to be finalised with regard to the hydrometallurgical plant location, waste rock/tailing storage type, and whether the 90km product transport to the Alice Springs to Darwin Railway would be via road-train or pipeline, before transport by rail to East Arm Wharf. New infrastructure requirements include:

Mount Peake Mine Area

- 150m-deep pit
- beneficiation plant
- hydrometallurgical plant including acid plant and oxygen generation facility (onsite or offsite, yet to be determined)
- dry stacked tailings cell, or conventional Tailings storage facility
- waste rock dump
- concentrate stockpile
- product stockpiles for titanium dioxide and hematite (or magnetite)
- leach and salt residue storage cells
- run of mine (ROM) pad
- gas-fired power station
- water and waste water treatment plants
- water treatment ponds or tanks
- explosives and detonator magazines
- bulk fuels storage area and water storage tanks
- mine access road
- gas and water pipelines
- construction camp and accommodation village
- administrative, control, laboratory, workshop and storage buildings
- air strip
- gatehouse and weighbridge
- workshops and offices.

Rail Siding

- product rail load-out facility at Adnera including hard stand storage shed for containerised vanadium and product stockpiles for titanium dioxide and hematite (or magnetite concentrate); and
- If transport via slurry pipeline is selected, additional new facilities required could include: filtration area with:
  - thickeners;
  - pressure filters;
  - control room; and
  - buffer tanks.
- transfer pond or tank;
- slurry pipeline from the Project Mining Area to Adnera Rail Siding; and
- return water line.

Corridors

- infrastructure pipeline corridor (gas, +/- slurry, +/- return water, <90km / 100.8 ha);
- road transport corridor (90km, 310 ha);

East Arm Wharf

- stockpiles for Fe_2O_3, TiO_2 and / or magnetite concentrate.
- laydown area for containerised V_2O_5; and
- reclaim hopper.

The Proponent submitted a Notice of Intent (NOI) for the Project to the Northern Territory Environment Protection Authority (NT EPA) on 4 July 2013 for consideration under the NT *Environmental Assessment Act* (EA Act). On 13 November 2013 the NT EPA decided that the Project required assessment under the Act at the level of an Environmental Impact Statement (EIS).

A review of the NOI identified that the project will potentially have a significant impact on the environment. The following environmental risks have been identified:

Environmental risks:

- waste rock dump (WRD) and dry stacked tailings cell, or conventional Tailings Storage Facility (TSF);
- potential for Acidic and/or Metalliferous Drainage from the WRD, TSF and other mine infrastructure;
- handling, storage and transport of mineral products: hematite powder (Fe_2O_3), vanadium pentoxide flake (V_2O_5), titanium dioxide (TiO_2) and magnetic concentrate;
- product transport alternatives to the railhead, i.e. slurry pipeline vs. road train transport;

- potential for product concentrate spills, such as from ruptured pipelines, traffic and rail transport accidents, and wind and water erosion of product stockpiles;
- alternative hydrometallurgical plant locations;
- handling, storage and transport of reagents and/or hazardous materials, including: hydrochloric acid, organic solvent, sulphuric acid, sulphur, sodium hydroxide, sodium chloride, calcium carbonate, oxygen, sodium hypochlorite; flocculent; and fuels;
- storm surge (East Arm Wharf infrastructure); and
- closure and rehabilitation.

Potential impacts to:

- sites of biological conservation significance, including Mud Hut Swamp and Anmatyerr North, downstream of the Project Area;
- sites of Aboriginal heritage significance;
- sites of cultural heritage (Indigenous and non-Indigenous);
- flora and fauna species of conservation significance for the NT and nationally;
- local communities;
- workers, such as from inhalation of product dust; and
- livestock at neighbouring pastoral properties.

Uncertainties:

- whether sufficient water will be available for the Project;
- whether ground and surface water resources will be protected from contamination;
- whether sensitive receptors to mine impacts have been identified. Impacts might include:
  i. groundwater drawdown (cone of depression) associated with pit dewatering, potentially affecting groundwater dependent ecosystems, livestock, nearby communities or other users of shared potable aquifers;
  ii. dust (including product dust) at all Project locations;
  iii. power station emissions;
  iv. erosion and sedimentation; and
  v. groundwater and surface water contamination.
- whether negative social and economic impacts will be avoided, and benefits optimised;
- whether breeding sites for biting insects will be created; and
- whether clearing of native vegetation will be minimised where possible.

The NT EPA decision that the project requires assessment at the level of an EIS was based upon the above potential environmental impacts and risks. Further studies and a more comprehensive assessment were considered to be required to ensure environmental impacts from the proposal would be minimised.

The Project was referred by the Proponent to the Australian Department of the Environment for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 13 November the Project was determined to be a controlled action under the EPBC Act due to the potential for significant impacts to listed threatened species and communities (Sections 18 & 18A). On the same day, a delegate for the Minister for the Environment agreed to accredit the Northern Territory's assessment process under the EA Act for the purposes of assessing the Project.

2 General Advice on EIS

2.1 General Content

The EIS should be a stand-alone document. It should contain sufficient information to avoid the need to search out previous or additional, unattached reports.

The EIS should enable interested stakeholders and the NT EPA to understand the environmental consequences of the proposed development. Information provided in the EIS should be objective, clear, succinct, and easily understood by the general reader. Maps (using an appropriate scale, resolution and clarity), plans, diagrams and other descriptive detail should be included. Technical jargon should be avoided wherever possible. Cross-referencing should be used to avoid unnecessary duplication of text.

The level of analysis and detail in the EIS should reflect the level of significance of the expected and potential impacts on the environment, as determined through adequate technical studies. Any and all unknown variables or assumptions made in the assessment must be clearly stated and discussed. The extent to which a limitation, if any, of available information may influence the conclusions of the environmental assessment should also be discussed.

Information materials summarising and highlighting risks of the Project should be provided in a culturally appropriate format and language, where relevant.

2.2 Format and Style

The EIS should be produced on A4 size paper capable of being photocopied, with any maps, diagrams or plans on A4 or A3 size paper, and in colour if possible.

The EIS should comprise of three elements:

- Executive summary

The executive summary must include a brief outline of the Project and each chapter of the EIS, allowing the reader to obtain a clear understanding of the proposed Project, its environmental implications and management objectives. It must be written as a stand-alone document, able to be reproduced on request by interested parties who may not wish to read the EIS as a whole.

- Main text of the document

The main text of the EIS should include a list of abbreviations, a glossary to define technical terms, acronyms and abbreviations, and colloquialisms. The document should consist of a series of chapters detailing the level of significance of the expected and potential impacts on the environment from the Project.

- Appendices

The appendices must include detailed technical information, studies or investigations necessary to support the main text that can be made publicly available, including:

- a table listing how these Terms of Reference have been addressed in the EIS, cross-referenced to chapters, page numbers and/or appendices;
- an outline of the relevant legislation, codes, standards and guidelines applicable to the Project;
- a list of persons and agencies consulted during the Environmental Assessment process;
- the names of, and work done by, the persons involved in preparing the EIS; and
- the qualifications and experience of the people involved in work contributing to the EIS.

The EIS must be written so that any conclusions reached can be independently assessed. All sources must be appropriately referenced using the Harvard Standard. The reference list should include the address of any internet pages used as data sources. All referenced supporting documentation must be available upon request.

2.3 Administration

The Proponent should lodge ten bound, hard copies and an electronic (Adobe PDF format) copy of the EIS with the NT EPA and two bound hardcopies with the Australian Government Department of the Environment (DoE). The electronic copies should be provided both as a single file of the entire document and separate files of the document components. Additionally, a Microsoft Word copy of the EIS should be provided to facilitate the production of the Environmental Assessment Report. The proponent should consider the file size, the number of files, format and style of the document appropriate for publication on the NT EPA website. The capacity of the website to store data and display the material may have some bearing on how the document(s) are constructed.

Hard copies of the EIS document should be offered to all neighbours of the Project, and other significant stakeholders.

At a minimum, the Proponent is to advertise when the EIS will be available for review and comment in *The Centralian Advocate, Tennant and District Times* and *NT News*.

To ensure sufficient time to review the advertisement and upload the documentation, the NT EPA requires that an electronic copy of the draft EIS and the draft advertisement is submitted to the NT EPA at least one week prior to advertising the draft EIS.

2.4 Public Involvement and Consultation

The draft EIS has an important role in informing the public about the risks associated with the Project. It is essential that the Proponent demonstrate how any public concerns were identified, and how those concerns will influence the design and delivery of the Project. Public involvement and the role of government organisations should be clearly identified. The outcomes of any surveys, public meetings and liaison with interested groups should be discussed including any changes made to the Project as a result of consultation.

To ensure that the draft EIS is publicly available to interested members of the public or stakeholders, the NT EPA requires that it be made available for a period of at least six weeks, at the following locations:

- NT Environment Protection Authority, 2nd Floor, Darwin Plaza, 41 Smith Street Mall, Darwin;
- Mines and Energy Information Centre, Department of Mines and Energy, 3rd Floor, Paspalis Centrepoint, 48 Smith Street Mall, Darwin;
- Department of Lands, Planning and the Environment, Floor 1, Alice Plaza Building, Todd Street Mall, Alice Springs;
- Central Land Council, 27 Stuart Hwy, Alice Springs;
- Northern Territory Library, Parliament House, Darwin;
- Alice Springs Public Library, Gregory Terrace, Alice Springs (telephone 8950 0555 Email: library@astc.nt.gov.au);
- Tennant Creek Public Library (telephone: 8962 2657 Email: library@tennantcreek.nt.gov.au); and
- Arid Lands Environment Centre, Alice Springs. Office cnr Warburton St and Lindsay Ave, Alice Springs NT 0870. (telephone: 8952 2497, email: info@alec.org.au)

The EIS exhibition period should not occur in late December or January in any year to ensure optimal opportunity for public and Government viewing of the EIS document. Additional time will be added to the EIS exhibition period if the EIS exhibition overlaps any Christmas and January periods.

3 Description of the Proposed Development

3.1 General Information

The EIS should provide a brief background and context to the Project, including:

- the title of the Project;
- the full name and postal address of the Proponent;
- an explanation of the objectives, benefits and justification for the Project;
- the Project's location in the region and its proximity to landmark features, sites of cultural/social significance, regional community centres, and sensitive environments such as major waterways, significant groundwater resources, significant natural features, conservation reserves and any areas on the National Reserve System;
- details of the Proponent's environmental record, including details of any proceedings against the Proponent under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources;
- climate and atmospheric characteristics relevant to the Project (e.g. air quality, wind speed and direction, seasonal temperatures, humidity, wind, evaporation, extreme events and rainfall);
- agreements between the Northern Territory Government, Traditional Owners, land manager(s) and the Proponent;

- the background to the development of the Project including discussion of previous environmental impact assessment and overview of historic mining activities;
- identification of areas under exploration which may be mined in future, or any other potential future activities being planned;
- how the Project relates to any other proposals or actions (of which the Proponent should reasonably be aware) that have been or are being taken, or that have been approved in the region;
- National and Northern Territory standards, codes of practice and guidelines which may be relevant to the Project;
- an overview of the schedule for the whole Project; and
- the current status of the Project.

3.2 Description of the Proposal

The EIS should identify all the processes and activities intended for the Project, and any associated ancillary activities, during the life of the Project. As background to discussion of specific components, the following should be included:

- an outline of the geology of the area including:
  - a summary of the results of studies and surveys undertaken to identify the extent of the resource within the Project area;
  - geological properties of the Project site including the results of studies to identify sulphidic ores;
  - characterisation of classes of ore and waste rock; and
  - the results of geotechnical studies undertaken for the purposes of designing open pit(s), waste rock dump(s), tailing storage facilities and water storage facilities.
- delineation of the Project footprint using detailed maps and diagrams, including:
  - location of the resource/s to be explored, developed or mined;
  - all areas to be cleared or disturbed (including mine, haul roads, pipeline corridors, product stockpiles and other infrastructure), both for the life of the Project and temporarily, prior to rehabilitation;
  - the location of any works to be undertaken, structures to be built or elements of the proposed Project. Where relevant this must include, but is not limited to, the location of the mine, water extraction points and storage facilities, roads, airfield, accommodation village or construction camp/s, hard stands, stockpiles (soil/ore/waste rock), haul roads, product rail load-out facility, beneficiation plant, hydrometallurgical plant, pipeline corridors, rail siding, and product export facilities;

Additionally, data should be provided to the NT EPA as importable GIS shape files with relevant features and areas marked as polygons, lines and points, and any relevant geospatially referenced underlays also included.

3.3 Project Components

3.3.1 Mine

Provide the following information (where relevant) with regard to mining activities for the Project:

- design details, dimensions and design concepts for the:
    - open-pit;
    - waste rock dump;
    - tailings storage facility;
    - run of mine (ROM) pad;
    - mine access road;
    - leach and salt residue storage cells;
    - explosives and detonator magazines;
    - product and other stockpiles; and
    - other significant mine infrastructure.
- timetable for construction, including staging of construction activities;
- native vegetation (community types, areas) to be cleared and disposal of consequent plant matter;
- methods of mine construction, including estimates of the volume of materials required for waste rock and tailings storages;
- sources and quantities of clay required, such as for construction of the TSF / WRD, drains, water dams and other mine infrastructure; and
- details of the plant and machinery required.

Provide specific details on the following aspects of operation:

- mining types and methods, including the major equipment to be used in the various components of the operation;
- handling/stockpiling of topsoil and waste materials;
- quantity of material to be mined, ore produced and waste rock generated annually, and any proposed ramping up of production or staging of development;
- describe methods for disposing of waste rock, tailings and any other residues;
- provide conceptual designs of the pit, WRD, TSF, processing facilities and power station to indicate their scale in relation to existing surrounding landscape; and
- timetable for operation of the mine including the targeting of each prospect or deposit.

3.3.2 Processing

Provide relevant information with respect to the beneficiation and processing plants, including but not limited to:

- conceptual designs and footprints of the Project beneficiation and processing plants;
- clearing and preparation of the site;
- final location of the sites;
- transport of materials to the site and assembly of the plants;
- ore beneficiation and processing methods, including flow diagrams, chemistry, quantities, variables, inputs and outputs;
- the recovery method proposed (including flow diagrams);
- history and explanation of the proposed TIVAN process, and evidence to demonstrate its levels of reliability to fulfil design specifications and mine processing objectives; and
- the physical and chemical characteristics of tailings and screenings.

3.3.3 Road Transport

Identify proposed routes for transport of construction materials, personnel, product and supplies for the Project, including use of existing transport infrastructure. Details of proposed road construction and/or upgrades should be provided, including:

- road designs, including methods of river crossings and intersection with other roads, including the Stuart Highway;
- maximum and average width of road corridors required for construction;
- plant and machinery required;
- road building material sources;
- vegetation clearing methods and disposal of plant matter following clearing;
- location of campsites for construction crews, if required;
- the results of surface water investigations in and around proposed road structures;
- sources of construction inputs and materials;
- methods including crossing techniques which will be used when bisecting creeks or linear infrastructure (provide cross section diagram/s);
- timeframes for transport infrastructure construction/upgrade;
- design requirements, Legislative approvals and/or requirements which will be applicable to the construction of the road; and
- ongoing provisions for transport infrastructure maintenance, including source and extraction of maintenance inputs and materials.

Details of road use should be provided including:

- type, size and number of vehicles required during all phases of the Project;
- estimated frequency of Project vehicle use on public roads;
- identification of sites of increased road traffic density, and potential traffic accident hotspots, such as around construction camps;
- requirements for new restricted speed limits due to roadworks;
- methods to convey all site traffic (including materials, workers and product) to and from the site;
- routes for transport, including details of proposed routes for over-dimension or very heavy loads, and when/where oversize escorts would be required,
- details of the method of truck loading and load constraint;
- peak user times for vehicular movements by staff/contractors;
- hazardous or dangerous material which may be transported (type, hazard, quantity, frequency, routes);
- additional transport infrastructure works required, including site access and signage; and
- hours of operation.

Describe proposed methods of product transport and export.

3.3.4 Infrastructure Corridor

Identify proposed route(s) for infrastructure corridor(s), such as for gas, concentrate slurry and water pipelines. Details of proposed corridor construction and maintenance should be provided, including:

- land tenure, and status of landholder agreements;
- design details of the corridor(s) and contained infrastructure;
- locations of non-linear items within corridors, such as pumping stations;
- maximum and average widths of infrastructure corridors required for construction;
- plant and machinery required;
- vegetation clearing methods and disposal of plant matter following clearing;
- location of campsites for construction crews, if required;
- the results of surface water investigations in and around proposed structures;
- sources of construction inputs and materials;
- designs and construction methods which will be used when bisecting creeks or linear infrastructure (provide cross section diagram/s); and
- design requirements, Legislative approvals and/or requirements which will be applicable to the construction of infrastructure corridors.

3.3.5 East Arm Wharf

Identify all infrastructure relating to the storage and shipping of material, in particular:

- stockpiles for material such as Fe_2O_3, TiO_2 and / or magnetite concentrate;
- laydown area for containerised V_2O_5; and
- reclaim hopper.

3.3.6 Water

Describe water-related infrastructure for the Project including location, footprint, design details and objectives for each of the following:

- water treatment systems, including sediment ponds;
- storage ponds (describe contents);
- pumps, pipelines, etc.;
- effluent disposal systems.

In addition:

- estimate water requirements (rates / quality) for (components of) the Project.
- estimate pit dewatering rates, de-water quality and describe proposed management of extracted waters.

3.3.7 Energy

Determine Project electricity and fuel requirements including proposed alternative fuels if a gas pipeline is not viable. Provide:

- description and map the proposed electricity, fuel and gas supply and storage infrastructure;
- conceptual designs and objectives of proposed power plants; and
- description of gas source(s) and any constraints to availability.

3.3.8 Waste management

Describe waste streams, and their management, storage, treatment and disposal;

- through construction and operational phases;
- at each Project component location;
- including industrial and domestic waste streams; and
- waste stream phases (solid, liquid, gas), environmental residency, environmental or human hazards, and proposed treatment and management.

In addition:

- provide an inventory of any hazardous wastes requiring management during the Project;
- describe proposed management of each hazardous waste type;
- define Legislation, standards and/or Guidelines applicable to handling of each type of hazardous waste.

3.3.9 Workforce and accommodation

- describe the number of people to be employed, skill-sets required, and likely sources (local, regional, overseas) of workforce during construction and operational phases;
- discuss arrangements for transport of workers to and from project areas, including air services required;
- specify the number of people to be employed to manage or undertake environmental duties on the site, and minimum requirements for qualifications and experience.

For the proposed construction camp / accommodation village, provide brief information on aspects of the facility such as:

- conceptual designs of:
  - construction camp;
  - accommodation village; and
  - administrative, control, laboratory, workshop and storage buildings.
- layout of the camp / village with respect to work sites and mining and processing operations;
- requirements for food preparation and storage; and
- whether the premises will be licensed and include alcohol storage facilities.

3.3.10 Adnera Rail load-out facility

- describe the facility's purpose and capabilities;
- describe facility components, footprints, configuration, product handling and processing;
- where relevant, include conceptual details of the:
  - filtration area with:
    - thickeners;
    - pressure filters;
    - control room; and
    - buffer tanks.
  - transfer pond or tank;

  - slurry pipeline; and
  - return water line.
- describe construction requirements and timing;
- describe proposed load out facility operations, workforce, raw material and energy requirements, clearing footprint, and local environmental and community context.

3.3.11 Ancillary infrastructure

Provide construction and operational information regarding ancillary infrastructure, including, but not limited to:

- telecommunications;
- information on potentially hazardous materials to be used or produced and methods for storage, transport, handling, containment, disposal and emergency management of these materials (including fuel);
- airstrip; and
- any existing ancillary infrastructure that could be used by the Project.

3.3.12 Closure and rehabilitation

Discuss the various aspects of proposed progressive and final rehabilitation of disturbed areas, including:

- proposed staging/timing;
- soil profile reconstruction;
- final landform design and any voids or landscape depressions to be left at cessation of mining;
- rehabilitation techniques to be used and the final topographic and drainage morphology;
- the proposed revegetation program, with selection and collection of local native species (e.g. native grasses and other vegetation);
- other preparations required for successful rehabilitation (seed harvesting, seedling generation, etc.); and
- closure plans for individual Project components including the WRD, TSF, Pit(s), pipelines, corridors, roads, etc.

Describe mine closure plans including:

- plans for unexpected or forced closure;
- removal of plant, equipment, structures, hardstand and concrete footings, buildings, water storages, and methods proposed for stabilisation of affected areas;
- reinstatement of creeks where diversion of creeks is proposed during operations; and
- future land tenure arrangements.

4 Alternatives

The EIS should describe any feasible alternatives to carrying out the proposed activity. The choice of the preferred option(s) should be clearly explained, including how it complies with the principles and objectives of ecologically sustainable development. Alternatives should include:

- not proceeding with the Project;
- options for concentrate transport and export;
- site selection for Project components;
- mining methods;
- management of waste rock and tailings streams, and waste facility designs;
- rehabilitation methods;
- methods of product treatment, storage, transport and export;
- energy sources for power generation; and
- consideration of alternative environmental management measures for key risks/impacts.

Discussion should include:

- adverse and beneficial effects of alternatives at national, territory, regional and local levels;
- the comparison of short (whilst operational), medium (post closure) and long term advantages and disadvantages of the alternatives;
- detailed alternative Project infrastructure configurations being considered in equivalent terms as in the preceding sections (above);
- the EIS should include an analysis of potential alternatives that will reduce net water use for the Project and contamination of water resources by the Project; and
- a comparative description of the impacts of each alternative on the matters of National Environmental Significance (NES) protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) controlling provisions applicable to the Project (Sections 18 & 18A - Listed Threatened Species and Communities).

5 Risk Assessment

5.1 Risk Assessment Approach

The EIS should be undertaken with specific emphasis on the identification, analysis and treatment of risks through a whole-of-project risk assessment. Through this process, the EIS will:

- acknowledge and discuss the full range of risks presented by the Project, including those of special concern to the public;

- quantify and rank risks so that the reasons for proposed management responses are clear;
- acknowledge levels of uncertainty about estimates of risk and the effectiveness of risk controls; and
- explicitly identify those members of the community expected to accept residual risks and their consequences, providing better understanding of equity issues.

Statements about levels of uncertainty should accompany all aspects of the risk assessment. Steps taken to reduce uncertainty or precautions taken to compensate for uncertainty should be identified and their effect/s demonstrated.

Information provided should permit the reader to understand the likelihood of the risk, its potential severity, and any uncertainty about the effectiveness of controls. Levels of uncertainty that preclude robust quantification of risk should be clearly acknowledged.

Risk rankings assigned should be fully justified. Where a risk score associated with the likelihood or consequence of an impact is reduced as a result of proposed mitigation measures, clear justification should be provided for the reduction in score. The adequacy and feasibility of mitigation measures must be demonstrable.

Sufficient quantitative analysis should be provided to indicate whether risks are likely to be acceptable or tolerable. A comparison can be made with similar ventures in Australia and internationally. Assumptions used in the analyses should be explained. Relevant standards, codes and best practice methodologies that minimise risks should be discussed.

The risk assessment should be based on international best practice. Processes for risk management are formalised in Standards Australia / Standards New Zealand (e.g. AS/NZS ISO 31000:2009; HB 436:2004; HB 158:2010; HB 203:2012).

A number of key Project risks have been identified through a preliminary assessment of the Project. Each of the risks defined in this Terms of Reference (Sections 1 and 5.2-5.8) should be addressed by the Proponent in the risk assessment and management process.

Additionally, it is expected that further risks will be identified through the comprehensive risk assessment process required for the EIS. These should also be addressed and appropriate management initiatives developed.

Environmental objectives, or overarching goals, and environmental values to be protected have been identified for each key risk.

5.2 Risks to Ground and Surface Water Resources

Key Risks

- potential for Acidic and/or Metalliferous Drainage (AMD) from the waste rock dump, tailings storage facility and other mine infrastructure, to contaminate shared water resources;
- surface water quality may be impacted by spills to surface water and runoff containing hazardous substances or elevated sediment concentrations;
- contamination of groundwater could occur through leaks from storages or pipelines and spills during handling of contaminants, chemicals and toxicants; and

- practically available water sources will not be sufficient to supply the needs of the proposed Project configuration; or will not be sufficient without causing environmental or social impacts.

Environmental Objectives

- demonstrate that available water supplies will be sufficient to fulfil the Project needs over the predicted life-of-mine, without causing environmental or social impacts.
- demonstrate that project configuration will optimise reduction of net water use for the Project and minimise contamination of water resources.
- ensure that surface water and groundwater resources and quality are protected both now and in the future, such that ecological health and land uses, and the health, welfare and amenity of people are maintained.

Information Requirements

- define water sources that may be used to fulfil the requirements of the Project, including:
    - target bore fields (existing / proposed) and surface waters;
    - predicted extraction rates;
    - seasonal requirements for additional clean water;
    - sources of water for construction of roads and infrastructure corridors; and
    - sources and requirements of potable water.
- describe the existing mine-site and regional hydrogeology in terms that will provide a comprehensive baseline of pre-disturbance conditions. The baseline should be adequate to identify any changes that may have occurred as a result of the Project. Emphasis should be given to factors that are likely to be affected by Project activities, such as, levels of aluminium that may be affected by tailings slurry, water-table depth and pit dewatering.

The EIS should include information on the current groundwater resources. In particular, the draft EIS should:

- map, describe and model site and regional groundwater resources for the mining leases, ore-processing and water extraction points.
- discuss significance and sensitivity of site and regional groundwater resources from ecological, public/social and economic perspectives. Include description of:
    - existing groundwater users;
    - location of groundwater bores for the Project with respect to any groundwater dependent natural features and community uses;
    - groundwater depths;
    - directions and rates of groundwater flow;
    - groundwater quality, with particular emphasis on contaminants likely to be elevated from mining activities, such as values for yield, fluoride, nitrate, sulfate and Total Dissolved Solids (TDS);

  - connectivity between aquifers and with surface waters;
  - points of recharge / discharge;
  - whether proposed bores or the Project footprint are within a declared Water Allocation Planning area. If so, describe how the proposed extraction can be accounted for in the relevant Water Allocation Plan; and
  - estimate total reserves and annual recharge.

Provide a description of site and regional surface water resources in the vicinity of the proposed mining areas.

- describe surface water resources - water quality and significance;
- discuss sensitivity and significance of site and regional surface water resources from ecological, public/social and economic perspectives. Include description of water quality, flow rates, existing surface water users;
- define baseline surface water quality (acidity, metals, sulfate, salinity, nutrients, major ions etc.) for Murray Creek and Bloodwood Creek, Mud Hut Swamp and Anmatyerr North if data is available.
- the nature of Murray Creek, including when it flows, flow rates, catchment size, width, and where it flows to; and
- whether Murray Creek presents a seasonal flooding/erosion risk to the pit, plant or proposed bridges/crossings.

Designs of river crossings, stormwater drainage flows, flood flows should be based on the recently released changes in rainfall intensities by the Bureau of Meteorology.

Provide a water balance model for the Project, detailing

- each Project site;
- construction and operational phases;
- water sources (extraction rates / quality);
- water uses;
- water treatments (such as of supplies, stormwater, waste water discharges); and
- recycling.

Describe AMD potential, including potential for circum-neutral drainage, with respect to the WRD, TSF, ROM and other Project infrastructure. Include:

- characterisation of AMD potential of ore (high and low grade), tailings, and waste rock types to be exposed by the Project, using representative samples for geochemical test work;
- description of planning, testing, ongoing identification, segregation and management of Potentially Acid Forming (PAF) material to minimise AMD risk;
- incorporate the findings of various investigations into AMD potential for Project waste rock into the block model and mine-sequencing plan for the mine, to minimise AMD risk; and

- detail the findings of testing carried out in accordance with recommendations of the NT EPA Environmental Assessment Guidelines for Acid and Metalliferous Drainage.

Define applicable Legislation, standards, and/or Guidelines, and proposed containment, handling, and spill management of product at the Adnera and East Arm load-out facilities.

Assessment of risk

Provide a groundwater and surface water model for the mine and processing site(s), to predict groundwater drawdown and contaminant transport dynamics over time, and in response to alternative management actions and infrastructure configurations.

Predict potential impacts of the proposal on downstream flora and fauna and communities, including drawdown cones and pollution pathways.

Where identified discharge risks to water quality and related sensitive receptors occur for the Project, interactions should be illustrated in a Conceptual Site Model for the Project. The Conceptual Site Model should include relevant impacts to human health and safety as well as air quality for the project. Model design and information content should be in accordance with the NT EPA Guidelines on Conceptual Site Models. (Available online at: http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0005/349943/guideline_pollution_conceptual_site_models.pdf)

The draft EIS should include an assessment of the Project's risks to the surface and groundwater resources in the vicinity of the site and Project components, as well as regionally. In particular, the draft EIS should identify and assess the risks associated with:

- disturbance, storage, and management of PAF material and contingency management of AMD;
- groundwater drawdown (cone of depression) and its impacts on other groundwater users, existing springs and groundwater dependent ecosystems.
  - identify sensitive receptors and risks to sensitive receptors from the predicted cone of depression as a result of dewatering activities;
- the construction of any infrastructure that crosses, is adjacent to, or situated within waterways. The draft EIS should include an discussion of the risks associated with the new infrastructure altering the hydrology and rates of erosion, and sedimentation;
- uncontrolled or unplanned releases of environmental contaminants such as AMD, leaking storage facilities or pipelines, accidental spills of hazardous materials or hydrocarbons;
- disturbance of soils, allowing mobilisation of sediments, erosion, and sedimentation of waterways;
- impacts to local livestock, such as through the exposure to salt or other contaminants associated with mining or waste storage activities; and
- land degradation from disposal of brine, sulfates, wastewater or other contaminants.

Identify areas of the Project presenting risks of spills, or need for discharge of environmentally hazardous substances.

- describe any proposed application for a waste discharge licence, from the NT EPA.

Identify environmental toxicity and hazardous risk to personnel or other sensitive receptors from potential escape of:

- vanadium compounds / magnetite concentrate;
- processing tailings / by-products;
- hydrochloric acid;
- organic solvent;
- sulphur, sulphuric acid;
- sodium hydroxide, sodium chloride, sodium hypochlorite;
- flocculent; or
- fuels.

Identify risks associated with stockpile areas and rail load-out facilities; including at Adnera, the mine site, and at the site of the processing plants.

Identify risks to marine water quality associated with Project load-out facilities, stockpiles and lay-down areas at East Arm Wharf. Consideration should be given to risks associated with:

- potential for escape of Product concentrates, with:
  - stormwater runoff;
  - groundwater infiltration;
  - dust mobilisation; and/or
  - storm surge affecting Project areas at East Arm Wharf. Estimates of storm surge extents are available from the Department of Land Resource Management. Design of Infrastructure at East Arm Wharf should consider potential primary and secondary extent / height of storm surge.
- disturbance of Potential Acid Sulfate Soils (PASS). Characterisation and management of PASS should be undertaken in consultation with the NT Department of Land Resource Management.

Mitigation

Describe contingency environmental management against risk of:

- AMD or other hazardous substances escaping to local creeks and/or aquifers;
- spills or need for discharge of environmentally hazardous substances or hazardous to human health;
- offsite impacts of spills, such as to water resources, ecosystems, workers, the public or sacred sites;

- spills of processing inputs/outputs such as: vanadium compounds, processing tailings / by-products, hydrochloric acid, organic solvent, sulphuric acid, sulphur, sodium hydroxide, sodium chloride, sodium hypochlorite, flocculent, and fuels.
- spill of magnetite concentrate from the slurry pipeline;
- offsite impacts, such as to water resources, ecosystems, workers, the public or sacred sites; and
- spills as a result of storm surge at East Arm Wharf.

Describe how AMD will be prevented in and from the WRD, TSF, ROM and other Project infrastructure.

- for designs of the WRD, TSF, Mine Pit, ROM and other Project structures to be built with waste rock, describe conceptually how designs will prevent AMD. Support discussion with relevant design details to demonstrate minimisation of AMD risk.
- detail proposed AMD management with reference to: *NT EPA Environmental Assessment Guidelines - Acid and Metalliferous Drainage*.
- describe any further proposed environmental management actions that will reduce the risk of AMD developing.

Define proposed management and erosion and sediment controls in an Erosion and Sediment Control Plan (ESCP) for the Project (components) for:

- construction and operational phases;
- mine infrastructure such as temporary haul roads, stockpiles, ore dumps, construction of tailings facilities and surface works relating to mine rehabilitation/closure;
- Off-mining lease construction works, vegetation clearance and/or infrastructure development such as airstrips, roads and pipeline corridors;
- transport, load-out facilities, associated stockpile areas; and lay-down / stockpile areas at East Arm Wharf; and
- sites of creek and river crossings by mine infrastructure, roads and infrastructure corridors.

The ESCP should be prepared by a suitably qualified professional and be consistent with ICEA's Best Practice Erosion and Sediment Control Guidelines 2008. The ESCP should include maps and diagrams which display where control measures are proposed to be installed. Further information about the composition and detail of an ESCP can be found at www.austieca.com.au and www.lrm.nt.gov.au/soil/management . Cross reference may be appropriate with the required Dust Management Plan for the Project, as defined in Section *5.8 (Air Emissions).*

To mitigate likely impacts of the action on groundwater and surface water resources, the EIS should contain a detailed Water Management Plan that outlines clear and concise mitigation measures. The purpose of the plan is to maintain and protect both the quality and quantity of ground and surface water resources. All mitigation and monitoring measures in the Water Management Plan should be consistent with best practice advice from relevant Northern Territory and Australian Government advisory agencies. The Water Management Plan must include but not be limited to measures that:

- avoid contamination of surface or groundwater resources;
- ensure the protection and resilience of water dependent ecosystems;
- protect and monitor water quality and levels for existing users of bores and/or surface waters;
- avoid the exposure of livestock to salt or other chemical substances which may be harmful; and
- treat and manage domestic wastewater and sewage.

Monitoring

To determine the effectiveness of the mitigation measures, the Water Management Plan and ESCP should outline details of monitoring programs that will be implemented throughout the life of the Project. The monitoring programs should identify clear thresholds and contingency measures should operational activities affect water quality on the site.

Describe programs monitoring for leaks /spills /escape of hazardous materials from pipelines, storage facilities (including TSF) and transport operations to ensure protection of local soils, aquifers, environments, workers and the public.

5.3 Risks to Biodiversity

Key Risks

- biodiversity values, conservation status, diversity, geographic distribution or productivity of local native flora or fauna species or ecosystems may be degraded by Project actions.
- the Project may result in one or more of the following significant impacts to species or communities listed as threatened under the EPBC Act and/or *Territory Parks and Wildlife Conservation Act* (TPWC Act):
    - long-term decrease in the size of an important population of a listed threatened species or community;
    - adverse effects on habitat critical to the survival of a species or community;
    - fragmentation of an existing important population into two or more populations;
    - reduced area of occupancy of an important population or community; and/or
    - modification, destruction, removal or isolation of the availability or quality of habitat, to the extent that a threatened species or community is likely to decline.
- degradation of the environment may occur through the introduction and spread of weeds and/or pest fauna species within and adjacent to the Project area;
- project inputs of environmental pollutants may result in reduced water quality (offsite) and impacts on sensitive ecosystems supporting higher biodiversity values, such as aquatic, riparian or wetland habitats; and
- wildlife may be exposed to metals and/or pollutants from the Project that will result in ongoing impacts, especially to long-lived species that accumulate toxicants and metals.

Environmental Objectives

- to maintain the conservation status, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts.
- to minimise the risk of significant impacts to EPBC Act listed threatened species and communities during construction, operation and closure of the Project.

Information Requirements

Baseline flora and fauna surveys are to be undertaken or presented to represent the entire Project footprint and associated areas, including but not limited to the:

- mining leases;
- corridors – road and infrastructure;
- rail siding site;
- any offsite processing plant site;
- adjacent areas potentially indirectly affected by, or sensitive to Project impacts
- Mud Hut Swamp, Anmatyerr North and connecting waterways (including surveys of aquatic and riparian ecosystems).

Vegetation community and habitat mapping should be undertaken across the Project footprint. The mapping should be of a standard that sufficiently identifies any areas which have already been subject to clearing activities or disturbance previously (if any) and to identify areas of vegetation that are proposed to be cleared. Mapping should include identification of any significant or sensitive vegetation types, at a scale appropriate to the assessment of risk to their biodiversity values.

The draft EIS should include the results of targeted surveys for listed threatened species and communities undertaken on the site. The draft EIS should include details of the survey methodology, sampling effort and qualifications of the survey team. Information on the minimum standards required for listed threatened species is available online at:

http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/policy

and,

http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0003/349941/guideline_assessment_terrestrial_biodiversity.pdf.

The draft EIS should identify and discuss the potential for the Project to impact on any sites which are of biological conservation significance, including: Mud Hut Swamp, Anmatyerr North and downstream of the Project Area.

Information provided in the draft EIS for Areas at East Arm Wharf that have already been subject to an environmental impact assessment may be described utilising findings from previous assessments and surveys.

Assessment of Risk

Provide a detailed risk assessment outlining the potential risks to listed threatened species and communities as a result of the action. When assessing the risk of impact, the draft EIS should include references to relevant research as well as relevant statutory plans including: action plans, recovery plans and threat abatement plans. The draft EIS should include the following information:

- a detailed assessment of the presence and potential impacts upon native fauna, including consideration where relevant of vegetation clearance, habitat fragmentation, creation of barriers to fauna movement, altered hydrology, water quality impacts, erosion and sedimentation impacting on waterways, soil compaction, inappropriate/ineffective rehabilitation, groundwater contamination, impacts on surface and groundwater systems, waste material, risks associated with transport and traffic during construction and operation, weed and pest invasion, dust and noise impacts;
- discussion of the potential impact of the Project to vegetation at a local and regional scale, including the potential for ongoing indirect impacts as a result of edge effects, weed incursion or other processes exacerbated through construction or operation of the Project;
- a discussion of the potential risks associated with the accidental introduction or spread of weed species onto or throughout the site. The discussion should consider relevant weeds of national significance and those listed under the *Weed Management Act*. Information on the records of weeds can be sourced from the Weeds Branch of the Department of Lands and Resource Management.
- Identification of all situations where construction and/or operation activities could potentially interact with listed threatened species and/or communities. Where a risk has been identified, the draft EIS should include a discussion of the severity of those risks to individuals and regional populations;
- a detailed assessment of the presence and potential impacts upon native fauna including consideration of the impacts of vegetation clearance, habitat fragmentation, altered hydrology, water quality impacts, erosion and sedimentation impacting on waterways, soil compaction, inappropriate/ineffective rehabilitation, groundwater contamination, impacts on surface and groundwater systems, waste material, risks associated with transport and traffic during construction and operation, weed and pest invasion, dust and noise impacts. Species assessed must include, but not be limited to:
  - giant sweet potato (*Ipomoea polpha latzii*);
  - dwarf desert spike-rush (*Eleocharis papillosa*);
  - black-footed rock-wallaby (MacDonnell Ranges race) (*Petrogale lateralis);*
  - greater bilby (*Macrotis lagotis);*
  - red goshawk (*Erythrotriorchis radiatus*);
  - great desert skink (*Liopholis kintorei*);
  - southern marsupial Mole (*Notoryctes typhlops*);
  - princess parrot (*Polytelis alexandrae*); and
  - mulgara (*Dasycercus cristicauda* and *Dasycercus blythi*).
- Identification of any potential risks to habitat for listed threatened species or communities during construction and operation of the Project. Where a risk or risks are identified, the draft EIS should outline the extent of habitat potentially at

risk and discuss the severity of any potential impacts and discuss whether the impacts are irreversible.

Mitigation

The EIS should contain a detailed Biodiversity Management Plan which outlines clear and concise methods to mitigate likely impacts to biodiversity. All mitigation and monitoring measures should be in accordance with best practice advice from relevant Northern Territory and Australian Government advisory agencies and focus on:

- potential significant impacts to biodiversity as a whole;
- the proponent's weed control measures and hygiene protocols as required under the *Weed Management Act*;
- potential significant impacts to vegetation types, short-range endemic, rare or threatened flora or fauna; and
- any sites of conservation significance, including Mud Hut Swamp and Anmatyerr North.

The following information should be provided for EPBC Act and TPWC Act listed threatened species and communities:

- description of proposed safeguards and mitigation measures to deal with relevant impacts of the action; and
- any statutory or policy basis for the mitigation measures.

Monitoring

The Biodiversity Management Plan should include details of a Fauna and Flora Monitoring Program which is designed to monitor the effectiveness of the mitigation measures proposed. The Flora and Fauna Monitoring Program should identify the methodology for monitoring the impacts to biodiversity and identify clear thresholds and contingency measures which will be implemented in the event that the mitigation measures appear ineffective.

5.4 Risks to Historic or Cultural Heritage

Key Risks

- construction of the Project has the potential to damage areas or degrade values of sites or items which have historic and/or cultural heritage significance;
- operations associated with the life of the Project and increased human activities in the vicinity have the potential to disturb or damage areas of historic and/or cultural heritage; and
- the Project has potential to disturb sites of Aboriginal heritage significance.

Environmental Objective

To identify, understand and prevent, minimise or mitigate impacts of the Project on items or places which have historic and/or cultural heritage values and are protected under the *Heritage Act* and / or *Aboriginal Sacred Sites Act.*

Information Requirements

The draft EIS should outline the cultural and/or heritage significance of any sites located during archaeological investigations on or near the Mining Lease Area. The draft EIS should include the results of searches on the Northern Territory Government database and identify any sites or places protected or nominated for protection under the following legislations:

- *Aboriginal and Torres Strait Island Heritage Protection Act 1984*;
- *Environment Protection and Biodiversity Conservation Act 1999*.
- *Heritage Act*; and
- *Aboriginal Sacred Sites Act*;

The draft EIS should provide a summary outlining the survey effort and level of confidence that all items of heritage or cultural significance at risk have been identified. The results of any archaeological or ethnographic investigations should be provided in the EIS as an appendix. The draft EIS should provide a summary outlining the survey effort and level of confidence that all items of heritage or cultural significance at risk have been identified. The draft EIS should provide information on the current status of any approvals, permits or clearances in relation to the protection of heritage items or places.

The draft EIS must outline consultations with Indigenous stakeholders and traditional owners for all areas potentially affected by the Project. Determination and details should be provided of current traditional owner utilisation of Project areas, and spiritual/cultural significance of potentially affected areas.

Assessment of risk

The identification of any impacts to Indigenous cultural heritage is to take place in consultation with relevant Indigenous groups. Provide:

- details of any requirements to apply to, or applications already made to, the NT Minister for Lands, Planning and the Environment to disturb or destroy a prescribed archaeological place and/or object under the *Heritage Act*; and
- provision of evidence of an Aboriginal Areas Protection Authority (AAPA) certificate issued under the *Aboriginal Sacred Sites Act*.

Mitigation

The EIS should outline the prevention and mitigation of risks to sites or items of historic and cultural heritage in a Cultural Heritage Management Plan. The plan should include:

- procedures to avoid significant areas and sites;
- protection of key sites during construction, operation and decommissioning work;
- ongoing protection measures;
- procedures for the discovery of surface or sub-surface materials during the course of the Project;
- procedures that will ensure protection of known and unknown heritage sites, to the extent required under the *Heritage Act*; and
- measures to enable the Proponent to meet its duty of care to protect the cultural and heritage values of any places or items of significance.

The Environmental Management Plan for the Project should define risks to Indigenous-held values associated with the Project areas, and proposed management to minimise risks to identified values and uses.

When preparing the archaeological report and the Cultural Heritage Management Plan it is strongly recommended that the Proponent give consideration to, and refer to, the Burra Charter and guideline (available online at: http://australia.icomos.org/publications/charters/) to ensure that the investigations and mitigation measures proposed meet best practice standards for the management of cultural heritage in Australia.

Monitoring

To determine the effectiveness of mitigation measures, the Cultural Heritage Management Plan should include details of a monitoring and reporting program which is to be implemented throughout the life of the project. The monitoring and reporting program should identify when further action is required and outline contingency measures should the proposed mitigation measures result in ongoing degradation to the values of items with heritage or cultural significance.

5.5 Socio-economic risks

Key Risks

- operations associated with the life of the Project and increased human activities in the Project area have the potential to change the social demographic, culture and economies; and
- Potential economic and social benefits may not be optimised and costs may not be fully understood and taken into consideration.

Objectives

To analyse, monitor and manage the Project's intended and unintended social consequences, both positive and negative, such that outcomes are optimised.

Information Requirements

The EIS should include a balanced summary of the Project's economic value (positive and negative) to the regional, state and national economies, in terms of direct and indirect effects on employment, income and production.

Information requirements with regard to economic and social risk assessment and management are defined in the NT EPA Guideline: *Northern Territory Environment Protection Authority - Guidelines for the Preparation of an Economic and Social Impact Assessment*.

Assessment of risk

The draft EIS should include an economic and social impact assessment which gives consideration to the potential benefits and costs of the Project. The economic and social impact assessment should include consideration of the following:

- estimates of the quantity and value of production/exports relating to the mine, including expected reduction in revenue should the proposal not proceed;
- an estimate of the value of the Project to the local economy. In particular, the value associated with expenditure during the construction phase and the annual expenditure on regional goods and services as it relates to the mine and associated infrastructure;

- any benefits to local communities, during and beyond the life of the mine, such as development of new skills and facilities, economic development and opportunities for local and regional business and employment opportunities; and
- any negative impacts to local communities during and beyond the life of the mine.

Mitigation and Monitoring

A Social Impact Management Plan (SIMP) should be prepared and included in the draft EIS which addresses any risks identified in the economic and social impact assessment. At a minimum, the SIMP should include:

- any stakeholder engagement strategies that have occurred and will continue throughout the life of the Project;
- prioritisation of potential economic and social impacts;
- mitigation and management strategies for the identified risks including a register of agreed activities and commitments;
- a mechanism for monitoring any identified potential socio-economic and cultural impacts. The mechanism should also have opportunities for review;
- mechanisms to resolve new and emerging issues as they transpire with consequential amendment of the SIMP; and
- outcome and threshold criteria that will give early warning that management and mitigation measures are failing.

5.6 Rehabilitation and Mine Closure

Key Risks

- following closure and rehabilitation, potential for the mine to negatively impact the environment and/or associated communities; and
- risk that the Project will create an ongoing environmental, social and/or economic legacy if operations are required to cease ahead of schedule due to unforeseen circumstances, prior to the planned closure and rehabilitation of the site.

Environmental Objectives

The EIS should include a detailed assessment to demonstrate that:

- as far as practicable, rehabilitation achieves a stable and functioning landform which is compatible with the surrounding landscape and other environmental values; and
- the prevention and mitigation of risks associated with closure and rehabilitation of the Project are adequately addressed.

Information Requirements

- outline final rehabilitation, revegetation and closure plans for all aspects of the Project on completion of mining on site;
- based upon consultation with Traditional Owners, detail how rehabilitation and closure plans incorporate recognition and consideration of traditional knowledge, cultural values, land management systems and significance of particular species and places;

- based upon landscape evolution modelling, demonstrate that legacy mine structures will be stable over a geologically relevant period; and
- describe standards, guidelines and legislation applicable to rehabilitation and closure of the Project, and describe how such requirements will be met.

Assessment of Risk

- identify and discuss risks associated with final rehabilitation, revegetation and closure of the Project; and
- demonstrate that identified risks associated with rehabilitation, revegetation and closure from the Project will be avoided, mitigated or otherwise minimised.

Mitigation

Provide a conceptual, whole-of-site Mine Closure Plan (MCP) (refer to the Western Australian Environment Protection Authority and Department of Mines and Petroleum mine closure guidelines: http://edit.epa.wa.gov.au/EPADocLib/Guidelines-for-preparing-mine-closure-plans-21061.pdf). The MCP must provide an understanding of the issues that require management at closure and demonstrate that all relevant issues and appropriate management measures have been identified.

Demonstrate that closure will be achieved in line with the industry best practice, including:

- contingency procedures in the event of any unexpected or temporary closure, to facilitate the closure process ahead of schedule, including making landforms secure and non-polluting;
- revegetation of the disturbed sites using local native plant species similar in type, density and abundance to those existing in adjacent areas;
- stabilisation of erosion, as far as can reasonably be achieved, to a level similar to comparable landforms in surrounding undisturbed areas. Information on the use of bunding and drainage around pits should be included;
- measures required to prevent contamination of groundwater, including contamination of aquifers;
- weed management; and
- fire management.

The EIS should also include details of a Care and Maintenance Plan which is based on the Mine Closure Plan. This Care and Maintenance Plan must include measures which outline how the Proponent will maintain its environmental obligations should the Project be temporarily closed.

Monitoring

Describe the post-mining monitoring and reporting used to evaluate and report on the effectiveness of rehabilitation and closure methods. The MCP should outline contingency measures that will be implemented in the event that monitoring demonstrates that rehabilitation and/or mitigation measures have not been effective.

5.7 Risks to Human Health and Safety

Risks

Potential risks might include:

- risks of health impacts to workers from exposure to hazardous, toxic or radioactive substances, associated with the Project.
- traffic or rail accidents;
- contamination of a shared potable aquifer accessed by workers or a local community;
- spread of mosquito-borne disease due to creation of mosquito breeding sites;
- sunburn, environmental exposure, heat exhaustion etc.; or
- risks to workers from animal attacks / bites.

Information Requirements

The EIS should include an assessment of the risks to human health and safety associated with the construction, operation and maintenance of the various components of the proposal, and the storage and transport of materials to and from the complex. The aim of this assessment is to demonstrate that:

- the proponent is fully aware of the risks to human health and safety associated with all aspects of the development;
- all potential hazardous substances and exposure pathways have been appropriately identified and assessed for the Project;
- the prevention and mitigation of risks to human health and safety are properly addressed in the design specifications for the facilities; and
- the risks can and will be managed effectively during the construction, commissioning, operation, and decommissioning of the development.

Sufficient quantitative analysis should be provided to indicate whether risks are likely to be acceptable. The analysis should draw from the experiences of similar ventures in Australia and Internationally, citing examples where appropriate. Assumptions used in the analyses should be explained. Relevant standards, codes and best practice methodologies that minimise risks should be discussed.

Human Health risks and exposure pathways should be summarised using a Conceptual Site Model for the Project (see - *NT EPA Guidelines on Conceptual Site Models*).

Mitigation

The hazard and risk analysis will identify the critical areas that need to be addressed in management plans, monitoring programs, contingency and emergency plans.

Detailed emergency plans and response procedures will need to be developed as a contingency in the event of an emergency or accident, incorporating management of all emergencies that may impact on the facility, its surrounds, personnel or the public. Responsibilities and liabilities in such an event should be included, and the Emergency Management Plan provided in the final Environmental Management Plan.

5.8 Air Emissions

Air pollution may result from Project air emissions, including: chemicals, particulates, or biological materials that cause discomfort, disease, or death to humans; damage other living organisms, biodiversity values, or to the natural or built environment.

Key risks

Potential risks to air quality for sensitive receptors may result from any of the following activities:

- drilling, blasting and materials handling;
- crushing, beneficiation and processing plants;
- general site movements over unsealed surfaces;
- wind erosion mobilising dust from exposed surfaces, such as from waste dumps, laydown areas, stockpiles, and sites of vegetation clearing.

Project related air emissions include:

- stack emissions from the power station containing NO_X, CO, particulate matter and SO_X; and
- combustion emissions from equipment and vehicles.

Information Requirements

The following information should be included in the EIS to describe atmospheric emissions from the Project and identify risks to sensitive receptors.

- identify legislation, guidelines, and standards applicable to management of air emissions from the Project;
- describe expected Project generated odours and atmospheric emissions, such as from combustion, processing, vehicles, power plants, or other sources. Quantify expected emissions where possible, before and after proposed management.
- present a baseline characterisation study to define pre-mining and processing air-quality, identifying parameters which may potentially by affected by the Project, measuring at a scale meaningful to potential effects on identified sensitive receptors. Define existing variability in target parameters, such as seasonal variability, and ensure change will be clearly measurable if/when it occurs from the Project, but before impacts on sensitive receptors could occur.
- describe sources and projected quantities of greenhouse gases to be emitted by the Project, including from clearing of native vegetation.
- identify sensitive receptors (human, biological, infrastructure or other) to emissions from the Project, and risks to sensitive receptors.

Assessment of Risk

The draft EIS should identify the likely risks to sensitive receptors from changes to air quality (health, wellbeing, amenity, functionality) associated with construction and operation of the Project. The draft EIS should outline any legislative requirements, guidelines and industry standards that are likely to be applicable to the management of air quality associated with the Project. The draft EIS should also identify any sensitive receptors and discuss the health/environmental risks associated with dust mobilised during mining activities. Consideration should be given to the methods of exposure, including: inhalation, ingestion, dermal contact, wind, stormwater and groundwater.

Mitigation and Monitoring

Where identified air quality risks and related sensitive receptors occur for the Project, illustrate potential interactions in the Conceptual Site Model for the Project. In particular, the draft EIS should include:

- a description of the proposed management of Project atmospheric emissions. Describe how identified risks to ambient air-quality or sensitive receptors will be prevented, minimised or mitigated;
- a description of proposed management to minimise emissions of greenhouse gases from the Project;
- define target thresholds with reference to regulatory industry-standard, health-related safe-limits, or aspirational parameter levels. Justify proposed target thresholds in terms of levels of risk to identified sensitive receptors;
- identification of any monitoring plans that include measuring target parameters, and proposed reactive management that are tied to monitoring thresholds; and
- inclusion of an Air Quality Management and Monitoring Plan that provides an overview of the risks, sources of emissions, monitoring programs and proposed management of identified risks.
- details of a management and monitoring plan which aims to remove or mitigate dust-related risks associated with the Project. The Dust Management and Monitoring Plan should include the results of baseline studies, mitigation measures and a monitoring program.

5.9 Other Risks

Where applicable, environmental risks should be identified and management strategies proposed for the following aspects:

5.9.1 Mosquito Breeding

The *Public and Environmental Health Act* should apply to the Project and as such it is appropriate that consideration be given to the risks of biting insects. Guidance on preventing the creation of mosquito breeding sites can be found in the Medical Entomology guideline: *Guidelines for preventing mosquito breeding sites associated with mining sites in the Northern Territory*. Reference to the Medical Entomology, Department of Health guidance documentation regarding biting insect management is located at: http://health.nt.gov.au/Medical_Entomology/Publications/Development_Guidelines/.

Despite the mine being in an arid area, there is potential for mine sites to create mosquito breeding sites. The Environmental Management Plan in the draft EIS should include a section on biting insect management and outline the appropriate mitigation and management measures. In particular the Environmental Management Plan should include:

- measures to ensure no residual shallow surface ponding is created by development activities;

- ensuring any water pond (i.e. sediment pond) is designed with minimal mosquito breeding potential (i.e. steep sides, deep open water);
- preventing mosquito breeding in receptacles such as rainwater tanks, drums, buckets, used tyres, machinery items, plastic sheeting etc.;
- preventing effluent dispersal areas from becoming mosquito breeding sites. See recommendations in *Mosquito breeding and sewage pond treatment in the Northern Territory*;
- preventing pit water discharge from creating new mosquito breeding sites;
- ensuring the ore storage site at East Arm Wharf is managed to be free from shallow wet season flooded depressions; and
- provide information on appropriate personal protection measures that could be utilised by workers during periods of elevated mosquito abundance.

5.9.2 Wastewater

NT Department of Health will require a notification to install a waste water treatment system outside of a building control area if a new effluent treatment system is to be installed to treat effluent. Any waste water treatment system(s) installed on-site shall be capable of collecting, treating and disposing of waste water on-site in accordance with the Code of Practice for Wastewater Management. Further information is available online at: www.health.nt.gov.au/Environmental_Health/Wastewater_Management.

Workforce and accommodation wastewater disposal shall be in accordance with the Code of Practice for Small On-Site Sewerage and Sullage Treatment Systems and the Disposal or Reuse of Sewerage Effluent; Refer to Environmental Health Fact Sheet 700: Requirements for Mining and Construction Projects. Further information is available online at: http://www.health.nt.gov.au/Publications/Environmental_Health_Publications/index.aspx

Should the Project require the discharge of wastewater into groundwater or waterways there may be a requirement for a license under the *Water Act*. Guidance and application forms can be found at: http://www.ntepa.nt.gov.au/environmental-assessments/factsheets-and-guidelines.

5.9.3 Solid Waste Storage and Disposal

The disposal of waste should be conducted in such a way as to avoid potential public health nuisances and environmental pollution. The draft EIS should identify any legislation, guidelines, and standards applicable to the Project's landfill, sewage treatment, or waste disposal facility. The draft EIS should describe how applicable requirements will be met. Include discussion of:

- proposed wastewater treatment plant(s), sewage treatment plant(s) and waste disposal /landfill facilities. proposed locations, and land capability at the sites;
- nature of by-products;
- usage of treated water/waste;
- proximity and risks to sensitive receptors;
- describe projected final water quality and destination of waste water from beneficiation and ore processing phases;

- methods for the storage handling containment and emergency management of chemicals and other hazardous substances (including fuel);
- describe and discuss proposed waste management strategies, including reduction, reuse, recycling, storage, transport and disposal of waste; and
- identify and discuss risks associated with waste and sewage:
  - facilities;
  - storage;
  - treatment; and
  - transport and handling.

Proposed management of identified risks should be presented and discussed.

- describe proposed methods for the transport, storage, handling, containment and emergency management of chemicals, hydrocarbons, toxic inputs and outputs, acids and other hazardous substances associated with the Project; and
- identify legislation, guidelines, and standards applicable to management of hazardous substances for the Project. The draft EIS should describe how applicable requirements will be met.

5.9.4 Noise and Vibration

Risk assessment for the Project should occur with respect to noise and vibrations from Project components. Potential sensitive receptors, expected impacts and proposed management should be identified with regard to Project-generated noise and vibrations.

A Noise Management and Monitoring Plan should outline proposed management to mitigate identified risks from the Project with regard to noise and vibration emissions. Cross reference should be made with a Project Public Consultation Plan facilitating communication with, and reducing the impact on, residents and communities who may be affected by the Project.

5.9.5 Pastoral Uses

The project is located within the Stirling and Anningie Perpetual Pastoral Leases, with land use immediately surrounding the project area of pastoral use. Potential risks and impacts to that activity should be detailed.

The outcomes of any consultation with potentially affected pastoralists, any representative bodies and the NT Department of Primary Industry and Fisheries (DPIF) to identify any risks to pastoral activities, issues or stakeholder concerns with regard to the proposed Project.

Identify and discuss:

- affected vegetation types, their extent, and to how these are important to cattle production in terms of livestock carrying capacity per km^2 (information held by DPIF);
- risks associated with the exposure of livestock to chemical substances, including metal ions, in terms of potential animal health impacts. Alternative exposure pathways should be considered;
- potential risks and effects of high levels of salt in water accessible to stock; and
- risks to and from aquifers.

Proposed management of identified risks should be presented and discussed.

5.9.6 Bushfires

The Proponent should be aware of sections of the *Bushfires Act* and Regulations that apply to the Project and address risk and management of bushfires. The development of the Fire Management Plan should be in consultation with traditional owners, pastoralists and their representative organisations, including the Central Land Council (CLC), that have specialist knowledge in fire management.

5.9.7 Public Health Premises and Food Premises

The Department of Health (DoH) require detailed plans of any shops or accommodation facilities to be submitted prior to construction. Further information from the DoH, including proponent responsibilities are provided in Fact Sheet 700 - *Requirements for Mining and Construction Projects*, available online at: http://www.health.nt.gov.au/Environmental_Health/Health_Risk_Assessment/index.aspx

The proponent must not abrogate their responsibility with respect to the required DoH approvals and licensing applicable to this project. If the proponent is uncertain about the DoH approval process then they must contact DoH (ph. (08) 8955 6122) prior to the commencement of works.

It is the proponent's responsibility to provide DoH with the relevant Environmental Management Plans (EMP) that relate to the camp or project operations for comment.

5.9.8 Radiation

Identify any radiation risks expected to be encountered by the Project or associated with its construction or operation. If the operator has any material that is a radiation source, as defined under the *Radiation Protection Act*, the operator must apply for all relevant authorities under the Act. It is possible that at least one fixed radiation gauge will be required at this operation. A fixed radiation gauge is a radiation source. Further information is available at: www.nt.gov.au/health/radiationprotection.

6 Environmental Offsets

The Australian Government Environmental Offsets Policy, October 2012 requires residual (after avoidance and mitigation measures have been implemented) significant impacts to be offset, with a focus on direct offsets. The Offsets assessment guide, which accompanies this policy, has been developed to give effect to the policy's requirements, utilising a balance sheet approach to quantify impacts and offsets. It applies where the impacted protected matter is a threatened species or ecological community. These documents are available at: http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html.

The EIS should provide information on:

- any identified impacts or detriments that cannot be avoided, reduced or mitigated at reasonable costs and whether these impacts could be considered as 'significant' under the EPBC Act;
- risks of failure of management actions (such as rehabilitation, weed control, etc.) and uncertainties of management efficacy should be identified; and
- proposed offsets for residual significant impacts to listed threatened species and an explanation as to how these proposed offsets are consistent with the requirements of the Environmental Offsets Policy and Offsets assessment guide, where relevant.

7 Environmental Management

Specific safeguards and controls proposed to be employed to minimise or remedy environmental impacts identified in previous sections are to be included in an Environmental Management Plan (EMP) or similar plan for the Project and its components.

The EMP should be strategic, describing a framework for environmental management of the Project. However, as much detail as is practicable should be provided to enable adequate assessment of the proposal during the public exhibition phase. Specific management practices and procedures should be included in the EMP, where possible. The EMP should include:

- the proposed management structure of the operation and its relationship to the environmental management of the site;
- management targets and objectives for relevant environmental factors, including stochastic events such as flooding and high rainfall events;
- mitigation and treatment strategies should any Potentially Acid Forming material be encountered, or any Acidic and/or Metalliferous Drainage be detected from mine infrastructure.
- the proposed measures to minimise adverse social, economic and environmental impacts and maximise opportunities;
- performance indicators by which all anticipated and potential impacts can be measured;
- proposed monitoring programs to allow early detection of adverse impacts;
- information on how areas of land will be managed should it be changed from existing land uses;
- hierarchical reactive management plans including defined quantitative triggers at each level, designed to avoid, mitigate and minimise identified high residual risks from the Project, to the greatest extent practicable.
- the EMP should address Project phases (construction, operation, decommissioning) separately. It must state the environmental objectives, performance criteria, monitoring, reporting, corrective action, responsibility and timing for each environmental issue;
- the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;
- a summary table listing the undertakings and commitments made in the EIS, including clear timelines for key commitments and performance indicators, with cross-references to the text of the EIS; and
- provision and timing for periodic reviews of the EMP to incorporate improvements to standards and technology as they occur.

Reference should be made to relevant legislation, guidelines and standards, and proposed arrangements for necessary approvals and permits should be noted. Proposed reporting procedures on the implementation of the plan, independent auditing or self-auditing and reporting of accidents and incidents should be included. The agencies responsible for overseeing implementation of the EMP should be identified.

The EMP would continue to be developed and refined following the conclusion of the assessment process, taking into consideration the proposed timing of development activities, comments on the EIS and incorporating the Environmental Assessment Report recommendations and conclusions.

8 Attachment A – NT EPA Assessment Guidelines

The following Guideline documents by the Northern Territory Environment Protection Authority have been referred to in this *Terms of Reference* document. These can be found on the NT EPA website at:

http://www.ntepa.nt.gov.au/environmental-assessments/factsheets-and-guidelines

i. *NT EPA - Guidelines On Environmental Offsets and Associated Approval Conditions*

ii. *NT EPA - Guidelines For Assessment of Impacts on Terrestrial Biodiversity*

iii. *NT EPA - Environmental Assessment Guidelines - Mining Exploration or Production Proposals Submitted under the Mining Management Act*

iv. *Guidelines for the Preparation of an Economic and Social Impact Assessment*

v. *NT EPA - Environmental Assessment Guidelines - Acid and Metalliferous Drainage*

vi. *Guidelines on Conceptual Site Models*

(available at: http://www.ntepa.nt.gov.au/waste-pollution/guidelines/guidelines *)*

Appendix E

Stakeholder Consultation Report

TNG Limited

Mount Peake Project
Environmental Impact Statement

Stakeholder Consultation Report

December 2015

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Appendices

1. Introduction

TNG Limited (TNG) is committed to consulting with stakeholders during the planning and development of their proposed Mount Peake Project in the Northern Territory, to identify and understand any potential issues and concerns, as well as possible management strategies that may be implemented for the Project.

This report documents the stakeholder consultation program undertaken by TNG specifically during the environmental impact assessment process for the Project, with focus placed on seeking input and feedback from stakeholders on the potential environmental and social impacts to be considered during the assessment and addressed in the development of the Project.

1.1 Overview of the Mount Peake Project

The mine site is located approximately 235 km north-northwest of Alice Springs and approximately 50 km west of the Stuart Highway (Figure 1-1).

The Mount Peak Project will comprise:

- the mining of a polymetallic ore body through an open-pit truck and shovel operation;
- processing of the ore to produce a magnetite concentrate;
- road haulage of the concentrate to a new railway siding and loadout facility on the Alice Springs to Darwin railway near Adnera; and
- rail transport of the concentrate to TNG's proposed Darwin Refinery located at Middle Arm, Darwin.

1.1.1 Product and key components

The Project will mine at a rate of up to 8.4 million tonnes per annum (Mtpa) and, following processing, will produce up to 1.8 Mtpa of magnetite concentrate.

This concentrate will be processed at TNG's proposed Darwin Refinery to produce 19,700 tpa of vanadium pentoxide (V_2O_5) flake, 292,000 tpa of pigment grade titanium dioxide (TiO_2) and 856,000 tpa of pig iron ingots. Processing of the magnetite concentrate in Darwin does not form part of the environmental impact assessment for the Mount Peak Project.

New facilities proposed at the Mount Peake Project Area will include (Figure 1-1 and Figure 1-2):

- open cut mine;
- waste rock dump (WRD) with up to 70 Mt capacity;
- run of mine (ROM) pad;
- four long term stockpiles of up to 4 Mt capacity each;
- process plant;
- tailings storage facility (TSF) with up to 63.41 Mt capacity;
- access road between the mine site and Adnera railway siding and loadout facility, including an underpass of Stuart Highway (for magnetite concentrate trucks) and intersections with Stuart Highway (for mine site access);
- borefield and associated water pipeline;
- concentrate stockpiles;
- water treatment plant;

- sewage treatment plant;
- gas fired power station;
- explosives and detonator magazines;
- accommodation village;
- administrative buildings, laboratory, workshops and warehouses;
- gatehouse and weighbridge;
- fuel farm; and
- concentrate loadout facility and rail siding at Adnera.

1.1.2 Timing

TNG proposes to commence construction in the late 2016 with mining commencing in 2018. The life of the Project is expected to be 19 years inclusive of construction (2 years), mining and production (15 years), and closure and rehabilitation (2 years).

1.1.3 Tenure

Mining and processing will occur within Mineral Lease Application (MLA) 28341 for the mine pit and MLA 29855 for all mining facilities (Figure 1-1). The accommodation facilities will be located within MLA 29856, 5 km to the east of the mine site.

The access road between the mine site and Adnera passes through Perpetual Pastoral Lease (PPL) 1057, EL 27941, PPL 1103 and PPL 1138.

All tenements lie within the Stirling and Anningie PPLs aside from a portion of crown land adjacent to the Stuart Highway.

The Anningie Station homestead is located approximately 30 km southwest of the mine site, and the transport corridor lies approximately 20 km to the south of the Wilora Aboriginal community.

The Project is also located within an area covered by a Native Title Application. TNG is seeking a Native Title Agreement with Traditional Land Owners, which is being progressed with the Central Land Council (CLC) on behalf of the Traditional Land Owners. It is the intention of TNG to consult with the Traditional Land Owners and the CLC in reaching agreement for development of the Project.

1.1.4 Workforce and accommodation

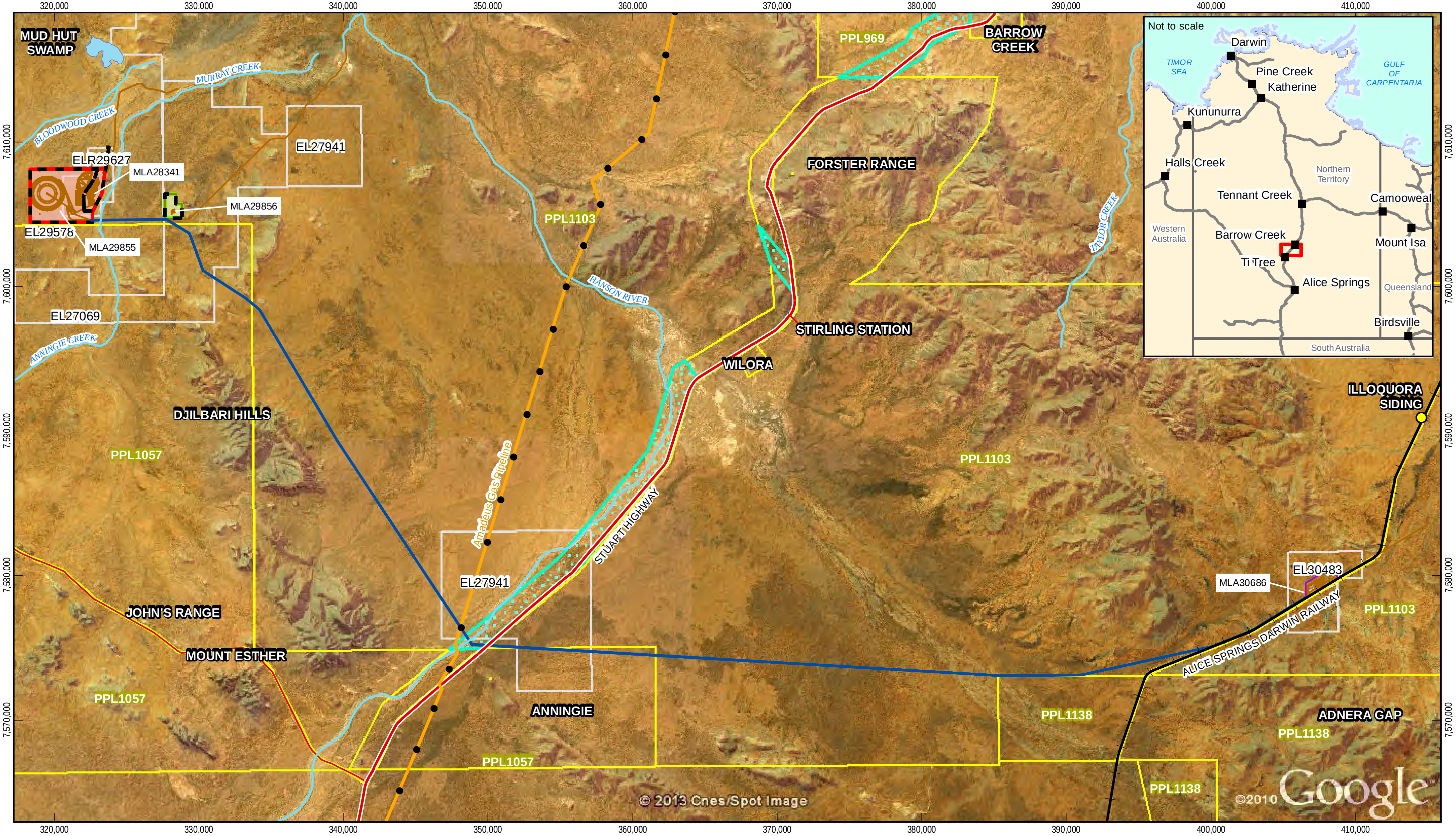
The construction and operations workforces are estimated to peak at 225 and 170 personnel respectively.

The workforces will be largely fly-in fly-out due to low population numbers in the local area. Workers will fly to Ti Tree and will then be bussed to the accommodation village for the duration of their roster.

The construction workforce traffic is expected to peak at six return bus trips and 30 light vehicle trips per day, with operation workforce traffic expected to peak at five return bus trips and 20 light vehicle trips per day.

The accommodation village will be established 5 km to the east of the mine site, to facilitate ease of access to the operation and crew rotations to and from the site. An adequate distance between the village and operations has been allowed for to minimise the exposure to noise, vibration and site dust emissions.

An initial 40 person “fly camp“ will be established to allow for early construction works. Following early site works, a permanent village will be constructed to provide housing for the main construction workforce prior to hand over for operations personnel.



Paper Size A4

0 2.5 5 7.5 10

Kilometres

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

N

LEGEND

- Illoquora Siding
- Principal Road
- Minor Road
- Major Watercourses
- Railway
- Amadeus Gas Pipeline
- Mine Site Facilities
- Mud Hut Swamp
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Crown Land
- Mount Peake Granted Tenements
- Mount Peake Mineral Leases
- Cadastral Boundaries
- Access Road
- Camp Facilities

TNG Ltd
Mount Peake EIS

Job Number | 61-29057
Revision | A
Date | 23 Oct 2015

Project Location
Mount Peake Project Area

Figure 1-1

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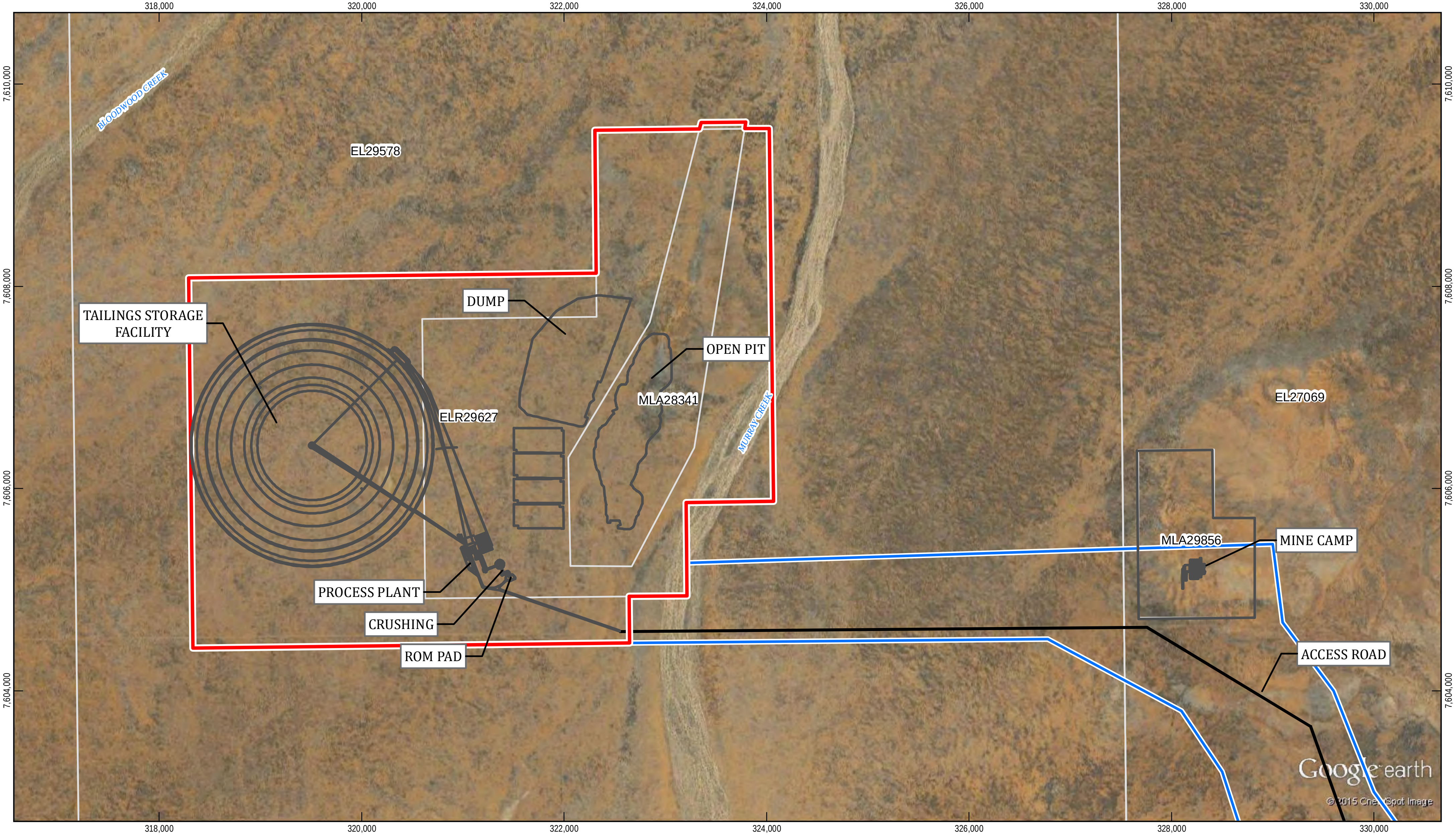
239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2015). Geoscience Australia - Waterways, mainland, placename, road (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). Created by: RB



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Kilometres

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

N

LEGEND

- Mine Site Facilities
- Mount Peake Granted Tenements
- Mount Peake Mining Area
- Access Road
- Transport Study Corridor

GHD

TNG Ltd
Mount Peake EIS

Job Number 61-29057
Revision A
Date 26 Oct 2015

Mine Site Detail
Mount Peake Project Area

Figure 1-2

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239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Google: Imagery - 20150910; TNG Ltd: Mine site facilities, access road, mining area,Tenure - 20151021

1.2 Overview of stakeholder consultation for the environmental impact assessment process

In 2013, TNG referred the proposed Mount Peake Project to the Northern Territory Environment Protection Authority (NTEPA) and the Commonwealth Department of the Environment (DotE) for a determination of the environmental assessment required. This involved preparing a Notice of Intent (NOI) and other referral documents which provided a description of the Project, an understanding of the existing environment and identified potential impacts and their possible management measures. The NTEPA determined that the Project requires assessment under the Northern Territory *Environmental Assessment Act 1982* at the level of Environmental Impact Statement (EIS), with the DotE determining that matters of national environmental significance are also to be assessed by the NTEPA via the same EIS under the assessment bilateral.

The *Terms of Reference for the Preparation of An Environmental Impact Statement: Mount Peake Project, TNG Limited* (NTEPA, 2014) states that it is “essential that the Proponent demonstrate how any public concerns were identified, and how those concerns will influence the design and delivery of the Project”.

The stakeholder consultation undertaken during the development of the EIS was designed to facilitate engagement with stakeholders to provide information about the Project and to gain feedback on potential environmental and social issues, allowing for these issues to be considered through the EIS process.

A Stakeholder Consultation Plan (SCP) specifically for the EIS process was developed by GHD on behalf of TNG, to provide structure and rigour to communications and consultation. Planning was underpinned by the NTEPA’s requirements for consultation in the development of the EIS, included in the EPA’s terms of reference for the Project (NTEPA, 2014).

Whilst the stakeholder consultation is focussed on the development of the EIS, TNG is committed to continuing to engage and consult with stakeholders throughout the life of the Project, including through the future construction and operation of the mine, which is reflected in the approach developed in the SCP.

The approach to stakeholder consultation during the EIS process was developed with reference to the following documents, guidelines and industry standards:

- *Guide to the Environmental Impact Assessment Process in the Northern Territory* (NTEPA, 2014a);
- *Guidelines for the Preparation of an Economic and Social Impact Assessment* (NTEPA, 2013);
- *Mount Peake Project Notice of Intent* (TNG Limited, 2013);
- *Terms of Reference for the Preparation of An Environmental Impact Statement: Mount Peake Project, TNG Limited* (NTEPA, 2014); and
- International Association for Public Participation (IAP2)[1].

This report documents the implementation and outcomes of the stakeholder consultation program as part of the EIS process.

[1] http://www.iap2.org.au/

1.3 Scope and limitations

This report has been prepared by GHD for TNG Limited and may only be used and relied on by TNG Limited for the purpose agreed between GHD and the TNG Limited as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than TNG Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by TNG Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Stakeholder engagement planning and approach

The stakeholder consultation undertaken during the development of the EIS was designed to provide information about the Project and to provide the opportunity to discuss concerns, potential impacts and proposed management measures, allowing for these issues to be considered early in the preparation of the EIS.

2.1 Stakeholder consultation objectives

Several objectives were established for the stakeholder consultation undertaken as part of the EIS process:

1. To ensure the relevant key stakeholders and the broader community are informed about the proposed Project, its current status and the EIS process;
2. To engage key stakeholders and the broader community through best practice processes, to discuss concerns, potential impacts and possible management measures, and demonstrate how stakeholder feedback will be considered in the EIS process; and
3. To develop and nurture stakeholder confidence and relationships for the life of TNG's Project, including throughout the future construction and operation of the mine.

These objectives are supported by:

- Establishing an open and honest communication process;
- Providing relevant, timely and factual information about the Project;
- Demonstrating a willingness to answer any questions and address potential concerns directly with stakeholders in a timely manner; and
- Providing concise information on the outcomes of engagement to be considered and integrated, as appropriate, into the EIS.

2.2 Participation goal and guiding principles of engagement

From a stakeholder consultation perspective, a core principle of the Project was to clearly communicate the level of consultation with stakeholders during the development of the EIS.

The consultation approach was guided by the Core Values and Code of Ethics of the International Association for Public Participation (IAP2). The IAP2 Spectrum for Public Participation, shown in Figure 2-1, is an Australian standard and aims to ensure public participation is given a place in the project planning, design and delivery phases.

Given the nature of the Project, the community and stakeholder consultation activities were conducted in accordance with the 'inform' and 'consult' level of the spectrum. In line with this level of participation, the goal for engagement was to provide stakeholders with clear information on the Project, its current status and its potential impacts, and to listen to any concerns and obtain feedback for consideration in the development of the Project and the EIS.

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions.	To obtain public feedback on analysis, alternatives and/or decision.	To work directly with the public throughout the process to ensure that public issues and concerns are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision-making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and issues are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for direct advice and innovation in formulating solutions and incorporate your advise and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.
EXAMPLE TOOLS	• Fact sheets • Websites • Open houses	• Public comment • Focus groups • Surveys • Public meetings	• Workshops • Deliberate polling	• Citizen Advisory committees • Consensus-building • Participatory decision-making	• Citizen juries • Ballots • Delegated decisions

Source: International Association for Public Participation (IAP2): http://www.iap2.org.au/

Figure 2-1 IAP2 Public Participation Spectrum

In order to achieve this goal, the following principles were established to guide the planning and delivery of the consultation program during the EIS:

- Involving stakeholders shows respect for them. It recognises them as recipients and ‘hosts’ of projects and allows them to have some ownership of the project outcomes;
- Using engagement techniques that effectively and meaningfully engage the community and stakeholders;
- Ensuring that all stakeholders have easy access to information about the Project;
- Demonstrating that concerns and aspirations raised by the community and other stakeholders have been considered during the Project development; and
- Ensuring that all information is provided in plain English.

2.3 Stakeholder Consultation Plan

The Stakeholder Consultation Plan (SCP), developed by GHD on behalf of TNG, provided structure and rigour to communications and consultation in support of the EIS process.

Whilst the purpose of the SCP was focussed on consultation during the development of the EIS, consideration was given to the ongoing engagement and consultation with stakeholders that will be undertaken for the life of TNG’s Project, including through the future construction and operation of the mine.

The SCP included:

- Establishing the objectives and participation goal for consultation;
- Identification of stakeholder and community groups and representatives;
- Development of key messages and responses to likely questions regarding the Project;
- Planning of the communications and consultation activities and tools together with the anticipated timings, underpinned by the NTEPA's requirements for consultation in the development of the EIS;
- Integration with other studies and activities for the Draft EIS and the project development process;
- Establishing consultation responsibilities and communication protocols; and
- Identifying monitoring and reporting requirements.

2.4 Integration with other studies for the Environmental Impact Statement

Information relating to the technical studies undertaken as part of preparing the EIS was integrated into the consultation and communication materials as required.

Of particular importance was the integration of the stakeholder consultation approach with the social impact assessment (SIA) to:

- Avoid potential duplication and consultation fatigue amongst stakeholders involved in both the consultation on the broader EIS and social research as part of the SIA; and
- Enable the effective and efficient sharing of information gathered from stakeholders for both the consultation and SIA processes.

Furthermore, specific consultation with traditional owners has been undertaken separately by the Central Land Council on behalf of TNG to inform the assessment of potential impacts to sacred sites.

3. Stakeholder identification

A stakeholder is defined as any individual, group of individuals, organisation or political entity with an interest in the outcome of a decision[2]. They may be, or perceive that they may be, affected directly or indirectly by the outcome of a decision.

The stakeholders likely to have an interest in the consultation undertaken during preparation of the EIS were initially identified based on a desktop analysis. As new stakeholders may emerge or the interest of existing stakeholders may change over the course of the Project, processes were established to accommodate ongoing stakeholder identification and refinement.

The stakeholders identified as having an interest in the consultation as part of the development of the EIS are listed in Table 3-1. In particular, input was sought from Northern Territory Government representatives, departments and agencies, local Government authorities, affected landowners including Traditional Aboriginal Landowners (via the Central Land Council), residents, service providers and businesses in the Ti Tree and Barrow Creek areas, conservation groups and the wider Alice Springs community.

Table 3-1 Identified stakeholders

Stakeholder category	Stakeholder
Commonwealth Government	Department of the Environment
Northern Territory Government – **Elected Representatives**	Member for Stuart Member for Barkly Member for Namatjira Member for Fong Lim
Northern Territory Government – **Departmental Ministers**	Minister for Mines and Energy Minister for the Environment Minister for Indigenous Affairs Minister for Land Resource Management Minister for Transport
Northern Territory Government – **Departments and Agencies**	Northern Territory Environment Protection Authority Department of Mines and Energy Aboriginal Areas Protection Authority Department of Lands, Planning and the Environment Department of Land Resource Management Darwin Port Corporation

[2] International Association for Public Participation, 2006

Stakeholder category	Stakeholder
Local Government	Central Desert Regional Council MacDonnell Regional Council Alice Springs Town Council City of Darwin
Traditional Aboriginal Landowners	Central Land Council (representing the traditional owners)
Pastoral lease holders	Stirling pastoral lease Anningie pastoral lease
Local residents / businesses / operators	Ti Tree and Barrow Creek residents Wilora, Ti Tree, Barrow Creek, Wauchope and Alice Springs Aboriginal communities Neighbouring pastoral stations Ti Tree Police Station Northern Territory Emergency Service – Ti Tree Volunteer Unit Ti Tree Health Clinic Ti Tree School Ti Tree Roadhouse and Caravan Park Ti Tree General Store Barrow Creek Hotel
Alice Springs residents / businesses / operators	Alice Springs residents and businesses Alice Springs Rural Fire Brigade Royal Flying Doctor Service – Alice Springs Base
Conservation groups	Territory Natural Resource Management Environment Centre NT Arid Lands Environment Centre
Industry / business representative groups	Chamber of Commerce Northern Territory – Alice Springs / Tennant Creek Regional Development Australia Northern Territory Tourism NT – Alice Springs

It is important to note that a separate consultation process focussed on land negotiations with the traditional Aboriginal landowners is being undertaken between TNG and the Central Land Council (representing the traditional owners). This process will continue to be undertaken separately and parallel to the development of the EIS.

4. Consultation program

The consultation program, outlined in Figure 4-1, highlights the key communications and consultation activities during the development of the EIS, together with the anticipated timings. The methodology is underpinned by the NTEPA's requirements for consultation in the development of the EIS.

The timings outlined below reflect the current Project schedule and may be subject to change.

	Commence Draft EIS process February 2015 – March 2015	**Prepare and submit Draft EIS** February 2015 – December 2015	**Public Exhibition of Draft EIS** Early 2016	**Prepare and submit Supplement to EIS** Early 2016
Consultation objectives	Provide stakeholders with information about the Project and the EIS process Engage with stakeholders to discuss concerns, potential impacts and proposed management measures	Report on consultation outcomes for consideration in developing Draft EIS	Publish Draft EIS and promote Public Exhibition period	Analyse submissions received during public exhibition period and prepare responses for consideration in preparing Supplement to EIS
Deliverables		Stakeholder Consultation Report for Draft EIS		Summary report of Public Exhibition period for Supplement to EIS
Communications and consultation activities	Meetings and information sessions with key stakeholders and broader community Introductory letter Project information sheet Public displays Project website Media release (if required) Print advertisement (if required)	Thank you letter to stakeholders involved in consultation Project information sheet (on progress of EIS) Project website Other direct courtesy communications as requested	Project information sheet (to promote public exhibition of Draft EIS) Public displays Project website Media release (if required) Print advertisement (if required)	Response to stakeholders involved in providing feedback Project information sheet (on progress of EIS) Project website Media release (if required)
	Project telephone number and email for enquiries **Issues and media monitoring**			

Figure 4-1 Stakeholder consultation program

Stakeholders were consulted using a combination of consultation and communication techniques, including meetings, public information sessions and Project information sheets. These were supported by communication channels to provide a point of contact for Project queries, further feedback or complaints.

The key activities that comprised the consultation methodology included:

- An introductory letter sent to all identified stakeholders to provide details of the Project, the EIS process and the associated consultation process, and to extend an invitation to meetings or public information sessions (copy provided in Appendix A);

- A Project information sheet providing details of the Project, the EIS and consultation process and the potential impacts to be included in the EIS as identified to date, with the letter made available at meetings and public information sessions, and with further copies provided for distribution at public buildings and businesses in Ti Tree and Barrow Creek (copy provided in Appendix B);
- Print advertisements in the NT News on 18 March 2015 and in the Centralian Advocate on 20 March 2015 to provide notice of the public information sessions (copy provided in Appendix C);
- A series of meetings with Government agencies, Local Governments and the Central Land Council held in Alice Springs on 24 March 2015 and in Ti Tree on 25 March 2015, to provide a briefing on the Project, to discuss concerns, potential impacts and possible management measures and to seek specific information to assist in the assessments undertaken for the Draft EIS;
- Three public information sessions held in Alice Springs on 24 March 2015, and at Stirling Station and Ti Tree on 25 March 2015, to provide a briefing on the Project and the discuss concerns, potential impacts and possible management measures;
- A Project telephone number and email featured in all Project information and communication materials to promote open communication and provide a point of contact for Project queries, to provide further feedback or discuss concerns, and to raise complaints; and
- A Stakeholder Database maintained throughout the preparation of the EIS to record the consultation undertaken and its outcomes, and the queries and feedback received and responses provided, as well as to assist in tracking issues, identifying trends and providing an early indication of concerns and issues that require management.

5. Consultation outcomes

The outcomes of the consultation activities in support of the preparation of the Draft EIS are detailed below. This process is ongoing with further consultation to occur as part of the Public Exhibition of the Draft EIS.

The interactive consultation activities included:

- A series of meetings with Government agencies, Local Governments and the Central Land Council and members of the TNG and GHD Project team held in Alice Springs on 24 March 2015 and in Ti Tree on 25 March 2015, to provide a briefing on the Project, to discuss concerns, potential impacts and possible management measures and to seek specific information to assist the assessments undertaken for the Draft EIS;
- Three public information sessions held in Alice Springs on 24 March 2015, and at Stirling Station and Ti Tree on 25 March 2015, by members of the TNG and GHD Project team to provide a briefing on the Project and the discuss concerns, potential impacts and possible management measures; and
- Queries and feedback received via the Project telephone number and email.

5.1 Stakeholders involved in consultation activities

The stakeholders involved in the direct consultation activities are detailed in Table 5-1, with the outcomes of discussions with stakeholders presented further below.

Table 5-1 Stakeholders involved in direct consultation activities

Date	Location	Attendees	Organisation
Briefings with Government agencies, Local Government and Central Land Council			
24 March 2015	Alice Springs	Glenn Irvine, Commercial and Planning Manager	Central Desert Regional Council
24 March 2015	Alice Springs	Julie-Ann Stoll, Mining Manager Peter Batey, Mining Manager	Central Land Council
24 March 2015	Alice Springs	Rex Mooney, Chief Executive Officer Greg Burton, Director of Technical Services	Alice Springs Town Council
24 March 2015	Alice Springs	Administration officer	Royal Flying Doctor Service – Alice Springs Base
25 March 2015	Ti Tree	Peter van Heusden, Regional Services Manager	Central Desert Regional Council
25 March 2015	Ti Tree	Adam Davey, Constable	Ti Tree Police Station
25 March 2015	Ti Tree	4 teachers / staff members	Ti Tree School

Date	Location	Attendees	Organisation
Information Sessions			
24 March 2015	Alice Springs	Jon Hodgetts, Tablelands Regional Coordinator	Territory NRM
		Peter Batey, Mining Manager	Central Land Council
		Lance Cramer	Sub-lessee of part of Mount Skinner Station (near to Stirling Station boundary)
		David Carpenter	Shareholder of TNG Limited
		Jimmy Cocking, Director	Arid Lands Environment Centre
		Alison Bitar	Aboriginal Areas Protection Authority
		Craig Marriott	Local business owner
25 March 2015	Stirling Station	Matthew and Anita McCarthy	Stirling Station
		Steven and Belinda Fogarty	Anningie Station
		Wilora community – approximately 50 attendees	Wilora
25 March 2015	Ti Tree	Ti Tree and surrounding communities – approximately 25 attendees (including 3 people who attended the earlier Stirling Station information session)	Ti Tree and surrounding areas

5.2 Outcomes of consultation

Table 5-2 presents the issues of high interest, which were raised by, and discussed with, stakeholders in the majority of the briefings and information sessions. The remaining issues are presented in Table 5-3.

Table 5-2 High interest issues resulting from stakeholder consultation

Potential impact or issue	Action
Safety, traffic and transport	
Concerns were raised regarding the potential safety impacts of the access road between the mine and the loadout facility at Adnera crossing the Stuart Highway at grade, with the potential conflict of trucks hauling magnetite concentrate and standard vehicle traffic. These concerns were raised particularly with consideration to the high volume of truck movements and the size of the trucks, as well as a potential issue with the angle of the sun during the morning and afternoon trips (as haulage will occur 24 hours a day over 7 days a week) with the east-west orientation of the majority of the transport corridor.	Feedback was considered in the design of transport corridor, with the outcome being the inclusion of an underpass of Stuart Highway for use by haul trucks and general traffic travelling between the mine site and loadout facility. An at-grade intersection will be constructed for general access to the Project area from Stuart Highway.

Potential impact or issue	Action
Potential safety and maintenance issues of having an unsealed access road were raised, given the high volume of return truck movements.	Unsealed roads are common in the mining industry. Recognising that a major use of the road will be for the transport of concentrate, the road will be regularly inspected and maintained. The road will also not be available for general use by the public.
Concern was raised regarding the potential degradation of the Stuart Highway with an at-grade crossing of the transport corridor, which would require haulage trucks to enter and exit the highway.	This has been resolved with the inclusion in the design of an underpass of Stuart Highway
Potential safety issue of having a shared road between the mine site and the railway siding and loadout facility for use by both haulage trucks and light vehicles (for site personnel, contractors, supplies and deliveries, police and emergency response) was raised.	The road has been designed to accommodate shared use by both heavy and light vehicles. All vehicles using the road will be road compliant. It is anticipated that there will be up to 50 deliveries of concentrate per day resulting in 4 (return) truck movements per hour.
Employment , training and economy	
Overall support was expressed for the Project and the potential opportunities for increased local employment and training, contractors, suppliers and other businesses and services in Ti Tree and Alice Springs.	It is anticipated that the workforce will primarily comprise personnel on a fly-in / fly-out basis from Darwin, Alice Springs and potentially further afield, depending on where the necessary skills reside, with some employment from local communities. The fly-in / fly-out workforce will fly to Ti Tree and be transported to site by bus. Opportunities for contractors, suppliers and other businesses could include road construction, plant / machinery operators, bus drivers, accommodation camp staff and suppliers, administration staff, Aboriginal rangers.
The potential employment opportunity for local Aboriginal communities was noted.	TNG's target is to employ 15% of the workforce from local Aboriginal communities.
Sacred Sites	
The assessment of potential impacts to sacred sites was discussed, which was assessed through a Sacred Sites Clearance managed by the Central Land Council with traditional owners. The Sacred Sites Clearance included the mining lease and the transport corridor and provides the opportunity to protect sites and the areas wider cultural integrity.	A summary of outcomes of the Sacred Sites Clearance has been documented in the Draft EIS, however the full report by the CLC will be subject to a confidentiality agreement between the Traditional Owners, the CLC and TNG.
Concern was raised regarding providing compensation to traditional owners and custodians for impact to land.	This will be the subject of discussions between TNG and Traditional Owners.
Project timing	
The anticipated timing of construction works and commissioning of the mine for operation was raised and discussed.	The progress and anticipated timing of the Project is included in the Draft EIS and will be included in follow up communications.
The anticipated timing of the final investment decision as to whether the Project will proceed to construction was raised and discussed.	The progress and anticipated timing of the Project is included in the Draft EIS and will be included in follow up communications.

Table 5-3 Other specific issues resulting from stakeholder consultation

Potential impact or issue	Action
Employment, training and economy	
The cumulative loss of the skilled workforce to mining projects was raised as a concern for Local Government and local businesses. It was noted that this may also contribute to rising salary costs	This is an unavoidable consequence of development and impossible to mitigate.
The potential employment of local Aboriginal rangers was raised as an opportunity, for monitoring of impacts to flora and fauna during the construction and operation of the mine and in providing recommendations for traditional species for rehabilitation (including food and non-food species), so that rehabilitation as closely as possible resembles the natural environment. There is one ranger currently located in Ti Tree.	TNG's target is to employ 15% of the workforce from local Aboriginal communities.
The potential opportunity to support the Ti Tree School to develop an education program for the middle school years (years 7, 8 and 9) as a stepping stone to future employment at the Mount Peake site was raised.	This will be considered as a component of a community benefits package.
The potential local business opportunity for the Remote Jobs and Communities Program (RJCP) was raised, which could provide training services to the workforce and contractors.	This will be considered as a component of a community benefits package.
Potential business opportunities for contractors in Alice Springs and the Project Area.	Opportunities for contractors, suppliers and other businesses could include road construction, plant / machinery operators, bus drivers, accommodation camp staff, administration staff and suppliers, Aboriginal rangers (for environmental monitoring and advice).
Potential economic opportunities for Alice Springs should some of the workforce fly in / fly out or drive in / drive out from Alice Springs.	It is anticipated that the workforce will primarily comprise personnel on a fly-in / fly-out basis from Darwin, Alice Springs and potentially further afield, depending on where the necessary skills reside, with some employment from local communities. Drive in / drive out of Alice Springs is unlikely due to the distance to site.
Potential economic opportunities for Alice Springs in supplying materials, food and other products to site.	Supply contracts will be advertised and considered on a commercial basis.
There may be an option to use the existing Ti Tree air strip for the fly-in / fly-out workforce.	The fly-in / fly-out workforce will use Ti Tree air strip and be transported to site. An upgrade of the air strip is proposed.
Environment	
The potential impact to the surrounding groundwater quality / quantity and ecology of sourcing the water supply for the Project was raised as an issue. Current water supplies to the stations need to be maintained during and post mining.	Studies indicate that sufficient water will be available from the Hanson River paleochannel. TNG has committed to the provision an alternative water supply if the Project impacts any existing supplies.
Concern was raised regarding the potential impact to Mud Hut Swamp from groundwater drawdown. Mud Hut Swamp is located approximately 7 km from the site.	Groundwater modelling indicates that Mud Hutt Swamp will not be impacted by the Project.

Potential impact or issue	Action
Concern was raised regarding management of the waste from the process and its potential impacts, including tailings, rock and water.	Waste rock and tailings are benign and the process does not use any hazardous chemicals. There will be no direct discharge of any contaminated water from the site.
The potential environmental impacts of chemicals used for mining and beneficiation were discussed. The chemicals that may be present on site are diesel, ammonium nitrate for blasting, and potentially chemicals to aid processing and chemical suppressants for dust management.	Diesel will be stored in self-bunded tanks. No hazardous chemicals are proposed to be used on the site. Chemical dust suppression is not proposed.
The potential environmental issues associated with insufficient and inappropriate drainage design of the access road and railway siding was raised. This may result in erosion and degradation of local environment.	Surface water modelling has demonstrated that impacts can be managed. Floodways are proposed across creeks and rivers which removes the potential for upstream flooding. Drainage design has been incorporated into the design of the access road.
Concern was raised regarding the potential dust issues along transport corridor and with stockpiles and unloading and loading at the loadout facility.	An air quality assessment has indicated that dust will not be an issue at any sensitive receptor.
The potential environmental impacts of the power supply for the Project were raised. It was suggested that solar energy with diesel back up could be considered.	The main source of power for the project will be gas, reducing emission levels from those of diesel. TNG will be investigating alternatives such as some of the energy demand being supplied from solar.
It was recommended that a greenhouse gas assessment should be included in the EIS.	This has been done.
Potential environmental offsets were discussed, with local offsets preferred, which could include: • Funding to local Aboriginal rangers to undertake monitoring during construction and operation • Contribution to the Ten Deserts Program, a landscape scale program promoting connectivity between individual desert ecological communities and the building of relationships between mining companies and local communities, for better governance and biodiversity outcomes The Arid Land Environment Centre is a partner in the Ten Deserts Program.	Potential offsets will be considered should the Project result in significant residual impacts.
Private land	
The potential safety issues of the transport corridor not being fenced were raised, given the likely access by cattle from Stirling and Anningie Stations.	The access road will be fenced to exclude cattle from the corridor.
The existing road access to Stirling Station on the eastern side of railway line may be impacted by the access road, depending on the alignment.	Discussions will be held with station owners during detailed design of the road to ensure that access can be maintained to the property.
Access to strategic areas of the stations, such as bores and gates, may be impacted by the access road and rail siding.	Discussions will be held with station owners during detailed design to ensure that access can be maintained to the property. The intent is that access to these areas of the stations will be maintained or replaced to allow a similar level of access.

Potential impact or issue	Action
The potential impact of the Project to Anningie Station's organic certification, and the possible future application of Stirling Station for organic certification, was raised. Anningie Station is currently certified by USDA and AusQual. Potential activities that may affect certification include the use of ammonium nitrate for blasting, transport of magnetite concentrate across properties with the potential for spills of concentrate and diesel, use of chemical suppressants for dust management, potential leaks of waste and sewage from the accommodation village.	Fencing and drainage containment along roads and around the mine and accommodation village will provide appropriate separation from the Project activities and the remainder of Stirling Station and Anningie Station. No hazardous chemicals are proposed for use on the Project.
Archaeological sites	
Appropriate assessment of the potential impacts to archaeological sites was recommended. It was advised that an archaeological survey is required to consider potential impacts and to address the NTEPA Terms of Reference. Sites of significance will be identified in the Sacred Sites Clearance, however the remaining sites such as artefact scatters will not be identified by this process.	An archaeological assessment has been completed.
Emergency response and policing	
Remote Health Alice Springs will be responsible for coordinating the Royal Flying Doctor Service to site.	This will be noted when TNG develops the site emergency response plan.
The transport corridor is within the Ti Tree police district. The mine site is most likely within the Wilaura police district, although the Ti Tree station would be likely to respond to an incident at the site given their closer access.	Noted.
The Ti Tree police station has fire response and roadside recovery capability, and the Ti Tree office of the Central Desert Regional Council has a fire vehicle.	Noted
There may be an option to use the existing Ti Tree air strip for emergency evacuation, although the air strip may need to be designed for night time evacuation.	An upgrade of the airstrip is proposed.
The Ti Tree police station will adopt the emergency response plan developed by TNG, and will coordinate with the Site Manager for any incidents or emergencies.	Noted.
The workforce at the mine site is not considered to pose issues for policing the district.	Noted.
Other issues, concerns and feedback	
A query was raised regarding the end use of the magnetite concentrate.	Concentrate will be processed at TNGs proposed Darwin Refinery.
The naming of the Project as Mount Peake has caused confusion for some Aboriginal communities as to whether their land is affected, as there is an area of cultural significance called Mount Peake which is some way west of the site	Noted.

6. Ongoing stakeholder consultation

TNG is committed to continued and ongoing engagement with stakeholders throughout the Project planning, development and operation.

The objectives of ongoing engagement are to:

- Maintain open dialogue regarding the Project timing and activities as approvals are secured; and
- Encourage stakeholders to continue to raise concerns and queries directly with TNG for response or resolution throughout the Project planning, development and operation phases.

Planning for stakeholder consultation has provided the flexibility to accommodate new stakeholders that may emerge following the submission of the Draft EIS and its release for Public Exhibition.

Consultation will continue throughout the life of the Project to ensure the consideration of all relevant and appropriate opportunities and concerns. TNG values all stakeholder comments and feedback, and will assess all stakeholder concerns or issues about the Project and take appropriate action which may include addressing the matters raised in its management or operations plans.

The planned ongoing stakeholder consultation program is discussed below. Additional stakeholder consultation may also be undertaken as required.

6.1 Public Exhibition of the Draft EIS

Following acceptance by the NTEPA, the Draft EIS will be available for review and comment through the Public Exhibition period, for a minimum of six weeks.

To support the Public Exhibition of the Draft EIS, information on the timing of the public comment period, locations for viewing the document (hard copy and electronic) and information on making a submission will be advertised to stakeholders through:

- Print advertisements placed in the appropriate local newspapers;
- A update and notification letter to identified stakeholders as recorded in the Stakeholder Database;
- A Project update placed on the TNG website; and
- Briefings to key stakeholder to discuss the outcomes of the Draft EIS.

6.2 Ongoing consultation

Information will be disseminated to stakeholders on a regular basis, particularly once construction commences.

7. References

Northern Territory Environment Protection Authority 2013. Guidelines for the Preparation of an Economic and Social Impact Assessment.

Northern Territory Environment Protection Authority 2014. Terms of Reference for the Preparation of an Environmental Impact Statement: Mount Peake Project, TNG Limited.

Northern Territory Environment Protection Authority 2014a. Guide to the Environmental Impact Assessment Process in the Northern Territory.

TNG Limited 2013. Mount Peake Project Notice of Intent.

Appendices

Appendix A Introductory Letter

TNG LIMITED
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16 March 2015

To XXXXXXXX

Dear Sir / Madam

Invitation to discuss the Environmental Impact Statement process for the Mount Peake Project

TNG Limited (TNG) is currently undertaking planning to develop its Mount Peake Project located about 280 km north-northwest of Alice Springs and 60 km west of the Stuart Highway in the Northern Territory.

The proposed project involves the mining of a magnetite ore body, beneficiating the ore to produce a concentrate and transporting the concentrate to East Arm Wharf at the Port of Darwin for export.

TNG has commenced the process of seeking environmental approval for the project, which will be assessed by the Northern Territory Environment Protection Authority (NTEPA) under the *Environmental Assessment Act 1982* at the level of Environmental Impact Statement (EIS).

TNG has commenced the EIS for the project in accordance with the Terms of Reference issued by the NTEPA. At this early stage in the EIS process, TNG is seeking input and feedback from stakeholders on the potential environmental and social impacts to be considered, and possible management strategies that may be implemented for the project.

In particular, we are seeking input from Northern Territory Government representatives, departments and agencies, local Government authorities, affected landowners including Traditional Aboriginal Landowners (via the Central Land Council), residents, service providers and businesses in the Ti Tree and Barrow Creek areas, conservation groups and the wider Alice Springs community.

We would like to invite representatives of the Alice Springs Rural Fire Brigade to attend one of a series of information sessions, the details of which are provided below, to discuss the project and the EIS process:

Alice Springs	**Stirling Station**	**Ti Tree**
Tuesday, 24 March 2015	Wednesday, 25 March 2015	Wednesday, 25 March 2015
3.00 pm – 6.00 pm	9.00 am – 12.00 pm	1.30 pm – 4.30 pm
Andy McNeill Room, Alice Springs Town Council (93 Todd Street)	Stirling Station Shop (Stuart Highway, 60 km north of Ti Tree)	Central Desert Regional Council office (meet on verandah)

We would welcome the opportunity to meet with you then, or alternatively to discuss the project by telephone should you not be able to attend an information session.

Please find enclosed additional information about the Mount Peake Project and the EIS process. Should you have any questions, or if you would like to confirm your attendance at an information session, please contact us on the details below.

Mount Peake Project EIS and Consultation	Mount Peake Project Development
GHD (on behalf of TNG) Telephone: (08) 6222 8373 Email: mountpeakeproject@ghd.com	TNG Limited: Paul Burton, Managing Director Telephone: (08) 9327 0900 Email: peb@tngltd.com.au

Yours faithfully

Paul Burton
Managing Director
TNG Limited

Att: Project Information Sheet March 2015

Appendix B Information Sheet

March 2015

PROJECT INFORMATION SHEET

Commencement of the Environmental Impact Statement for the Mount Peake Project

TNG Limited (TNG) has commenced the process of seeking environmental approval to develop its Mount Peake Project located about 280 km north-northwest of Alice Springs and 60 km west of the Stuart Highway in the Northern Territory (shown in the map overleaf).

The proposed project involves the mining of a magnetite ore body, beneficiating the ore to produce a concentrate and transporting the concentrate to the Port of Darwin for export.

Environmental impact assessment process and your input

In the Northern Territory, the environmental assessment process for development proposals (shown in the figure overleaf) is administered by the Northern Territory Environment Protection Authority (NTEPA).

In 2013, TNG referred the proposed project to the NTEPA and the Australian Department of the Environment (DotE) for a determination of the environmental assessment required. This involved preparing a Notice of Intent (NOI) and other referral documents which provided a description of the project, an understanding of the existing environment and identified potential impacts and their possible management measures. The NTEPA determined that the project requires assessment under the Northern Territory *Environmental Assessment Act 1982* at the level of Environmental Impact Statement (EIS), with the DotE determining that matters of national environmental significance are also to be assessed by the NTEPA via the same EIS.

TNG is about to commence preparing the EIS for the project, in accordance with the requirements and guidelines set out by NTEPA.

At this early stage in the EIS process, TNG is seeking input and feedback from stakeholders on the potential environmental and social impacts to be considered and possible management measures that may be implemented. This forms a valuable part of the EIS process.

TNG is planning to submit the Draft EIS to the NTEPA in August 2015, and it will then be made available for further public comment through an advertised Public Exhibition period.

The Mount Peake Project

The major components of the Mount Peake Project are:

- Open cut mining of the ore body with beneficiation at the site to produce a magnetite concentrate
- Road transport of the concentrate via a new 90 km transport corridor to a new railway facility near Adnera on the Alice Springs to Darwin railway
- Rail transport of the concentrate from Adnera to East Arm Wharf at the Port of Darwin for export

- Onsite tailings storage facility and waste rock dump
- Power generated by an onsite gas fired power station with natural gas supplied by a gas pipeline to the mine site from the Amadeus Basin to Darwin Natural Gas Pipeline
- Accommodation about 5 km east of the mine site for a peak construction workforce of about 350 people, which will be converted to a fully serviced accommodation village for a peak operations workforce of about 175 people operating on either a fly-in / fly-out or drive-in / drive-out basis

It is expected that approximately 1.7 million tonnes per annum (Mtpa) of concentrate will be produced at peak production, which would require up to 100 return truck movements per day between the mine site and Adnera and around 10 train movements per week between Adnera and the port.

TNG proposes to commence construction in the first half of 2016 with mining commencing in the second half of 2017. The life of the mine is expected to be 20 years.

Once the magnetite concentrate is exported, it will either be directly used in steel making or processed further to produce hematite powder (Fe_2O_3), vanadium pentoxide flake (V_2O_5) and titanium dioxide (TiO_2). The potential use and processing of the concentrate is not a component of the Mount Peake Project approvals.

Land ownership and surrounding use

The land immediately adjacent to the Mount Peake Project area is used for pastoral activities. The mine site, accommodation village and transport corridor are located predominantly within the Stirling perpetual pastoral lease (PPL), with the exception of a small portion of the transport corridor located on the Anningie PPL.

The Mount Peake Project is also located within an area covered by a Native Title Application. TNG is seeking a Native Title Agreement with the Traditional Land Owners of the Mount Peake Project area, which is being progressed with the Central Land Council (CLC) on behalf of the Traditional Land Owners. It is the intention of TNG with the CLC to consult with the Traditional Land Owners in reaching agreement for the development of the Mount Peake Project.

The Anningie Station homestead is located approximately 30 km southwest of the mine site, and the transport corridor lies approximately 20 km to the south of the Wilora Aboriginal community.

Potential environmental impacts and their management

The preparation of the EIS for the Mount Peake Project requires identifying and assessing the potential environmental impacts and developing possible management and control measures to reduce potential risks or impacts to as low as reasonably practicable and to an acceptable level, in accordance with legislation and regulations, industry standards and TNG's environment, community and health and safety policies.

Some of the potential environmental impacts that have been identified to date, and which will require mitigation and management strategies to be further developed, include flora and vegetation, fauna, surface water and groundwater, Aboriginal heritage, air quality, noise and vibration, greenhouse gas emissions and waste management. The EIS will also give consideration to any social and community impacts that may arise.

For more information

TNG is committed to keeping nearby residents, communities and businesses, and the wider Alice Springs community, informed of the progress of the development of the Mount Peake Project and the EIS process.

In particular, TNG welcomes comments and feedback from interested stakeholders as part of the development of the EIS, particularly about the potential impacts of the project and their possible management, prior to its submission to the NTEPA in August 2015.

To provide comments or feedback, or if you have any queries, please contact us by telephone or email using the details below or visit www.tngltd.com.au/projects.

Mount Peake Project EIS and Consultation	Mount Peake Project Development
GHD (on behalf of TNG) Telephone: (08) 6222 8373 Email: mountpeakeproject@ghd.com	TNG Limited: Paul Burton, Managing Director Telephone: (08) 9327 0900 Email: peb@tngltd.com.au

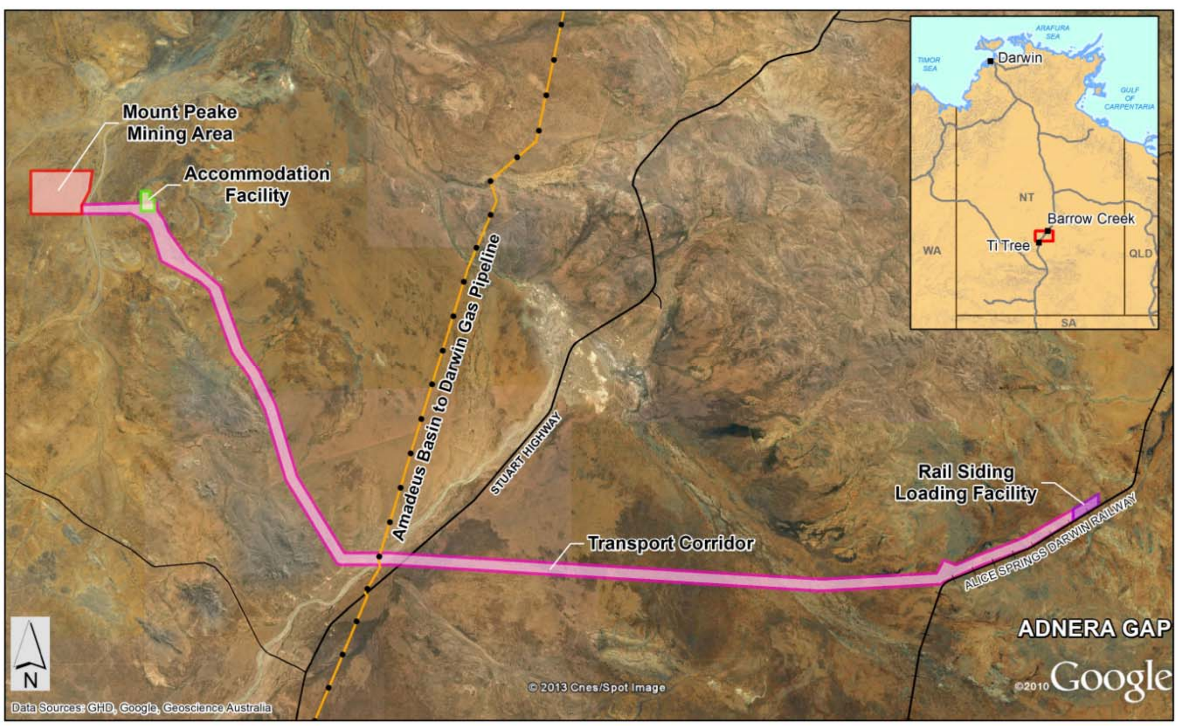

***Figure 1:** Map of Mount Peake Project site*

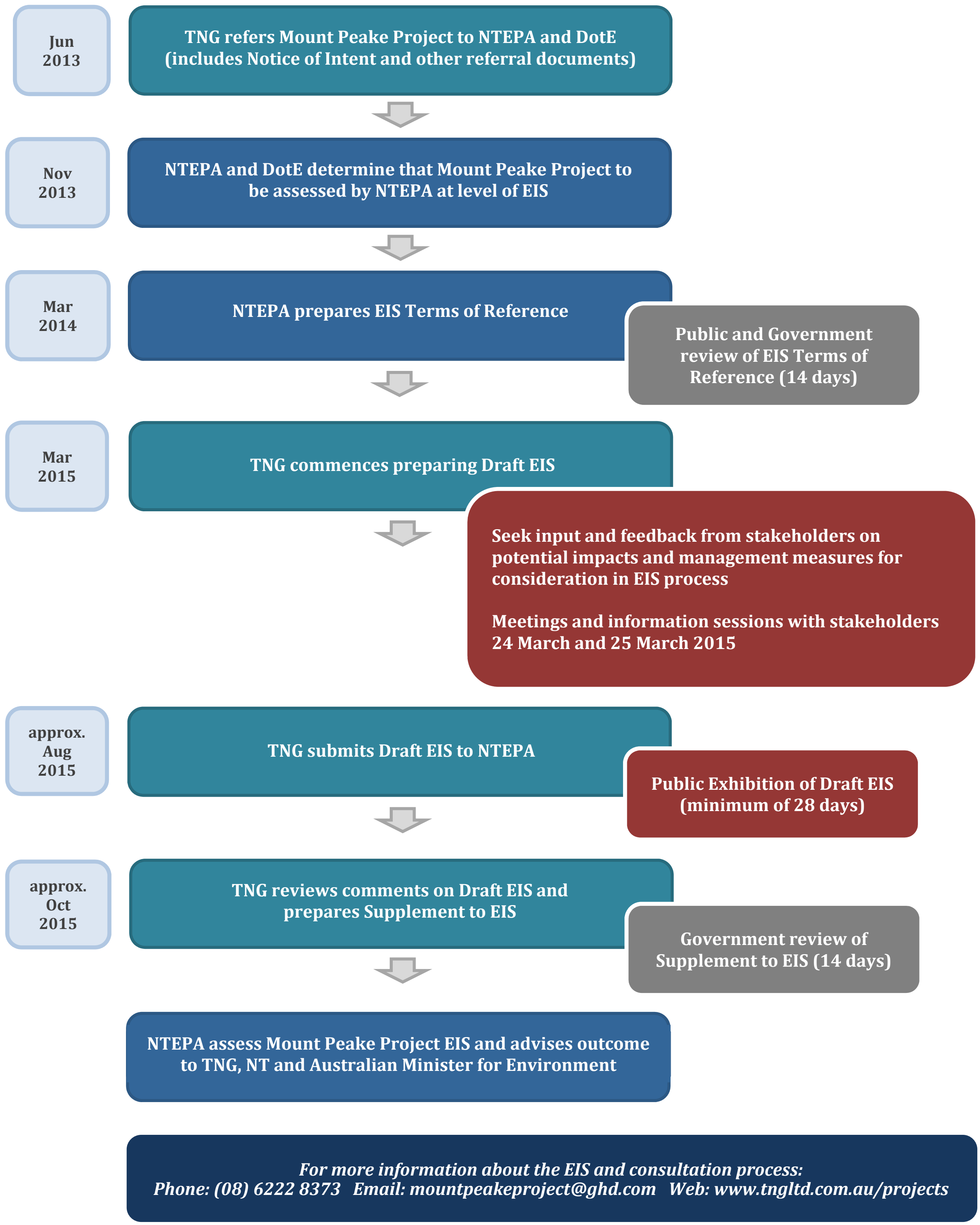

Figure 2: *Environmental impact assessment process for the Mount Peake Project (with upcoming stakeholder consultation shown in red)*

Appendix C Print Advertisement

TNG LIMITED

Public Notice

TNG Limited – Proposed Mount Peake Project

Consultation for the Environmental Assessment Process

TNG Limited (TNG) is seeking environmental approval to develop its proposed Mount Peake Vanadium-Titanium-Iron Project in the Northern Territory.

Mount Peake will be one of the most significant new resource projects in Australia, comprising a mining operation based on a world-class magnetite ore body, beneficiation of the ore to produce a concentrate and transportation of the concentrate to the Port of Darwin for export.

The mine site is located about 280km north-northwest of Alice Springs and 60km west of the Stuart Highway.

TNG is about to commence preparation of an Environmental Impact Statement (EIS) for the project, and is seeking early input and feedback from stakeholders on the potential environmental and social impacts and management strategies to be considered.

Three public information sessions, details of which are provided below, will be held for all interested stakeholders to learn more about the Project and the EIS process, and to provide feedback.

Mount Peake Project Public Information Sessions

Alice Springs	**Stirling Station**	**Ti Tree**
Tuesday, 24 March 2015	Wednesday, 25 March 2015	Wednesday, 25 March 2015
3.00 pm – 6.00 pm	9.00 am – 12.00 pm	1.30 pm – 4.30 pm
Andy McNeill Room, Alice Springs Town Council (93 Todd Street)	Stirling Station Shop (Stuart Highway, 60 km north of Ti Tree)	Central Desert Regional Council office (meet on verandah)

For more information, please contact us on (08) 6222 8373 or mountpeakeproject@ghd.com
or visit www.tngltd.com.au/projects.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L. Jefferys	I. McCardle				27/11/2015

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Appendix D

Cross Reference to EIS Guidelines

Cross Reference of Draft EIS Guidelines with Content of Mount Peake Terms of Reference

Terms of Reference requirements	EIS section / Appendix
General Advice on EIS	
Executive summary	Executive Summary
Main text of the document - list of abbreviations, glossary and acronyms	Provided
A table of how these Terms of Reference are addressed in the EIS, cross-referenced to chapters, page numbers and/or appendices	This table
An outline of the relevant legislation, codes, standards and guidelines applicable to the Project	Chapter 4
A list of persons and agencies consulted during the Environmental Assessment process	Chapter 6, Appendix E
The names of, and work done by, the persons involved in preparing the EIS	Appendix A
The qualifications and experience of the people involved in work contributing to the EIS.	Appendix A
Public Involvement and Consultation	
Demonstrate how public concerns were identified and how those concerns will influence the design and delivery of the Project	Chapter 6, Appendix E
Description of the Proposed Development	
General Information	
The full name and postal address of the Proponent	Section 1.3
An explanation of the objectives, benefits and justification for the Project	Sections 1.1 and 3.1
The Project's location in the region	Figure 2-1
Details of the Proponent's environmental record	No project record to date
Climate and atmospheric characteristics relevant to the Project	Section 9.1.1, Appendix J
Identification of areas under exploration which may be mined in future, or any other potential future activities being planned	Not relevant

Terms of Reference requirements	EIS section / Appendix
How the Project relates to any other proposals or actions	Section 2.1.2
An overview of the schedule for the whole Project	Section 2.1.4
Description of the Proposal	
An outline of the geology of the area	Section 2.2
Delineation of the Project footprint using detailed maps and diagrams	Figures 2-1 and 2-2
Project Components	
Mine	Sections 2.4.1 and 2.4.2
Processing	Section 2.4.3
Road transport	Section 2.4.4
Water	Section 2.5.3
Energy	Section 2.5.2
Waste management	Section 2.7
Workforce and accommodation	Section 2.6
Adnera rail load-out facility	Section 2.4.5
Ancillary infrastructure	Section 2.5
Closure and rehabilitation	Section 2.8, Chapter 16, Appendix M
Alternatives	Chapter 3
Risk Assessment	Chapter 5

Terms of Reference requirements	EIS section / Appendix
◗ Risks to Ground and Surface Water Resources	Chapter 7, Appendix F
◗ Risks to Biodiversity	Chapter 8, Appendices G and H
◗ Risks to Historic or Cultural Heritage	Chapter 11, Appendix K
◗ Socio-economic Risks	Chapter 12, Appendix L
◗ Rehabilitation and Mine Closure	Section 2.8, Chapter 16, Appendix M
◗ Risks to Human Health and Safety	Chapter 13
◗ Air Emissions	Chapter 9, Appendix I
◗ Other Risks	
• Mosquito Breeding	Section 13.4
• Wastewater	Sections 2.5.5, 2.7.2, 2.7.3, 2.7.4, 2.7.5, 14.5.3
• Solid Waste Storage and Disposal	Sections 2.7.1, 2.7.2, 14.5.1, 14.5.2, 14.5.3
• Noise and Vibration	Chapter 10, Appendix J
• Pastoral Uses	Sections 6.6 and 12.3.4
• Bushfires	Sections 8.1.4, 8.1.5, 8.2.4, 8.2.6
Environmental Offsets	Section 2.9
Environmental Management	Appendix N

Appendix F

Groundwater and Surface Water Assessment Report

TNG Limited

Mount Peake Project

Groundwater and Surface Water Assessment Report

December 2015

Limitations

This report has been prepared by GHD for TNG Limited and *may only be used and relied on by TNG Limited for the purpose agreed between GHD and TNG Limited as set out in this report.*

GHD otherwise disclaims responsibility to any person other than TNG Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by TNG Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Executive summary

Background

TNG Limited (TNG) is proposing to develop the Mount Peake Project (the Project) on Stirling Station, approximately 235 km north-northwest of Alice Springs. The Project will comprise:

- Mining of a polymetallic ore body through an open-pit truck and shovel operation;
- Processing of the ore to produce a magnetite concentrate;
- Road haulage of the concentrate to a new railway siding and loadout facility on the Alice Springs to Darwin railway near Adnera; and
- Rail transport of the concentrate to TNG's proposed Darwin Refinery located at Middle Arm, Darwin.

Mining will occur at a rate of up to 3 Mtpa during the first four years of operation and will double to 6 Mtpa thereafter. Up to 1.8 Mt of concentrate will be produced at full production.

TNG commissioned GHD Pty Ltd (GHD) to prepare an Environmental Impact Statement for the Project to support key Commonwealth and Territory Government approvals. This water resources assessment has been prepared to provide the specified ground and surface water information to inform the EIS.

The scope of this water resources assessment was to:

- Develop a mine site water balance;
- Provide an overview of the surface and ground water resources;
- Undertake a site hydrological assessment;
- Determine groundwater drawdown due to abstraction for dewatering and water supply; and
- Identify potential impacts of potential contamination and determine mitigating interventions.

Water Balance

A preliminary water balance was developed to determine the capacities of the infrastructure components comprising the water supply system and the sizing of the proposed borefield. The raw water requirements were estimated at 178 m^3/h 300 m^3/h for the two proposed operational stages of the Project. The key components of the water supply system are outlined below.

Water supply system component	Stage 1	Stage 2
Borefield	8 x 8.5 L/s bores	12 x 8.5 L/s bores
Raw water transfer pipeline	40.8 km	48.8 km
Raw Water Dam	12.3 ML	20.7 ML
Process Water Dam	3.6	7.2 ML
Water Treatment Plant	370 m^3/d	650 m^3/d
Potable Water Tanks at Processing Plant	0.5 ML	1.0 ML
Potable water tanks at Accommodation Village	0.3 ML	0.3 ML
Potable water supply pipeline	10 km	10 km

Surface Water Setting

The Project site comprises numerous ephemeral dendritic drainage systems with a number of smaller watercourses originating out of rocky outcrops into the surrounding plains. Key water courses in the vicinity of the Project include the Murray and Bloodwood Creeks and the Hanson River, the latter two of which will be crossed by the site access road.

Drainage tends to transition from annular water courses generally controlled by geology, to highly distributed channels associated with the formation of extensive alluvial fans. Groundwater recharge is likely in the vicinity of these fans. Water courses are typically sandy and highly braided. Surface water flow within the Project area is likely to spread laterally from channels across the extensive floodplain environment as low energy sheetflow. Sediment transport is most likely dependent on the magnitude of the event, with larger events responsible for sediment transport and channel formation.

Given the alluvial nature of terrain and the presence of ephemeral surface water drainage systems with floodout zones and palaeodrainage channels, there is potential for significant surface water - groundwater interactions within the vicinity of the creeks and rivers.

Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, and Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River, are both listed as Sites Conservation Significance. The channel of the Hanson River becomes ill defined, or braided, in the vicinity of Stirling Swamp, before becoming more defined again downstream.

Hydrological Assessment

An assessment of the hydraulics of the access road floodways was undertaken using the Australian Rainfall and Runoff guideline. The elevation datasets provided are coarse so the relatively simple Rational Method hydraulic modelling approach was adopted to determine flood peaks. This entailed the determination of runoff coefficients for application in the Rational Method, followed by the estimation of peak discharges by parameter transfer from similar gauged streamflow sites.

Peak discharges were estimated at the access road floodways across Murray Creek, Hanson River and Wood Duck Creek. Floodway flow depths were estimated using Manning's equation based on the peak discharge estimates. An assessment of the flow durations was undertaken through derivation of flood hydrographs using the Extended/Modified Rational Method for a range of storm event durations between 24 and 72 hours. The resulting flow depths and durations are summarised below.

Target catchment	**Peak flow depths (m) by ARI**		
	10-year	**20-year**	**50-year**
Murray Creek	0.42	0.76	0.99
Hanson River	1.44	1.81	2.15
Wood Duck Creek	0.37	0.51	0.71
Target catchment	**Flow duration (hours) by ARI**		
	10-year	**20-year**	**50-year**
Murray Creek	25-27	35-51	43-86
Hanson River	81-129	81-129	91-129
Wood Duck Creek	93-104	98-117	107-148

Properly constructed floodways should be considered at Murray Creek and Hanson River should the estimated disruption times be acceptable. Such crossings would not be expected to interrupt natural streamflow and geomorphological processes, but would require ongoing maintenance to ensure accessibility. There is no evidence of a single specific drainage line associated with Wood Duck Creek and surface flows in this vicinity are likely to present as sheet flow. Given the relatively long length of this crossing, regularly spaced and appropriately sized culverts are recommended.

A mine site flood risk assessment was undertaken using the HEC-RAS 1-D hydraulic model assuming steady flow water surface profile computations. The resulting flooding extents along Murray Creek in the vicinity of the mine site indicate that the mine site is not expected to experience any significant flooding for events up to the 50-year ARI. However, the bench of lower lying topography in the vicinity of the proposed pit may be prone to flooding during more extreme events. Further investigation is required to establish the need for flood protection measures in this vicinity.

Sheetflow processes are likely to occur along the access road within the alluvial plains to the east of the Stuart Highway. No specific drainage lines have been defined and it is recommended that regularly spaced and appropriately sized culverts be installed across the access road to prevent the creation of sheetflow shadow zones.

Sediment sampling was undertaken to characterise sediment quality as a proxy for water quality given the infrequent nature of flow events in the region. Samples revealed that particle size distribution ranges from sand and gravel to fines and sand. Sediment pH ranges from neutral to very strongly acid and sediment electrical conductivity was observed to be very low. Whilst metals were detected at concentrations above the Limit of Reporting (LOR) in the fluvial samples, none of the sediment samples exceeded the respective ANZECC sediment guideline for metals. No total recoverable hydrocarbon analytes exceeded their respective LOR.

Groundwater Setting

The orebody target is the mineralised Mount Peake gabbros, which are generally found concealed beneath recent Quaternary sediments. The gabbro unit is located within outliers of Neoproterozoic sediments of the Georgina Basin. The Neoproterozoic sediments rest unconformably on metasediments and granites of the Aileron Province within the Lower Proterozoic Arunta Region. Within the immediate area of the mine pit, Quaternary sediments are the dominant surface geological unit and regolith.

Regional aquifer mapping indicates that the predominant aquifer type in the vicinity of the pit comprises fractured and weathered rocks with minor groundwater resources, which are considered local scale aquifers only. Accordingly, dewatering is unlikely to yield adequate water for mine operations and alternative sources of water are required.

A water supply borefield is proposed on the western bank of the Hanson River. The dominant surface geological unit here is the alluvial deposits of relict fluvial system largely covered by sheet sand and alluvial/red soil plain deposits. The thickness of the alluvial units within the borefield locations are significantly thicker with comparison to the general alluvial units found on the plains. The increased thickness relates to the incised channels of the palaeodrainages of the Hanson River. This system is thought to be the northern discharge of the Ti Tree Basin, passing through Stirling Swamp and connecting with the existing Hanson River Channel. Utilisation of the Hanson River palaeovalley is currently limited to stock bores.

Stirling Swamp is thought to be connected to groundwater through a topographic low forming a ‘window’ to the relatively shallow Ti Tree aquifer water table. This area is therefore considered a discharge zone of the Ti Tree aquifer. Mud Hut Swamp is formed from a flood-out of the Bloodwood Creek and, based on its location as an outflow of the creek, it is unlikely that the swamp is maintained by groundwater. There are no known permanent or semi-permanent water holes along the Hanson River.

Aquifer recharge predominantly occurs from direct infiltration of rainfall. Due to the sporadic and minimal amount of rainfall typical of the region, this volume is quite low. Large rainfall events and subsequent flooding is known to significantly increase groundwater levels in areas close to active flow channels. However, a lack of monitoring data for the Hanson River channel means that recharge volumes for this system cannot be accurately quantified.

An investigation of the groundwater potential in the area of the pit entailed the assessment of 11 boreholes located both within and adjacent to the pit area. Groundwater was measured at a depth around 22 mbgl and airlift tests typically yielded low volumes with flow only being sustained in five of the boreholes. This testing also allowed the determination of indicative aquifer parameters through the analysis of groundwater recovery data at each test site. Test results indicate the pit will not be subject to significant groundwater inflow so is unlikely to require substantial dewatering infrastructure.

A drilling and testing program was also undertaken to assess the groundwater supply potential of the Hanson River palaeovalley. Groundwater levels were found to be relatively consistent between sites along the Hanson River palaeochannel at a depth of around 10 mbgl and had salinities generally between 6,000 and 8,000 mg/L TDS. All bores produced significant water during drilling and 150 mm wells were constructed, with a 200 mm well installed at WB05, the most productive investigation site. Pump testing of borehole WB05 allowed the determination of aquifer properties and recommendations for operational pump rates of 8.5 L/s for the proposed production bores.

Groundwater modelling

Groundwater flow modelling was undertaken to assess the cumulative impact of the operation of the borefield and pit dewatering on nearby groundwater users (stock bores and potential groundwater dependent ecosystems).

A conceptual hydrogeological model was developed based on the available data, maps and reports to provide a framework for numerical model development. A broad two layer system was adopted to describe the key modelling areas of the mine site and the palaeovalley aquifer. Based on this two layer concept, a four layer numerical model was adopted as follows:

- Layer 1 represents the extent of the weathered zone in the bedrock outside of the palaeovalley and sandy-silt layer in the palaeovalley;
- Layer 2 represents a transition zone between the weathered bedrock and fresh bedrock in the area outside of the palaeovalley and lower sand aquifer in the palaeovalley;
- Layer 3 represents fresh bedrock (igneous and metamorphic) in the area outside of the palaeovalley and sedimentary rock (claystone/sandstone) in the palaeovalley; and
- Layer 4 represents fresh bedrock throughout the model domain in order to account for the potential vertical flow into proposed mine pit.

The MODFLOW-USG model configured in three-dimensional mode was used for simulations. Layer thicknesses and hydraulic properties were determined based on resource drilling within and around the mine site, groundwater drilling and testing in the palaeovalley and lithology data from historic drilling. Both steady state and transient modelling was undertaken.

The steady state model was calibrated to fit historical water level observations tests undertaken for model convergence, water balance and other qualitative and quantitative measures. Model parameters and boundary conditions were changed to match the measured head with the modelled head. Of note, depth to groundwater in the area of Mud Hut Swamp is modelled as being around 20 mbgl (i.e. conceptually the swamp is not connected to the regional groundwater system).

The model was applied in transient state mode to assess the maximum potential drawdown of the palaeochannel aquifer through borefield abstractions and from pit development. This allowed the simulation of both drawdown and recovery in annual increments over a period of 100 years (17 years of abstraction followed by 83 years of recovery). This also allowed the staging of the borefield operation to be assessed.

Modelling results indicate that:

- Maximum groundwater drawdown at the borefield at the end of mining is modelled as being up to 12 m at the location of the operating bores in the centre of the borefield. Drawdown decreases significantly with depth away from the palaeovalley. The 1 m drawdown contour extends to around 6 km south of the borefield;
- At the end of mining, drawdown under transient conditions reaches a maximum of around 100 m within the location of the pit, and rapidly decreases with distance from the pit. The 1 m drawdown contour is predicted as being around 1 km from the pit edge, and the approximate limit of drawdown (0.05 m) a further 1 km from this;
- Drawdown is predicted at several pastoral bores located close to the borefield, with groundwater levels expected to experience a drop in water level of greater than 3.0 m, which may lead to water supply problems;
- Stirling Swamp and the outflow of the Ti Tree basin are unlikely to be impacted by either borefield abstraction or pit dewatering;
- Drawdown extent in the area of the mine site at 100 years increases to 3.5 km from the mine pit for 1 m drawdown. No drawdown impacts are expected at Mud Hut Swamp;
- At 100 years, the groundwater levels recover in the area of the borefield, with maximum drawdown reducing to less than 5 m. However the overall extent of drawdown does increase slightly as groundwater from storage drains to the recovering borefield;
- The transient simulations indicate that groundwater level recovery is slow in the palaeovalley, largely related to the recharge characteristics of the model, which are conservative; and
- Following cessation of mining a shallow pit lake is predicted to form.

Potential for contamination

The following is noted with regard to the ore and waste characterisation:

- The ore body and overburden have low sulphide contents and are considered benign in terms of potential acid formation, so the waste rock dump and ore stockpiles should not pose any discernible risk to the identified receptors and endpoints;
- The magnetite concentrate is inert and non-toxic and does not constitute a threat to identified receptors and endpoints; and
- The tailings stream will consist of non-magnetic silts and sands and will be dewatered using a flocculant in a tailings thickener. The potential hazard of the flocculant to humans is low and there are no known ecotoxicological effects.

A variety of chemicals and reagents will be used to facilitate construction and operation of the Project and will include explosives and hydrocarbons. The Project will not use any hazardous chemicals that require special storage or handling. Potential contaminants could include:

- Sediments from disturbed areas, exposed areas and dispersive materials;
- Windblown dust from mining, transport, waste dumps and stockpiles;
- Blast residues;
- Hydrocarbon spills from plant and equipment;
- Sediments from altered geomorphology at waterway crossings;
- Spillage of concentrate during transport;
- Runoff of stormwater containing fines;
- Chemicals and reagents from storage facilities and spills;
- Hydrocarbons from storage facilities;
- Solvents and surfactants from workshops;
- Cleaning agents and saline reject from the water treatment plant; and
- Microbial contaminants and nutrients from accidental spills/discharged from wastewater treatment plant.

Potential impacts of these contaminants on water resources could include:

- Soil erosion at site;
- Accumulation of sediments in receiving waters;
- Release of salt and/or contaminants to receiving waters; and
- Accumulation of dust in receiving catchments.

Key control measures should include:

- Preparation of an Erosion and Sediment Control Plan to provide a framework for managing the risk of erosion and release of sediments to receiving environment or the contamination of stormwater (including delineation of runoff separation catchments);
- Preparation of a Water Management Plan for mine operation with a particular focus on mine affected water to be retained within mine water system and discharged through controlled release points; and
- Determination of design criteria for elevated drill pads for protection of well casings, headworks, generators and fuel tanks, which are stable under saturated conditions and protected against likely flooding and erosion.

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1. Introduction

1.1 Background

TNG Limited (TNG) is proposing to develop the Mount Peake Project (the Project), approximately 235 km north-northwest of Alice Springs in the Northern Territory (Figure 2-1).

TNG commissioned GHD Pty Ltd (GHD) to prepare an Environmental Impact Statement (EIS) for the Project to support key Commonwealth and Territory Government approvals. The Terms of Reference for the preparation of the EIS was issued by the Northern Territory Environment Protection Authority (NT EPA) in March 2014. This water resources assessment report has been prepared to provide the specified ground and surface water information to inform the EIS.

1.2 EIS term of reference

The Terms of Reference for the preparation of an EIS (NT EPA 2014) identified the following key risks to ground and surface water resources:

- Potential for Acidic and/or Metalliferous Drainage (AMD) from the waste rock dump, tailings storage facility and other mine infrastructure, to contaminate shared water resources;
- Surface water quality may be impacted by spills to surface water and runoff containing hazardous substances or elevated sediment concentrations;
- Contamination of groundwater could occur through leaks from storages or pipelines and spills during handling of contaminants, chemicals and toxicants; and
- Practically available water sources will not be sufficient to supply the needs of the proposed Project configuration, or will not be sufficient without causing environmental or social impacts.

The environmental objectives pertaining to water resource protection (NT EPA 2014) are:

- Demonstrate that available water supplies will be sufficient to fulfil the Project needs over the predicted life-of-mine, without causing environmental or social impacts;
- Demonstrate that Project configuration will optimise reduction of net water use for the Project and minimise contamination of water resources; and
- Ensure that surface water and groundwater resources and quality are protected both now and in the future, such that ecological health and land uses, and the health, welfare and amenity of people are maintained.

Groundwater

The NT EPA (2014) specified that the EIS should include information on the current groundwater resources, particularly:

- Define water sources that may be used to fulfil the requirements of the Project, including:
  - Target bore fields (existing / proposed) and surface waters;
  - Predicted extraction rates;
  - Seasonal requirements for additional clean water;
  - Sources of water for construction of roads and other infrastructure; and
  - Sources and requirements of potable water.

- Describe the existing mine-site and regional hydrogeology in terms that will provide a comprehensive baseline of pre-disturbance conditions;
- Map, describe and model site and regional groundwater resources for the mining leases, ore-processing and water extraction points;
- Discuss significance and sensitivity of site and regional groundwater resources from ecological, public / social and economic perspectives, including descriptions of:
  - Existing groundwater users;
  - Location of groundwater bores for the Project with respect to any groundwater dependent natural features and community uses;
  - Groundwater depths;
  - Directions and rates of groundwater flow;
  - Groundwater quality, with particular emphasis on contaminants likely to be elevated from mining activities;
  - Connectivity between aquifers and with surface waters;
  - Points of recharge / discharge;
  - Whether proposed bores or the Project footprint are within a declared Water Allocation Planning area; and
  - Estimate total reserves and annual recharge.

Surface water

The NT EPA (2014) also requires a description of site and regional surface water resources in the vicinity of the proposed mining area as follows:

- Describe surface water resources - water quality and significance;
- Discuss sensitivity and significance of site and regional surface water resources from ecological, public / social and economic perspectives. Include description of water quality, flow rates, existing surface water users;
- Define baseline surface water quality (acidity, metals, sulfate, salinity, nutrients, major ions etc.) for Murray Creek and Bloodwood Creek, Mud Hut Swamp and Anmatyerr North if data is available;
- The nature of Murray Creek, including when it flows, flow rates, catchment size, width, and where it flows to; and
- Whether Murray Creek presents a seasonal flooding / erosion risk to the pit, plant or proposed bridges / crossings.

Designs of river crossings, stormwater drainage flows, flood flows should be based on the recently released changes in rainfall intensities by the Bureau of Meteorology.

Water balance

The development of a water balance model for the Project should detail (NT EPA 2014):

- Project site;
- Construction and operational phases;
- Water sources (extraction rates / quality);
- Water uses and requirements (rates / quality);
- Water treatments (such as of supplies, stormwater, waste water discharges); and
- Recycling.

Describe water-related infrastructure for the Project:

- Water treatment systems, including sediment ponds;
- Storage ponds (describe contents);
- Pumps, pipelines, etc.; and
- Effluent disposal systems.

1.3 Scope of work

The scope of this water resources assessment included the following:

- Acquisition and desktop review of data and information including meteorology, elevation, geology, landuse, hydrogeology, hydrology, water quality and sediment;
- Determination of a water balance through the development of a preliminary process flow diagram, assessment of water requirements for key processes and the potential for recycling and reuse of water;
- Definition of conceptual hydrological models including the delineation of catchments of potentially impacted waterways and identification of associated runoff processes;
- Configuration of a numerical hydrological model based on parameters determined via the desktop assessment and conceptual model development, undertaking streamflow assessments to appraise likely baseline hydrological conditions including likely sheetflow areas and potential hydrological changes resulting from the development;
- Undertake a flood risk assessment through the determination of design rainfall events, definition of cross sections of target waterways, configuration of a hydraulic model and determination of the extents of flood risk and estimation of associated flood peaks and durations;
- Definition of a conceptual hydrogeological model and interactions including an assessment of geological sequences / units, inferring the extents of potential aquifers and an investigation into the surface water - groundwater interactions;
- Configuration of a numerical groundwater model to undertake hydrogeological assessments to establish the likely baseline groundwater conditions and evaluate potential hydrogeological changes and dewatering requirements associated with both the mine pit and borefield; and
- Identify potential impacts of potential contamination and determine mitigating interventions through an assessment of potential contaminant sources and release mechanisms, pathways, receptors and endpoints.

An assessment of the Project's risks to surface and groundwater resources is included in the EIS. A Water Management Plan and an Erosion and Sediment Control Plan are incorporated into the Project Environmental Management Plan.

2. Project description

2.1 Project overview

2.1.1 Introduction

The Mount Peak Project will comprise:

- Mining of a polymetallic ore body through an open-pit truck and shovel operation;
- Processing of the ore to produce a magnetite concentrate;
- Road haulage of the concentrate to a new railway siding and loadout facility on the Alice Springs to Darwin railway near Adnera; and
- Rail transport of the concentrate to TNG's proposed Darwin Refinery located at Middle Arm, Darwin.

Processing of the magnetite concentrate in Darwin does not form part of this assessment.

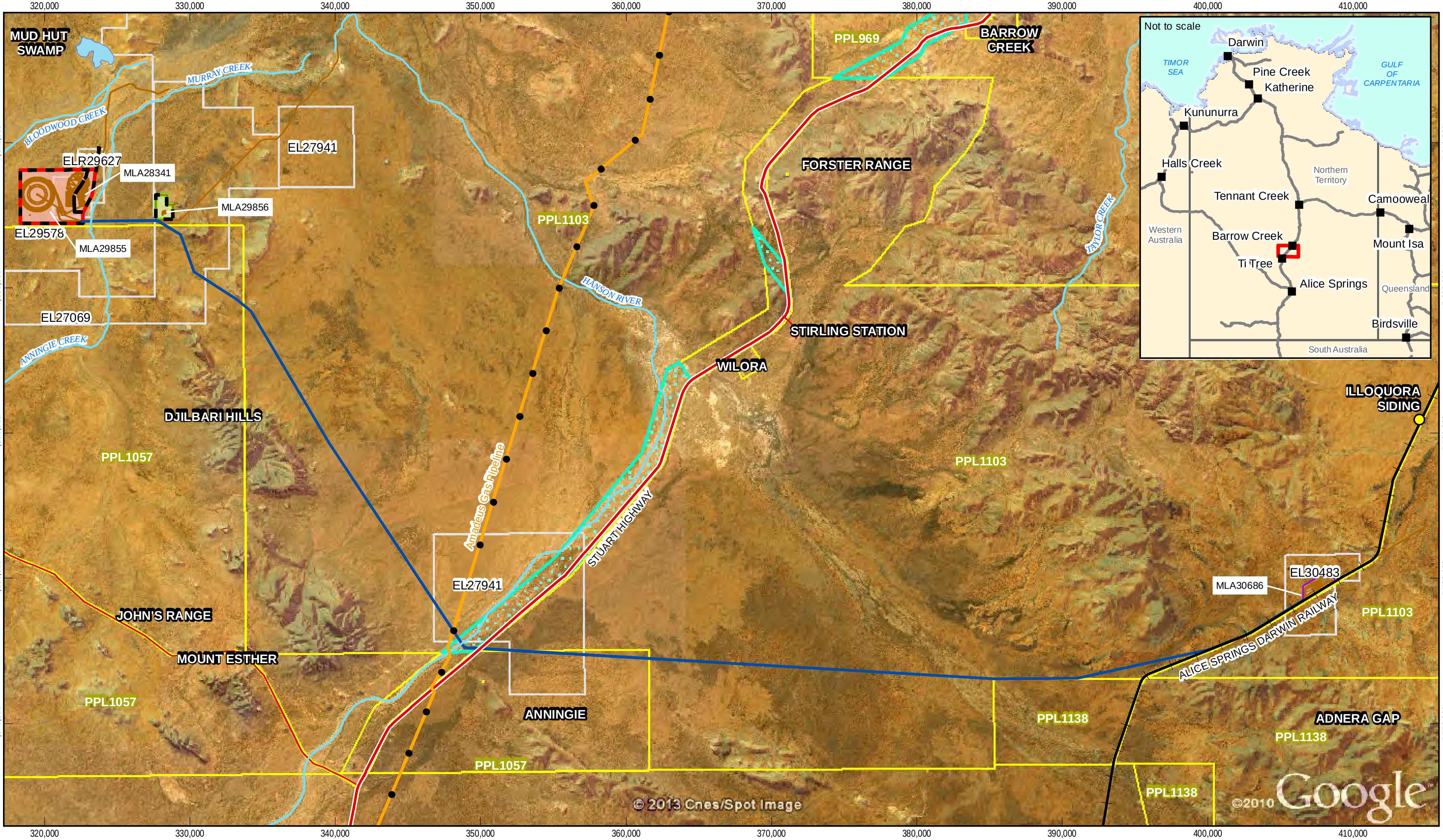
The Project will mine at a rate of up to 8.4 million tonnes per annum (Mtpa) and, following processing, will produce up to 1.8 Mtpa of magnetite concentrate.

TNG proposes to commence construction in late 2016 with mining commencing in 2018. The life of the project is expected to be 19 years inclusive of construction (2 years), mining and production (15 years), and closure and rehabilitation (2 years).

2.1.2 Key project components

The Mount Peake Project includes the following components (Figure 2-1 and Figure 2-2):

- Open cut mine;
- Waste rock dump (WRD) with up to 70 Mt capacity;
- Run of mine (ROM) pad;
- Four long term stockpiles of up to 4 Mt capacity each;
- Process plant;
- Concentrate stockpiles;
- Tailings storage facility (TSF) with up to 63.4 Mt capacity;
- Access road between the mine site and Adnera Loadout Facility including an underpass of Stuart Highway (for concentrate trucks) and intersections with Stuart Highway (for mine site access);
- Concentrate loadout facility and rail siding at Adnera;
- Borefield and associated water pipeline;
- Water treatment and sewage treatment plant;
- Fuel farm;
- Gas fired power station;
- Explosives and detonator magazines;
- Accommodation village;
- Administrative buildings, laboratory, workshops and warehouses; and
- Gatehouse and weighbridge.



Paper Size A4

0 2.5 5 7.5 10

Kilometres

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

N

LEGEND

- Illoquora Siding
- Principal Road
- Minor Road
- Major Watercourses
- Railway
- Amadeus Gas Pipeline
- Mine Site Facilities
- Mud Hut Swamp
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Crown Land
- Mount Peake Granted Tenements
- Mount Peake Mineral Leases
- Cadastral Boundaries
- Access Road
- Camp Facilities

GHD

TNG Ltd
Mount Peake EIS

Job Number 61-29057
Revision A
Date 23 Oct 2015

Project Location
Mount Peake Project Area

Figure 2 -1

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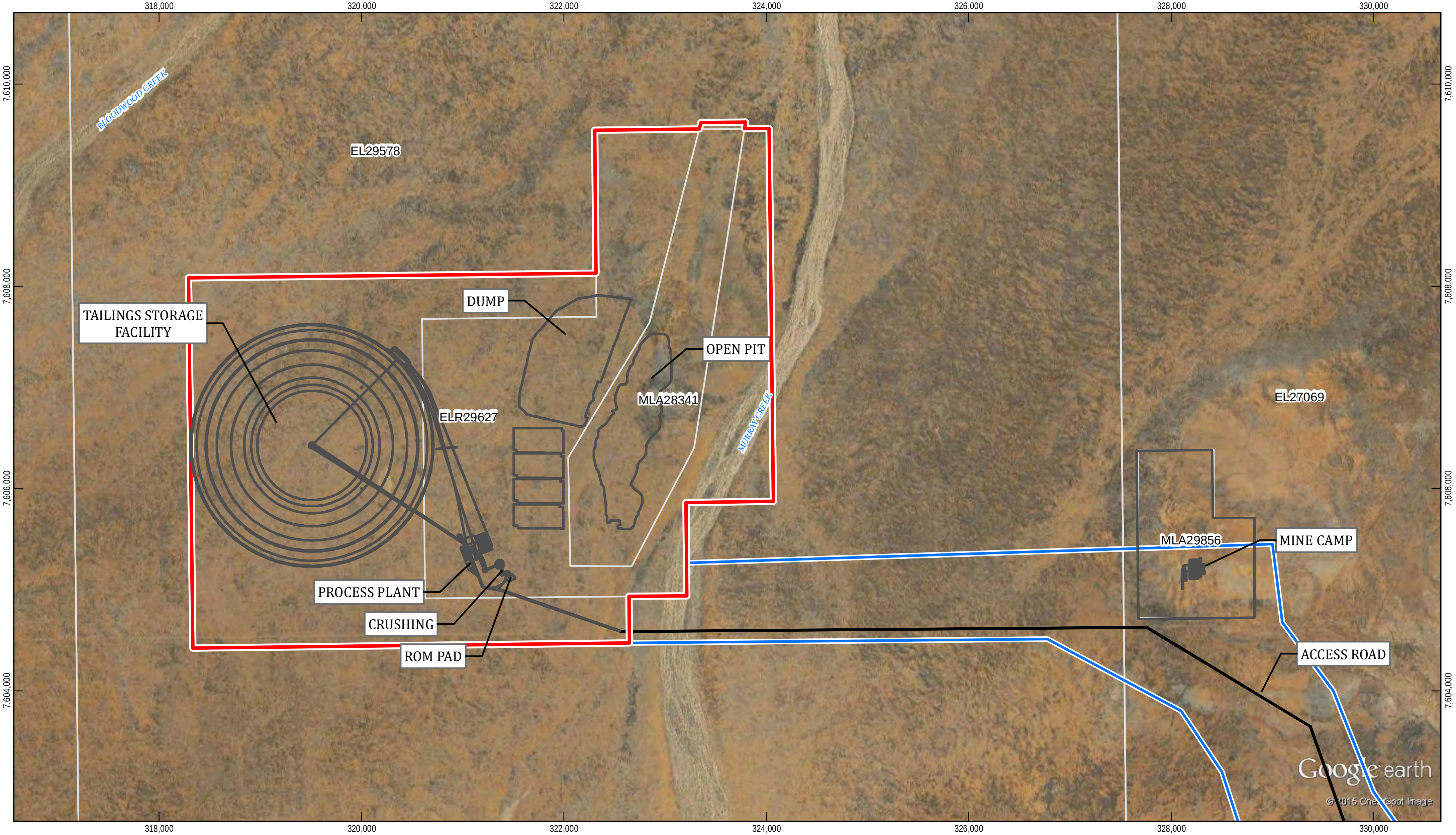
239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2015). Geoscience Australia - Waterways, mainland, placename, road (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). Created by: RB



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0 0.5 1 1.5

Kilometres

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

N

LEGEND

- Mine Site Facilities
- Mount Peake Granted Tenements
- Mount Peake Mining Area
- Access Road
- Transport Study Corridor

GHD

TNG Ltd
Mount Peake EIS

Job Number | 61-29057
Revision | A
Date | 26 Oct 2015

Mine Site Detail
Mount Peake Project Area

Figure 2-2

G:\61\29057\11 GIS\Maps\MXD\6129057_002_Fig2MineSiteDetail.mxd

239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Google: Imagery - 20150910; TNG Ltd: Mine site facilities, access road, mining area,Tenure - 20151021

2.2 Construction

Construction will take around 24 months.

Potable water will be trucked to site during the early stages of construction until supply is established from the borefield.

Pre-production mine preparation works will also commence during this stage. Selected materials from the pit area will be stockpiled and placed to build bases for the HPGR, ROM ramp and pad, TSF perimeter bund and central access ramp, access road and other site roads. Excess material will be trucked to the WRD.

General site works

Earthworks will involve clearing, grubbing, cut and fill, preparation of unsealed roads and hardstands and basic drainage works. Areas will be levelled and compacted prior to construction of infrastructure.

Toward the end of the construction program a second phase of earthworks will be initiated. This work will involve trimming to final level, constructing final drainage profiles, installing culverts and sealing sections of road requiring a bitumen seal.

Areas to be cleared for construction will be grubbed of trees and larger vegetation with material collected and stored for reuse in rehabilitation. Topsoil, where present, will be removed and stored for future use in rehabilitation. Where necessary stockpiles will be protected with erosion and sediment control structures and stabilised to prevent excessive wind erosion. Vegetation clearing and topsoil removal will be carried out shortly before the area is required for construction.

Construction materials

Construction materials (steel, plate work, piping, cable, timber, cement, aggregate etc.) will be trucked to site from Stuart Highway via the access road. Materials will be sourced locally where available.

Transportation vehicles will be a combination of standard and oversize loads. Once the Adnera rail siding is established, some construction materials may be imported by rail.

Concrete will be supplied from an onsite batch plant.

Borrow pits will be established along the alignment of the access road to provide road base course. The location and size of these borrow pits still needs to be determined.

Construction equipment

Construction activities will use standard construction machinery, general trade equipment and specialised equipment including excavators, scrapers, front-end loaders, graders, cranes, water tankers, concrete trucks / pumps, dozers, dump trucks, forklifts, busses and light vehicles.

Fuel consumption during construction is estimated to be 3.5 megalitres (ML). Fuel will be delivered to site by tanker on a weekly basis and stored in self-bunded storage tanks.

Access Road

The access road connecting the mine site with the Adnera Loadout Facility will be approximately 100 km long and constructed with two 5 m traffic lanes with two 0.5 m shoulders. Table drains will be constructed adjacent to the road. The key steps in construction are:

- Establish borrow pits (maintaining where possible a haulage distance <10 km);
- Clear and grub vegetation and stockpile as required for borrow pit remediation works;
- Cut to fill where possible;
- Rip and scarify subgrade;
- Condition and compact subgrade material;
- Place and compact base course material; and
- Final grade and trim of road surface and batters including cutting of drainage swale.

Several bores will be established along the access road to provide construction water.

An underpass of Stuart Highway will be constructed to remove road trains from the highway. To allow for construction of the underpass Stuart Highway will be temporarily diverted.

At grade connections from the highway to the access road will be provided for vehicles accessing the mine site and Adnera.

Flood ways will be constructed across the Hanson River, Murray Creek and some minor watercourses that bisect the access road. Crossing design incorporates a 300 mm thick stabilised fill road boarded with rock filled gabion baskets to sit at grade. The crossing will be designed to tolerate small river flows and to wash out during significant flood events to eliminate the potential for backup of flood waters.

2.3 Mining, processing and product export

Mine plan and pit development

Mining will occur at a rate of up to 8.4 Mtpa. The ultimate pit shell will be reached through five intermediate but overlapping stages. These stages have been developed to minimise waste movement and haulage distances. Once mining is complete the pit will be approximately 2,000 m long and 600 m wide with a maximum depth of 150 m.

There will be a pre-production year that will occur during the second year of construction and will involve pre-stripping of waste material. Some 139 Mt of material is expected to be extracted over the life of the mine, comprising around 78 Mt of ore and 61 Mt of waste.

Mining

Mining will commence with a “starter pit” accessing high grade and low strip ratio ore. Drilling and blasting, to loosen rock ahead of mining, will be undertaken to produce rock sizes that conform to processing requirements. Extracted high grade ore will be transported by haul truck from the pit to the ROM pad and directly fed into the process plant.

Four long-term stockpiles will be established according to grade.

Waste material will be trucked to the WRD that will progressively develop to the west of the pit.

Testing of the orebody produced limited volumes of groundwater. It is proposed to use in-pit sump pumps to remove any water accumulating in the pit due to seepage and direct rainfall.

Processing

Processing involves crushing, grinding and magnetic separation to produce a magnetite concentrate.

A front end loader will feed ore onto a static grizzly above the ROM bin. Screened oversize material (+500 mm) will be broken by a mobile rock crusher and re-fed into the grizzly.

The ROM bin material will be fed to a vibrating grizzly. Screened oversize material (+150 mm) will be crushed in a primary jaw crusher with crushed product mixed with -150 mm material and conveyed to a primary screen bin feed. The +30 mm material will be conveyed to a secondary cone crusher, then recombined with screened undersize (-30 mm) material and conveyed to a High Pressure Grinding Rolls (HPGR) stockpile.

The HPGR stockpile will have a live capacity of 20,000 tonnes. Material will be reclaimed from beneath the stockpile and sent to the HPGR feed bin. Tertiary crushing will be achieved using an HPGR. The grinding elements of the HPGR are two counter-rotating rolls, between which the material is crushed.

The HPGR product will be conveyed to the HPGR screen feed bin. Screening of the HPGR product will be a wet process. Screen oversize (+2.8 mm) will be returned to the HPGR feed bin with undersize either sent to a secondary ball mill for further milling or fed directly to cyclones. Cyclone overflow (<90 µm) gravitates to the magnetic separation circuit with underflow returned to the ball mill for further grinding.

Cyclone overflow gravitates to a bank of Rougher Magnetic Separators (RMS) to remove entrained highly magnetic material (magnetite). The RMS concentrate then gravitates to a bank of Cleaner Magnetic Separators (CMS) to lift the final concentrate grade by providing a high degree of selectivity in the separation. The CMS concentrate gravitates into the Magnetite stock feed tank.

Non-magnetic tailings streams will be pumped to a tailings thickener where the solids density is increased to approximately 65 %. Overflow from the thickener will gravitate to the process water dam whilst underflow will be pumped to the TSF for storage.

The magnetite slurry is filtered to achieve a moisture content of 10% w/w which is required to minimise the transport and shipping costs. Filter cake is then stockpiled in a concentrate storage area.

Product transfer

Magnetite will be loaded into trucks using a front end loader. The concentrate will be trucked via the access road to a new rail siding and loadout facility at Adnera. Loads will be covered to prevent dust generation and product loss.

Adnera loadout facility

Road trains will side dump concentrate to a stockpile adjacent to the rail siding. The stockpile will have capacity for storage of up to 150,000 tonnes, sufficient for four weeks. Train loading will occur directly by up to four front-end loaders. The train will have a length of 1.5 km and consist of 60 hopper wagons with a total capacity of around 5,500 tonnes. Around one train movement per day is expected.

Potable water and diesel will be trucked from the mine site as required. Adnera is expected to have a workforce of four, accommodated at the camp adjacent to the mine site.

Reagents and consumables

Reagents and consumables expected to be used at Mount Peake include:

- Nalco 83372 (or similar) as a flocculant in the process plant – 300 tpa;
- Sodium hypochlorite (or similar) for disinfection in the water treatment plant – 5 tpa;
- Antiscalent for use in the water treatment plant – 1 tpa;
- Primary and secondary mill balls – 15,000 units; and
- Operating consumables associated with wear in the apron feeders, vibrating grizzly, crushing circuit, crusher screens, HPGR screens and HPGR liners.

Reagents and consumables will be delivered by truck. It is estimated that up to four deliveries per day will occur.

2.4 Infrastructure

Access road

An access road between the mine site and Adnera Loadout Facility will serve the dual purpose of providing general vehicle access from Stuart Highway to both the mine site and loadout facility, and as the haulage route for concentrate product. Road trains used to transport the concentrate will be highway compliant and will operate under shared usage conditions with other highway compliant vehicles such as delivery trucks, busses and light vehicles.

Power supply

At full production the power draw for the mine and process plant is estimated at 24 MW. Power will be supplied from gas fired generating sets. Emergency backup will be provided from 3 x 1,250 kVA diesel generators.

Gas will be provided from the Amadeus Gas Pipeline via a hot tap. Road train tankers will commute between the pipeline and the mine site along the access road.

Power for construction will be provided by diesel powered generators until the power station is operable.

Diesel generators will be used to power the borefield. Power to each bore will be supplied via a 50 kVA generator with a 4,670 L diesel tank, sufficient for around 20 days continuous operation. Generators will be located on bunded hardstand pads. Diesel will be delivered by tanker.

Water supply and storage

The water supply infrastructure is discussed in detail within Section 3 of this report.

A new borefield will be established within the alluvial aquifer of the Hanson River. Six supply bores with two standby bores will provide water for the first four years of the project with an additional four bores installed from year 5. Bores will be spaced approximately 1,800 m apart and will pump at around 8.5 L/s each.

A water supply pipeline will be constructed between the borefield and the Raw Water Dam predominantly along existing tracks, a distance of approximately 49 km. The pipeline will have a diameter of up to 450 mm.

A water balance for Mount Peake is provided in Appendix A. Around 2,625 MLpa of make-up water will be required for mining, processing, dust suppression and potable use. Water for use at the Adnera Loadout Facility will be trucked from the mine site.

A 1.5 ha Raw Water Dam will be constructed adjacent to the process plant to manage project water supply. Total storage will be around 21 ML, sufficient for three days supply.

A 0.9 ha Process Water Dam will be constructed adjacent to the process plant to provide process water and to receive recovered water from the plant and tailings storage facility. Total storage will be around 7 ML, sufficient for 2 days supply.

A water treatment plant will be constructed. The plant will treat 35.6 m^3/h for potable use, irrigation and process plant gland water. Water treatment will comprise:

- Filtration using multi-media filters (MMF);
- Desalination using brackish water reverse osmosis (BWRO); and
- Disinfection using sodium hypochlorite or similar.

The brine reject will be discharged to the Process Water Dam.

Buildings

The administration building will be single storeyed containing offices, open plan work area, meeting room, archives, crib room, training facilities, emergency response facilities, change room and store. The mill office will house the main control room, process plant office area, changing room, crib room and a general covered area.

Two workshops will service the mine site.

A separate reagent storage warehouse will be provided for solid reagents that require protection from the elements.

A metallurgical laboratory will be provided to allow adequate monitoring for grade control of incoming ore and to allow process and product monitoring.

Sewage

Two pump stations will be installed to collect sewage and wastewater for treatment in a Sewage Treatment Plant. One station will service the mine site with a second station servicing the accommodation village. Treated waste water will be used around the site for landscaping purposes. The untreatable solids will be collected and disposed of offsite by a licensed waste transporter.

Sewage at the Adnera Loadout Facility will be treated by septic tank and leach drains.

Chemical and hydrocarbon storage

Diesel will be required to fuel the mining and vehicle fleet, and generators at the borefield. At a mining rate of 6 Mtpa the estimated diesel requirement is 15 MLpa. To achieve this there will be three 100,000 L deliveries per week by triple carriage semitrailer.

Diesel at the mine site will be stored in 85,500 L self-bunded tanks with a total storage capacity of around 850,000 L. The tanks are effective storage solutions for type 1 or 2 combustible fluids. The tanks are manufactured to comply with Australian Standard AS1692 and when installed in compliance with AS1940 for Storage of Combustible Fluids easily meet regulatory requirements.

Lubricating oil will be stored in bulk containers inside a bunded area with spill protection and recovery. Waste hydrocarbons will be stored in a tank within a bunded area to be held for collection by a contractor for reprocessing and recycling.

The project will no use any hazardous chemicals that require special storage and handling.

Explosives magazine

A total of 24,000 t of explosives is estimated to be required over the life of mine peaking at 2,200 tpa. Around 55% of the explosives required is emulsion for use in fresh material with the balance being ammonium nitrate / fuel oil. Explosives will be stored in a dedicated magazine.

Airstrip

The project is expected to use the existing Ti Tree airstrip, 70 km from the mine site.

2.5 Workforce and accommodation

The construction and operations workforces are estimated to peak at 225 and 170 personnel respectively. The workforces will be largely fly-in fly-out due to low population numbers in the local area. Workers will fly to Ti Tree and will then be bussed to the accommodation village for the duration of their roster.

An initial 40 person “fly camp“ will be established to allow for early construction works. This will consist of separate four room en-suited accommodation units together with kitchen / diner, laundry units, wet mess, and office / administration building.

Following early site works a permanent village will be constructed to provide housing for the main construction workforce prior to hand over for operations personnel.

2.6 Waste management

Waste rock dump

Geochemical investigations by TNG have confirmed that the orebody does not contain AMD materials.

A WRD will be constructed to contain waste rock from mining operations. The dump will have an ultimate height of 40 m and a footprint of 90 ha with capacity to store up to 70 Mt of waste. It is proposed to use up to 5 Mt of waste from pre-production for project construction requirements. There are no specific strategies to manage waste placement in the dump as the waste rock is benign.

Tailings Storage Facility

Tailings will be produced following the magnetic separation of the crushed and screened ore and will consist of non-magnetic silts and sands. Central Thickened Discharge (CTD) was selected as the preferred method for tailings disposal based on balancing water recovery, environmental risk, the relatively flat nature of the site, ease of closure, and construction and operating costs.

The initial mining rate of 3 Mtpa will be doubled to 6 Mtpa from year five. The tailings thickener and the tailings discharge system will be duplicated in year five in line with the duplication of the process plant. The various components of the tailings disposal system are described below.

The tailings streams from the process plant will be combined in a tailings thickener where flocculant will be added to settle the fine solids. Thickener underflow, with a solids content of 65%, will be pumped to the TSF with overflow reused within the process plant.

Thickened tailings will be pumped from the thickener to a central discharge area along the access ramp through a main delivery pipeline.

Tailings deposition will be via spigots placed around the perimeter of the central discharge area. The spigots will open and closed progressively to form an even beach that will allow effective draining and drying of the tailings. Discharged tailings will form a cone shape tailings beach creating a roughly circular storage area.

The TSF will develop in stages related to the incremental raising of the central access ramp. The rate of raise of the TSF gradually decreases, reducing to less than 1 m per year in the final stages of the design life. This slow rate of raise also allows for drying and densification of the tailing surface which is important for tailings to achieve a high density. Given that the tailings do not contain contaminants, the TSF will not be lined.

The perimeter embankment will be constructed in stages to nominal height of 2 m. It is expected that due to minor slope change across the site, the height of the embankment will vary between 1 m and 4 m across the site. The final shape, size and capacity of the facility will depend on the beach slope. The 2 m high perimeter embankment is sufficient for a beach angle of 3% and this will be confirmed during the initial years of tailings deposition after the beach slope is well understood. The perimeter embankment will be constructed using selected material from the mine pre-strip or from materials borrowed from within the storage facility.

Implementation of a drainage system is important to maximise functionality for the TSF and to maximise water recovery from the tailings. The drainage system will comprise drains placed at radii of 600 m, 850 m and 1100 m from the central discharge area. These drains will collect water from the entire area and flow to the central main collector drain connected to the recovery water pond. The drains will be constructed using free draining rockfill materials.

A seepage recovery trench will be constructed along the upstream toe of the perimeter embankment to recover seepage that would otherwise pass under the embankment.

To control surface runoff and avoid erosion of the perimeter embankment, surface runoff collector drains will be constructed along the downstream toe of the perimeter embankment. These drains will collect clean surface runoff and direct the flow away from the TSF.

Excess water from the deposited tailings will be collected in a recovery water pond located at the north-east part of the TSF. Shortly after discharge, the tailings will settle and release excess water. The expected initial settlement of the 65% solid content of the slurry to a 75% solid content at the beach, will result in the release of about 70 m^3 of water per hour). This water, together with rainfall collected within the TSF, will flow to a lined 20,000 m^3 recovery water pond and returned to the process water dam for use in the process plant.

The emergency spillway will be constructed at the lowest part of the perimeter area. The emergency spillway will discharge into Bloodwood Creek. No infrastructure will be constructed within in the flood plain of this creek. The spillway will be around 14 m wide to safely convey the 100 year storm event.

To monitor behaviour of the TSF and its influence on the environment, a seepage monitoring system will be installed. The proposed monitoring system comprises 14 monitoring bores designed primary to monitor groundwater level and allow for sampling to carry out water quality checks.

Drainage

There will be no uncontrolled discharges of untreated process water from the Mount Peake Project Area.

2.7 Closure and rehabilitation

A Conceptual Mine Closure Plan has been prepared.

A number of mine landforms will remain at the site after closure, essentially in perpetuity. These are:

- the open pit void;
- the WRD and ROM pad; and
- the TSF.

All other landforms and infrastructure is proposed to be removed.

3. Mine site water balance

3.1 Water balance approach

A preliminary water balance was developed to determine the capacities of the various infrastructure components comprising the water supply system. Further, the preliminary water balance informed the sizing of the proposed borefield for assessment with the groundwater model.

The water balance was developed for the two proposed operation stages, namely:

- Stage 1: Processing capacity of 3 Mtpa of dry ore feed (years 1-4); and
- Stage 2: Processing capacity to 6 Mtpa of dry ore feed (years 5-15).

The water balances for the respective operation stages are provided in Appendix A and descriptions of the key water balance components are provided in the following sections.

3.1.1 Processing plant

The two main water outflows from the Processing Plant are associated with the concentrate and tailings. An allowance has also been made for losses within the plant and a contingency for the makeup requirements. An inflow of treated water has been allowed for the pump glands and the balance, after allowing for water entrained in the ore, is made up with process water from the Process Water Dam.

3.1.2 Tailings storage facility

Water associated with the underflow from the tailings thickener will be disposed to the TSF. Outflows from the TSF comprise water recovered to the process water dam, assuming a recovery rate of 30%, and losses due to seepage and evaporation, which is the balancing item.

3.1.3 Process water dam

The Process Water Dam primarily functions to supply makeup water to the Processing Plant and to receive water recovered from the TSF and brine effluent from the Water Treatment Plant. The only other outflow from the dam is evaporation which is based on an assumed square water surface area of 45 m by 45 m. Inflows to the dam are water recovered from the TSF and the balancing item of makeup water from the Raw Water Dam.

3.1.4 Raw water dam

Outflows from the Raw Water Dam are the makeup water supplied to the Process Water Dam, water supply to the Water Treatment Plant, water abstracted for dust suppression purposes and evaporation losses. The balancing item is the raw water inflow supplied from the borefield.

3.1.5 Water balance summary

In summary, the raw water requirements for the two proposed operation stages have been estimated as follows:

- Stage 1: 178 m^3/h; and
- Stage 2: 300 m^3/h.

This demand will need to be supplied from the proposed borefield. It should be noted that the water balance does not include water required during construction.

3.2 Water supply system

A conceptual design of the water supply system was developed based on the preliminary water balance (GHD 2015). The conceptual plan of the water supply system is outlined in Figure 3-1.

The key components of the water supply system included in this conceptual design are:

- Borefield;
- Raw water transfer pipeline from the borefield to the Raw Water Dam;
- Raw Water Dam;
- Process Water Dam;
- Water Treatment Plant (WTP);
- Potable water tanks at the Processing Plant and accommodation village; and
- Potable water supply pipeline from the WTP to the accommodation village.

The conceptual designs of each system component are developed in the following sections.

3.2.1 Borefield

Based on the results of the groundwater drilling program (Section 6.7.2), it was determined that the Hanson River palaeovalley aquifer system would be suitable for the Project water supply. The borefield is to be located along the western bank of the Hanson River (Figure 3-1) and will eventually include up to 12 production bores in order to meet the demand and offer additional standby bores. The borefield will be developed in two stages as summarised Table 3-1.

Table 3-1 Summary of proposed borefield

Item	Stage 1	Stage 2	Comment
Overall water demand	1.6 GL per annum (51 L per second)	2.6 GL per annum (82 L per second)	Total water demand based on water balance.
Minimum number of active production bores required	6	10	Two bores from Stage 2 to augment supply during any reduction in supply from Stage 1 bores (maintenance/failure)
Proposed standby bores	2	2	
Proposed spacing of bores	1800 m		Aligned on track parallel to river channel.
Proposed continuous pumping rate	8.5 L/s		Based on limited pumping and modelling data.

In addition to the production bores, development of an appropriate groundwater monitoring network is an integral part of borefield development. An effective monitoring network ensures that the aquifer performance can be measured and adapted where necessary. This is essential to safeguard the water supply for the life of the mine whilst ensuring that impacts are minimised.

The monitoring network will need to be consistent with the borefield design, therefore at this stage is presented as conceptual only. The network will include monitoring wells located at the indicative locations summarised in Table 3-2. In total, a monitoring network of 20 monitoring wells is recommended.

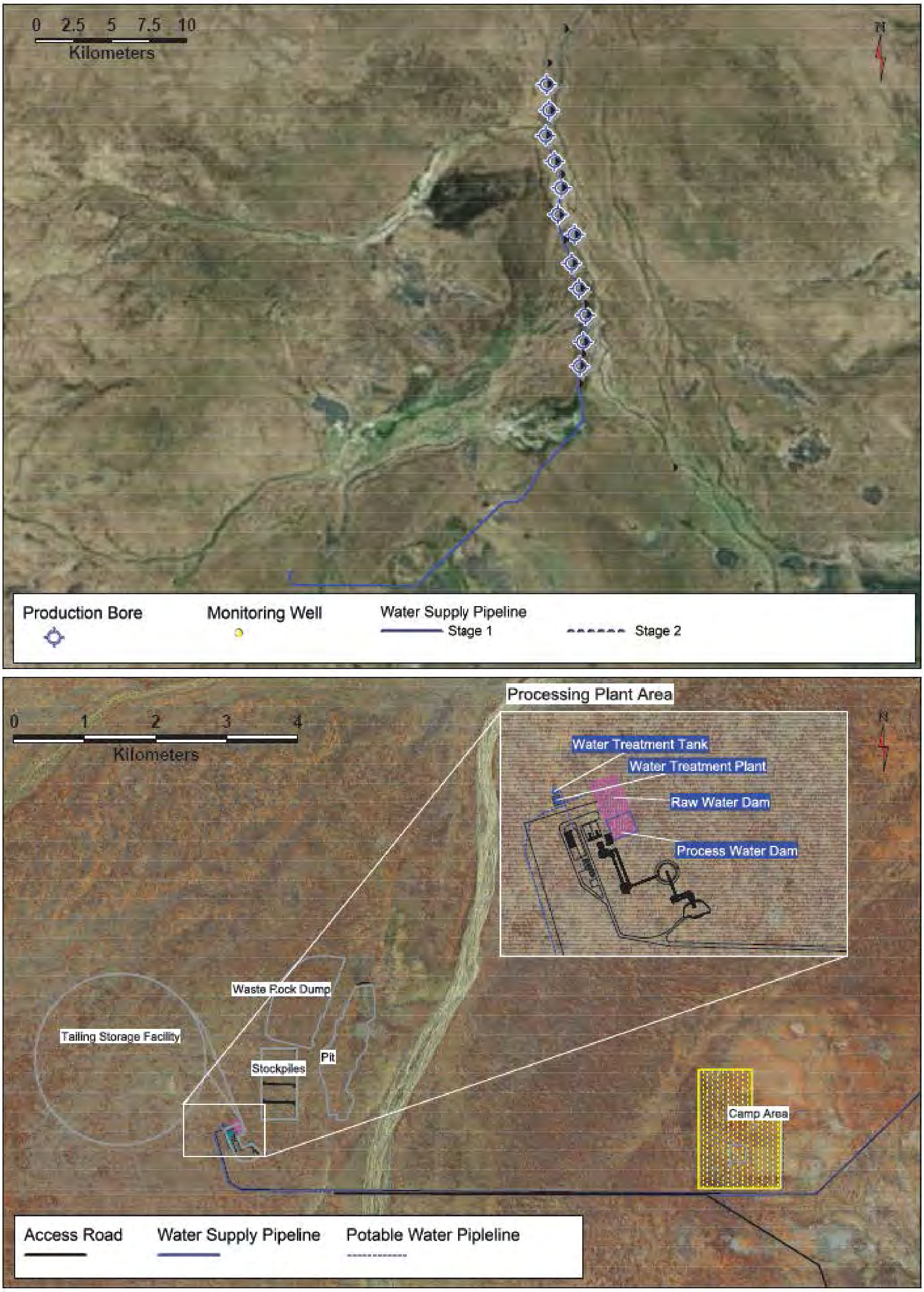

Figure 3-1 Water supply system conceptual plan

Table 3-2 Summary of proposed monitoring network

Location	Number of monitoring wells	Comment
Next to production bores	Stage 1: 8 Stage 2: +4	A monitoring well will be located at each production bore. These will be the investigation holes for each site (production bores then constructed where investigation drilling is favourable). The monitoring well will be used to determine aquifer properties from the pump testing and ongoing performance of the aquifer immediately adjacent to the production bore site. One monitoring well has already been established at production bore WB05 (monitoring well WB01).
Between select production bores	Stage 1: 3 Stage 2: +1	Locating monitoring wells between the production bores will determine the aquifer response to pumping and the cumulative impacts from bores.
At northern and southern extent of borefield	Stage 1: 1 Stage 2: +1	Monitoring bores to the north and south of the borefield will assist in determining the impacts up and down gradient of the borefield. This is important as it will show impacts on station wells located close the borefield (for example Browns Bore), and to monitoring for potential saline ingress to the borefield from the known high salinity area in the south.
Regional locations	Stage 1: 2 Stage 2: +0	The use of existing bores in regional locations outside the modelled extent of drawdown will be used as control bores. These bores are already in place (WB02 & WB03).

3.2.2 Raw water pipeline

An assessment of the raw water transfer pipeline from the borefield to the Raw Water Dam was undertaken considering the water requirements for both Stages of development. The length of the pipeline for both stages was estimated based on the proposed locations of the bores and Raw Water Dam as well as the proposed alignment. The estimated pipeline length is:

- Stage 1: 40.8 km; and
- Stage 2: 48.8 km (8 km extension to Stage 1).

3.2.3 Raw Water Dam

The preliminary sizing of the Raw Water Dam has been based on the requirements for both emergency storage and for buffering of the daily consumptive fluctuations. The Raw Water Dam would need to store a total of 12.3 ML and 20.7 ML for Stages 1 and 2 respectively.

Given the need for staging, consideration could be given to constructing two storage cells, one of 12.3 ML and the other of 8.4 ML. Each cell would utilise a common embankment wall to reduce costs. Typical dimensions of square turkeys nest dams comprising excavated centres enclosed within an embankment wall are provided in Table 3-3.

Table 3-3 Indicative raw water dam dimensions

Dimension	Stage 1	Stage 2
Volume water (ML)	12.3	8.4
Length of inside base of pond (m)	34	25
Length of top of pond embankment (m)	70	67
Length of pond embankment at ground level (m)	91	82

3.2.4 Process Water Dam

The Process Water Dam has also been sized based on the requirements for emergency storage and for buffering of the daily consumptive fluctuations. The storage requirements based on the water balance indicate that the Process Water Dam would need to store a total of 3.6 ML and 7.2 ML for Stages 1 and 2 respectively.

Given the need for staging, consideration could be given to constructing two cells of 3.6 ML each utilising a common embankment. Typical dimensions of square turkeys nest dams comprising excavated centres enclosed with embankment walls are provided in Table 3-4.

Table 3-4 Indicative Process Water Dam Dimensions

Dimension	Stage 1 and 2
Volume water (ML)	3.6
Length of inside base of pond (m)	11
Length of top of pond embankment (m)	47
Length of pond embankment at ground level (m)	68

3.2.5 Water Treatment Plant (WTP)

Water treatment is required for the Project in order to provide water that is suitable for human consumption, amenity irrigation and the slurry pump glands. Water from the Raw Water Dam will be treated to bring it up to potable water standard. Assuming a plant availability of approximately 90%, the required plant capacities will be:

- Stage 1: 370 m^3/d; and
- Stage 2: 650 m^3/d.

Limited raw water quality information is available with current water quality data obtained during test drilling undertaken at the proposed borefield in March 2015 (Section 6.7.2). The borefield design indicates that most of the bores will be located in the vicinity of bore WB05 for Stage 1, but will expand northwards towards bore WB02 for Stage 2. To this end, the average water quality observed between these two bores has been adopted for preliminary design purposes. According to the Australian Drinking Water Guidelines (2011), these data are suggesting that the bore contains elevated levels of turbidity, iron, manganese and ammonia. It should be noted that some of these results may be due to insufficient bore development and concentrations could improve over time with continued pumping.

For the purpose of this study it has been assumed that the water must be treated to gain compliance with the Australian Drinking Water Guidelines (2011). Assuming that the production bores are of a good design with suitably protected well heads to prevent influence from the surface, the following treatment objectives will need to be met:

- Disinfection; and
- Desalination for salinity reduction and hardness management.

In order to minimise fouling of the desalination process and to provide a multiple barrier approach as required by the ADWG, filtration of the raw water is also expected.

Based on the above water treatment objectives, the water treatment process will comprise:

- Filtration using multi-media filters (MMF);
- Desalination using brackish water reverse osmosis (BWRO); and
- Disinfection using sodium hypochlorite or similar.

The expected treatment process is summarised in Figure 3-2.

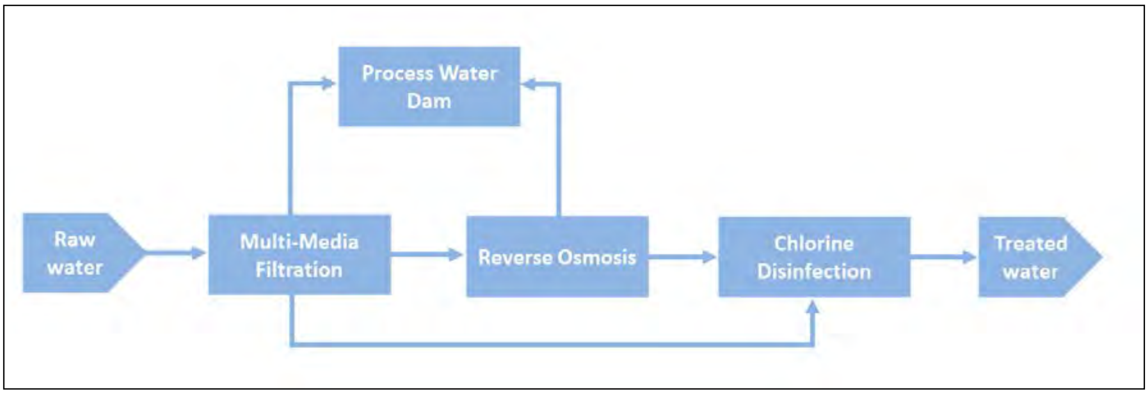

Figure 3-2 Water treatment process block diagram

A portion (about 2 – 5%) of the filtered water will be required to bypass the desalination process and be blended downstream to achieve the final treated water Total Dissolved Solids (TDS) of around 500 mg/L.

The filtration system is expected to have a recovery (ratio of treated water to raw water) of about 95% depending on the concentration of suspended solids in the raw water. Depending on the concentration of sparingly soluble salts in the raw water, the desalination process is expected to have a recovery of around 70%.

There is no chloride limit for the water entering the Processing Plant. To this end, the waste water streams from the MMF and BWRO will be discharged to the Process Water Dam for reuse in the Processing Plant.

3.2.6 Potable Water Tanks

Potable water tanks are proposed at both the processing plant and the Accommodation Village. Both tanks have been sized to provide emergency storage capacity and to buffer the daily consumptive fluctuations, the requirements of which are based on the nature of the water use. The capacities of the Potable Water Tank at the Processing Plant would need to be 0.5 ML and 1.0 ML for Stages 1 and 2 respectively. Given the need for staging, consideration could be given to providing a 0.5 ML tank with each stage.

The capacities of the Potable Water Tank at the Accommodation Camp would need to be 0.25 ML and 0.3 ML for Stages 1 and 2 respectively. There seems to be little benefit in staging this infrastructure and consideration could be given to providing the full Stage 2 storage of 0.3 ML at Stage 1.

3.2.7 Potable Water Pipeline

The water demands of the accommodation camp are similar for Stages 1 and 2. To this end, the assessment of the potable water supply pipeline from the WTP to the Accommodation Village was undertaken considering the water requirements for Stage 2 only. The length of the pipeline was estimated to be 10 km based on the proposed locations of the WTP and the Potable Water Tank at the Accommodation Camp.

4. Surface water resources setting

4.1 Climate

The Project site is at the southern extent of the Australian monsoon belt and in the centre of the Australian continent. The climate is arid to semi-arid with an annual rainfall of approximately 320 mm recorded at the Bureau of Meteorlogy (BoM) Station 15525 at Barrow Creek (BoM, 2013), which is located approximately 50 km east of the Project site. Annual rainfall is highly variable, with records at Barrow Creek ranging from 70 mm in 1963 to 1,150 mm in 2010.

Rainfall is highly seasonal with the majority of rainfall occuring as thunderstorms between November and March. Monthly rainfall statistics at this station are depicted in Figure 4-1.

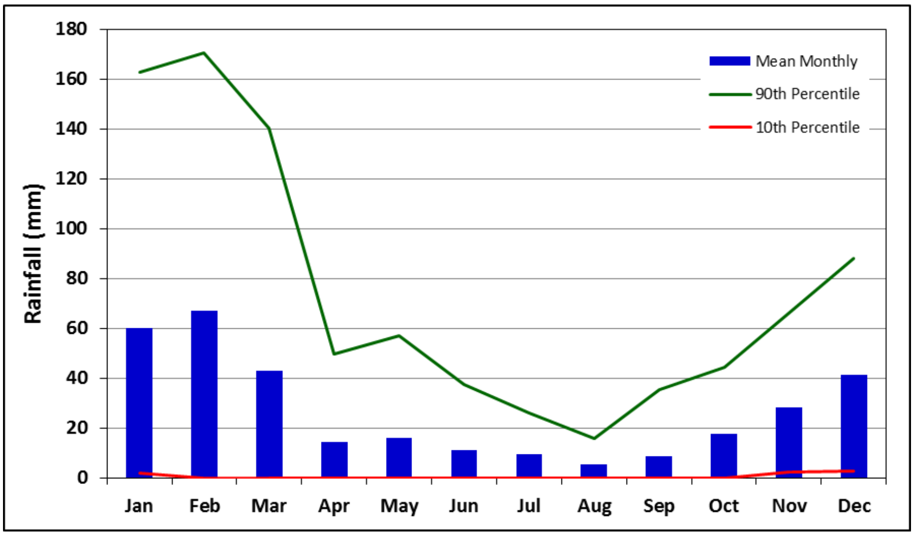

Figure 4-1 Monthly rainfall statistics at Station 15525 (Barrow Creek)

Monthly temperature statistics at Barrow Creek are depicted in Figure 4-2. The mean monthly maximum temperature ranges from about 22°C in July to 37°C in January and the mean monthly minimum temperature ranges from 8°C in July to 24°C in January (BoM, 2013).

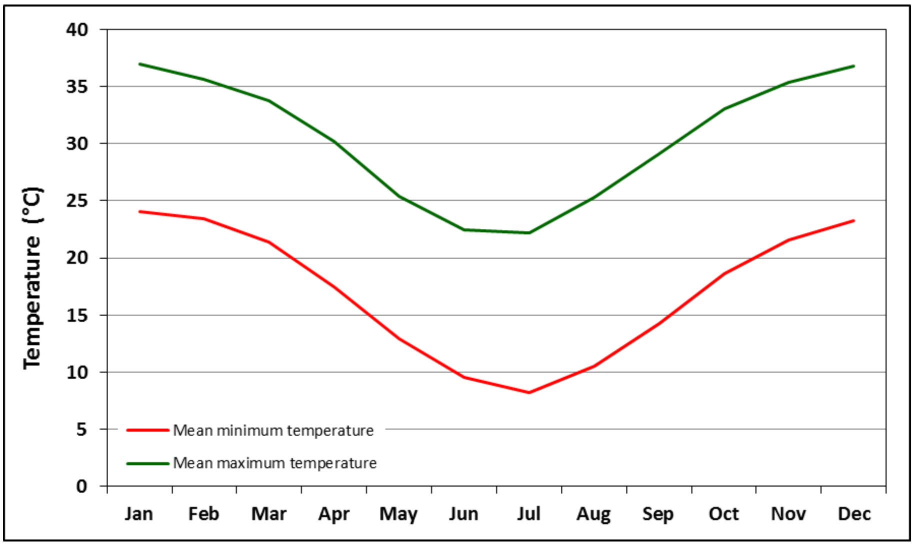

Figure 4-2 Monthly temperature statistics at Station 15525 (Barrow Creek)

Average annual evaporation for Barrow Creek totals approximately 2,980 mm with average monthly evaporation exceeding rainfall in all months.

4.2 Landform

The Project is located in the Wiso Basin (Figure 4-4) and overlies the Arunta Province in the Burt Plain Bioregion. Regional surface drainage flows north and floods out into the sandy plain of the Tanami Desert. The Bioregion covers an area of some 73,600 km^2 with elevation ranging from 300 to 1,252 metres above sea level. The Bioregion is dominated by undulating stepped plains, consisting generally of red soils, with earthy sands and red siliceous sands also occuring extensively across the plain (Neave *et al*. 2006).

Mapping of surface geology by the Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (2009a and b) identifies predominantly alluvial floodplains in the vicinity of the Project area (Table 4-1).

Table 4-1 Surface geology across the Project area

Location	Water Course/Feature	Surface Geology
Headwaters of water courses upstream of the proposed mine site	Anningie Creek Murray Creek Bloodwood Creek	Granite plains and rises
Incremental catchments of watercourses downstream of the proposed mine site	Mud Hut Swamp	Alluvial plain Desert sandplain Granite plains and rises Sandstone hills
	Murray Creek Hanson River	Alluvial plain Desert sandplain
Watercourses intersecting and/or downstream of the proposed access road	Stirling Swamp	Salt pans
	Hanson River	Alluvial floodplain Desert sandplain

At a regional scale, the Project area is located within outliers of the Neoproterozoic sediments of the Georgina Basin. The rocks of the Project area appear to be unmetamorphised and are emplaced in unmetamorphised shallow water sediments (siltstones, sandstone and quartzites). The age of the target mineralised Mount Peake gabbro body is likely to be 520 milion years based on the stratigraphy of the bedrock and surrounding rocks in the vicinity of the body.

The site visit completed in January 2013 identified evidence of erosion as a result of livestock traffic and the construction of a pipeline for stock watering in the vicinity of Mud Hut Swamp. The potential presence of dispersive soils in the Project area was also noted. Erosion has the potential to be a considerable issue at the site if dispersive clays are present at the Project area.

4.3 Vegetation

The Burt Plain Bioregion is broadly characterised by plains of acacia shrubland, tussock grassland, hummock grassland, acacia and eucalypt woodlands, and mountain ranges in the east, north and west of the bioregion (Neave *et al*. 2006). Vegetation cover in the vicinity of the Project correlates with the landforms across the region with *Eucalyptus camaldulenses* (River Red Gum) found along drainage channels and *Acacia aneura (*Mulga) dominating shrublands within the alluvial plains. Regional mapping of the Burt Plain by the Department of Natural Resources, Environment and the Arts (NRETA) (2004), shown in Figure 4-3, identifies the vegetation units described in Table 4-2 in the Project area.

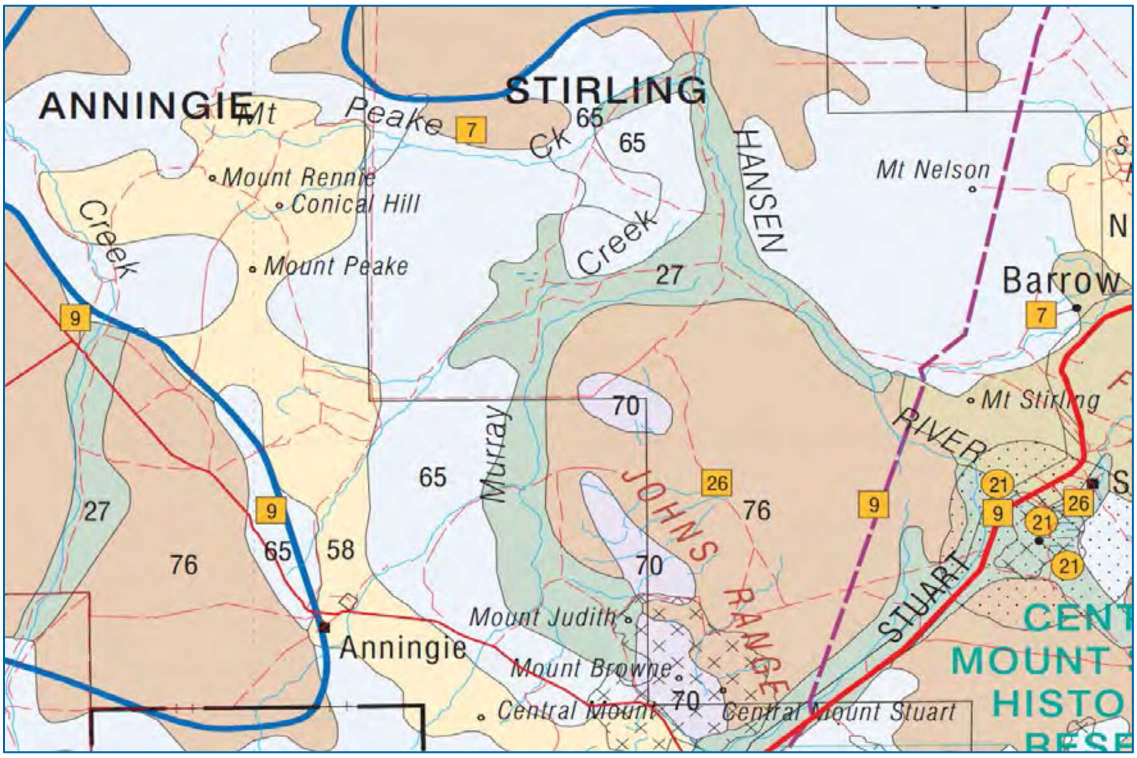

Figure 4-3 Vegetation unit mapping (NRETA 2004)

Table 4-2 Vegetation units across the Project area (NRETA 2004)

Vegetation Unit	Type	Description	Occurrence in Project area
Unit 27	Low open woodlands	*Eucalyptus microtheca* (Coolibah) low open-woodland with open-grassland understorey	Riparian areas of Murray Creek, Bloodwood Creek and the Hanson River
Unit 65	Tall open shrubland	*Acacia aneura* (Mulga) tall open-shrubland with *Eragrostis eriopoda* (woolybutt) open-grassland understorey	Floodplains/sandplains of the Murray Creek and Hanson River downstream of the proposed mine site
Unit 70	Sparse shrublands	*Acacia anuera (*Mulga) tall sparse shrubland with *Cassia spp, Eremophila spp* (Fuschia) low sparse-shrubland understorey	Isolated pocket east of Murray Creek in vicinity of transport corridor
Unit 76	Tall shrublands	*Triodia pungens* (Soft Spinifex), *Plectrachne schinzii* (Curly Spinifex) hummock grassland with Acacia tall sparse-shrubland overstorey.	Floodplain/sandplain between Murray Creek and Hanson River, and east of Stuart Highway to rail siding

4.4 Drainage

The Project site is located within the Wiso Surface Water Management Basin (Figure 4-4), which comprises numerous ephemeral dendritic drainage systems across the region. Watercourses generally flow north, with a number of smaller watercourses originating out of rocky outcrops into the surrounding plains. Key water courses in the vicinity of the Project site include the Murray and Bloodwood Creeks. These are tributaries of the Hanson River, the main watercourse draining the western part of the Ti-Tree Basin.

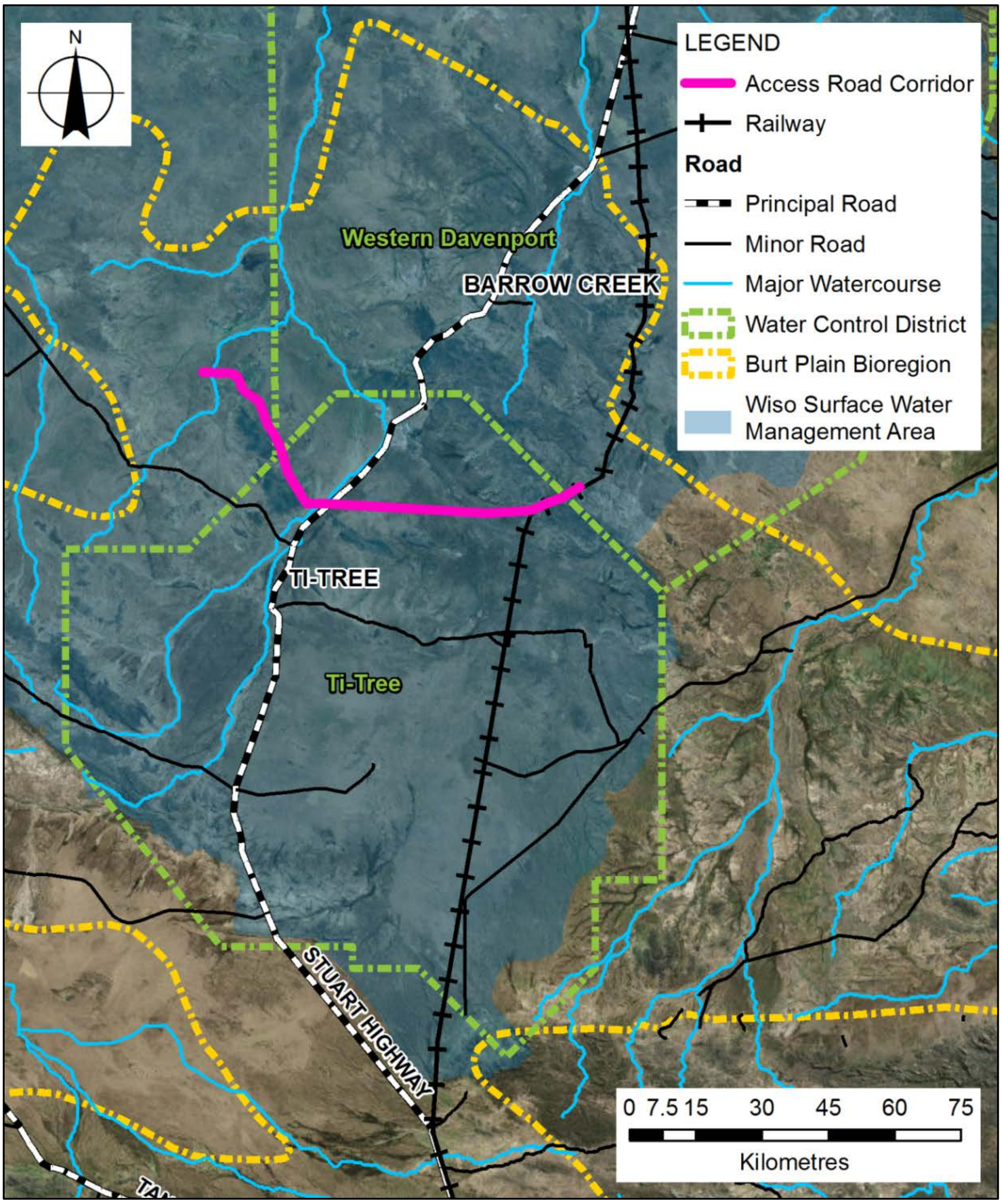

Figure 4-4 Water Management Area and Control Districts

The alluvial floodplains that separate the channels are referred to as floodouts, a term which has broad application and includes places where a drainage channel becomes subdivided, indistinct or disappears completely and water from the channel is dispersed across a plain or between dunes (Duguid *et al.* 2005). Several of the water courses are considered to be joined, with shared floodouts in large flood events.

A number of minor watercourses emanate from the Djilbari Hills in the vicinity of Mistake and Gingers Bores, flowing northwards before terminating a short distance later in the sandplain. Runoff is ephemeral and likely to be rapid in the foothills but slowing substantially on the plain.

Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River and Wood Duck Swamp, 10 km south of the access road and outside of the Study area, are listed as Sites of Conservation Sigificance (NRETAS 2009a, b, c). The channel of the Hanson River becomes ill defined, or braided, in the vicinity of Stirling Swamp, before becoming more defined again downstream.

The Hanson River rises in the Reynolds Range (also referred to as the Anmatijira Range) to the south west of the Project site, and flows north flooding out into the Tanami Desert, west of Tennant Creek. This floodout area is considered an important source for groundwater recharges (Duguid *et al.* 2005).

Flows in the Woodforde River, which runs east of the Hanson River upstream of Ti-Tree, have been monitored continuously since 1975 (gauging station G0280010). However, these records are not considered reliable since only a few events have been recorded (Department of Infrastructure, Planning and Environment 2002). The Australian Natural Resources Atlas (ANRA) indicates that the Hanson River flows once in every 12 years on average (ANRA 2013). The Department of Infrastructure, Planning and Environment (2002) found that regional rivers located in the Ti Tree Groundwater Basin are only likely to flow when monthly rainfall exceeds 100 mm, with this threshold being achieved approximately once every two years on average.

Surface water use in the Wiso Basin is used primarily for stock watering and domestic supply to rural communities, but is not licenced (ANRA 2013).

4.5 Geomorpolgy

Drainage from the Reynolds Range tends to transition from annular water courses generally controlled by geology, to highly distributed channels associated with the formation of an extensive alluvial fan known as Burt Plain. Significant groundwater recharge is likely in the vicinity of this fan. The highest peaks in the Reynolds Range reach over 1000 m above sea level (e.g. Mt Freeling at 1005 m; Mt Thomas at 1116 m) whereas the adjacent lowlands are at about 650 m above sea level (Goulevitch 2005).

Water courses in the vicinity of the Project site are typically sandy and highly braided along reaches. These drainage channels rise in upland areas where surface runoff feeds into clearly defined channels. Duguid *et al.* (2005) noted that many of the watercourses in the area are characterised by discontinuous channels which diminish, or disappear, before reforming downstream.

Surface water flow within the Project area is likely to spread laterally from channels across the extensive floodplain environment as low energy sheetflow. Sediment transport is most likely dependent on the magnitude of the event, with larger events responsible for sediment transport and channel formation.

Active processes observed in the Project area included bank erosion and sediment transport in the alluvial creek beds. Disturbed sites are also likely to result in soil erosion and sediment transport. Localised erosion with the potential to alter surface water flow pathways were observed in the vicinity of Mud Hut Swamp.

4.6 Surface water - groundwater interactions

Given the alluvial nature of the Burt Plain, the presence of ephemeral surface water drainage systems with floodout zones and palaeodrainage channels, there is potential for significant surface water - groundwater interactions within the vicinity of the creeks and rivers.

The Hanson River is considered to contribute significant recharge to the Ti Tree Basin aquifer when floodouts are activated (Knapton 2006).

Furthemore anecdotal information aquired from sites in the headwaters of the Woodforde River indicates that there is surface water - groundwater interaction within the alluvial formations associated with the drainage networks in the region (G. Ride, pers. comm. 2011). As such, this interaction may form the main recharge mechanism for local aquifer systems within the region.

The Hanson River flows across the western and northern zones of the Ti Tree Water Control District Boundary. A regional water balance for the study area identifies a contribution of 760 ML from Hanson River flood recharge to the Ti Tree Basin (Department of Infrastructure, Planning and Environment 2002).

Groundwater flows in the Ti Tree Basin are from east to west and south to north, with the water table becoming shallower in the northern extent (Knapton 2007). Stirling Swamp is identified as a natural discharge zone for the basin. Knapton (2007) indicates that groundwater dependent ecosystems occur within the basin with vegetation able to access water in areas where the water table occurs within 10 m of the ground surface.

The proposed access road will traverse the Ti Tree Water Control District Boundary in the vicinity of the Hanson River floodout.

4.7 Sites of Conservation Significance

4.7.1 Mud Hut Swamp

Mud Hut Swamp has been identified by NRETAS (now the Environmental Protection Authority) as a Site of Conservation Significance and is listed in the "*Inventory of sites of international and national significance for biodivserity values in the Northern Territory".* Figure 4-5 depicts the various landforms in the vicinity of Mud Hut Swamp.

Mud Hut Swamp is a large, isolated, gum-barked coolabah (*Eucalyptus vitrix*) swamp that is fed by Bloodwood and Murray Creeks in the south-east and runoff from low hills and rises to the north and west (NRETAS 2009a). This is the largest swamp in the Burt Plains bioregion and remains inundated for a relatively long time after flooding, possibly retaining water for several months following inundation (NRETAS 2009a). The swamp is likely to support a range of wetland birds, fish and plants.

Any interruption or alteration of surface water drainage in the vicinity of the Project area has the potential to adversely affect the downstream ecosystem, including Mud Hut Swamp.

4.7.2 Anmatyerr North (including Stirling Swamp)

The Anmatyerr North site is located across Stirling, Anningie and Ahakeye Stations (Figure 4-6). This site includes Stirling Swamp, a large wetland complex comprised of claypans, lignum swamp, semi-saline samphire and temporary open water, and the adjacent Hanson River (NRETAS 2009b). The Site extends to low rocky ranges about 20 km south of Stirling Swamp to encompass the known extent of the threatended giant sweet potato (*Ipomoea polpha* subsp. *latzii*).

Stirling Swamp is noted to form occasionally at the northern edge of the Ti Tree Basin, storing flood waters discharged from the Hanson River and the ridges to the east of Wilora. This area is believed to act as an evaporation area for the basin (NRETAS 2009b).

4.7.3 Wood Duck Swamp

Wood Duck Swamp is an ephemeral swamp that may hold water for many months in an otherwise dry landscape. It fills periodically after heavy rain. Wood Duck Swamp is dominated by smooth-barked coolabah *Eucalyptus victrix*. It is one of the largest such swamps in the Burt Plains bioregion (NRETAS 2009c). Wood Duck Swamp is entirely pastoral leasehold land within one pastoral lease (Mount Skinner). The main land use within the site and broader catchment is cattle grazing on native pastures.

Wood Duck Swamp is located approximately 10 km south of the access road, outside of the Study Area.

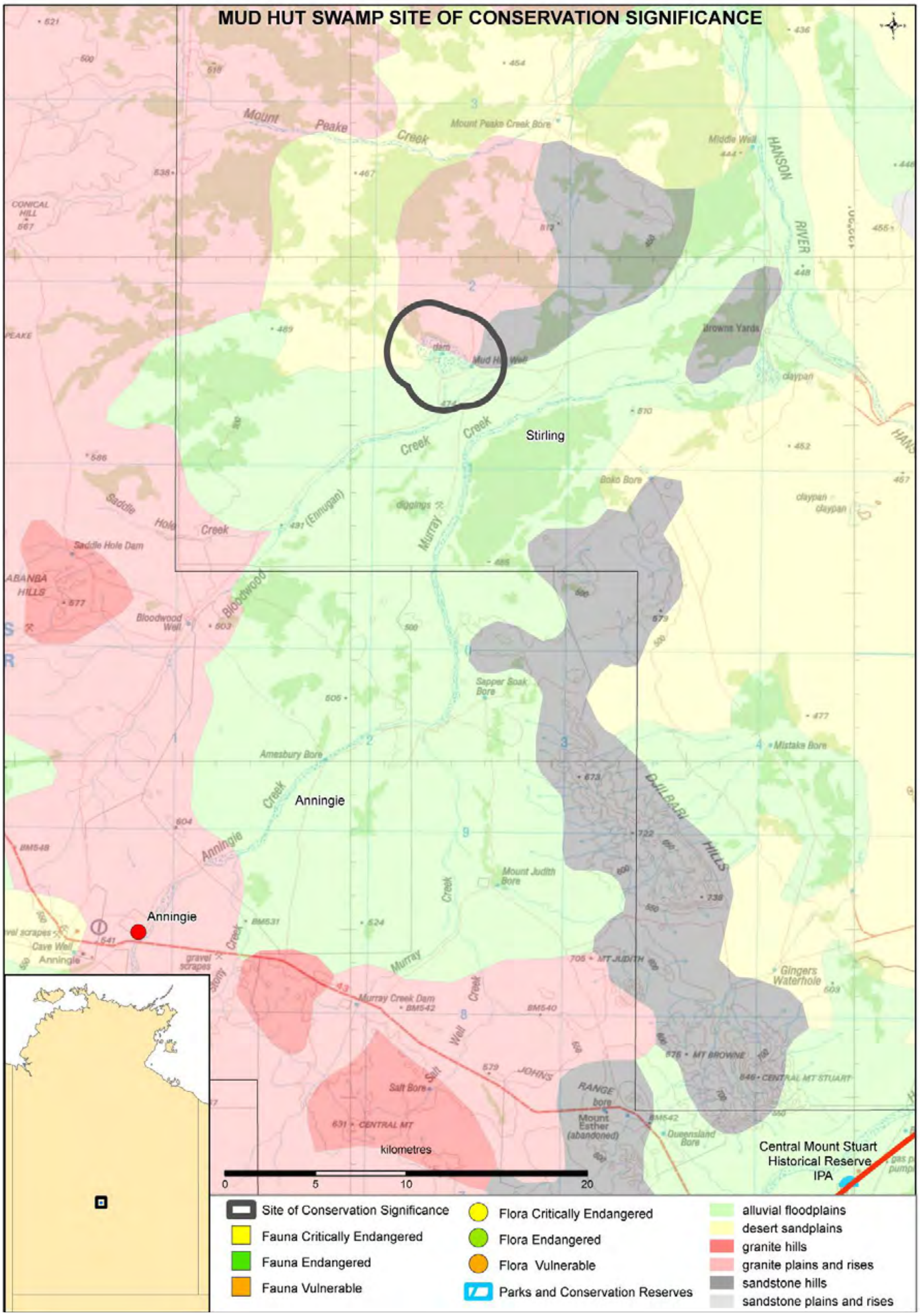

Figure 4-5 Landforms in vicinity of Mud Hut Swamp (NRETAS 2009a)

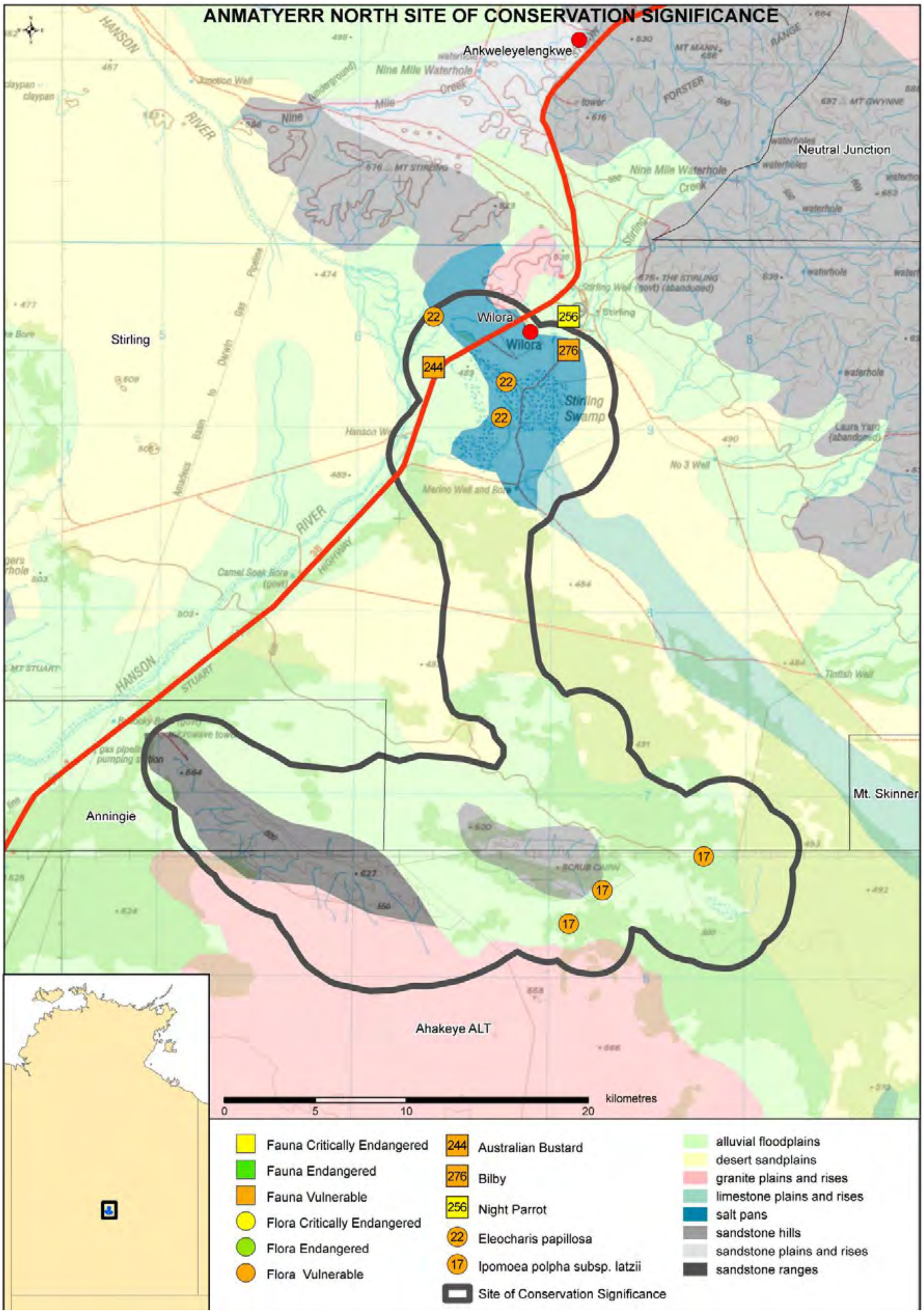

Figure 4-6 Land forms in vicinity of Anmatyerr North (NRETAS 2009b)

5. Site hydrological assessment

5.1 Approach

The hydrological assessment comprised four main activities:

- Determination of the baseline hydrology of the Hanson River and the Murray and Wood Duck Creeks to understand the hydrological regimes of these systems;
- An assessment of the frequency and duration of flooding of the proposed access road floodways to be constructed across the above-mentioned waterways;
- An evaluation of potential risks associated with the Murray Creek inundating the mine site; and
- An investigation into potential sheetflow shadows resulting from the construction of the access road.

The locations of these road crossings are depicted in Figure 5-1.

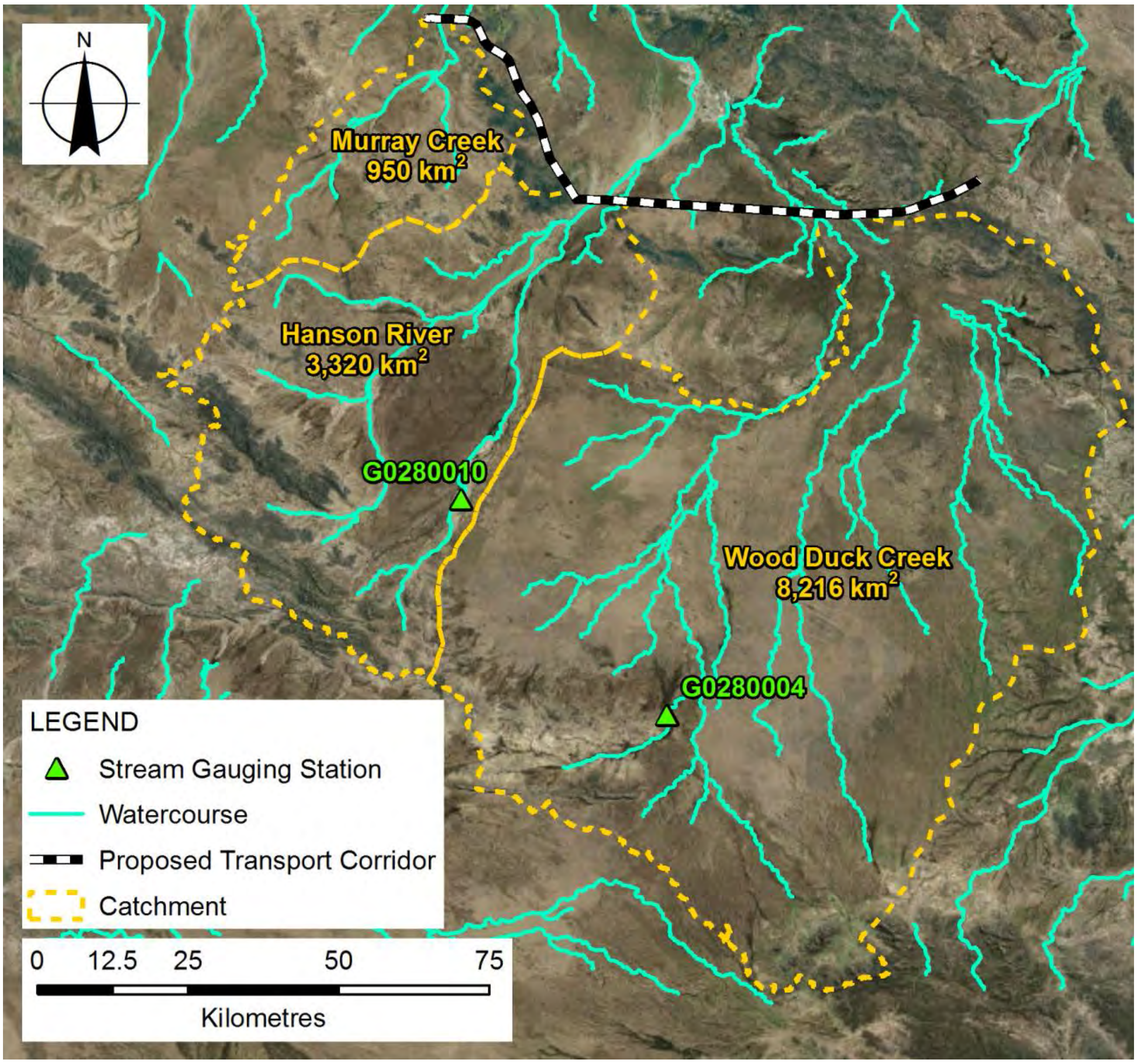

Figure 5-1 Location of road crossings and catchment extents

5.2 Catchment topography and channel geometry

Available elevation data for the study area comprises:

- 1-second Shuttle Radar Topography Mission (SRTM) derived Digital Elevation Model Version 1.0 from Geoscience Australia (2011); and
- 1 m contours of the proposed transport corridor from Geoimage (2015).

The SRTM data are captured at a 30 m grid using satellite based remote sensing techniques and has a vertical accuracy ±9 m. Given this resolution, it is not possible to define the cross sectional details of channel geometry for hydraulic modelling purposes.

The extent of the Geoimage (2015) contours is limited to the mine site and access road corridor only, so the SRTM data had to be applied to provide an indication of the gradient of the waterways downstream of the crossings. These gradients are required to provide an estimate of the depth of flow and an indication of the potential of downstream back water effects. The resulting gradients of Murray Creek, Hanson River and Wood Duck Creek are provided in Figure 5-2, Figure 5-3 and Figure 5-4 respectively.

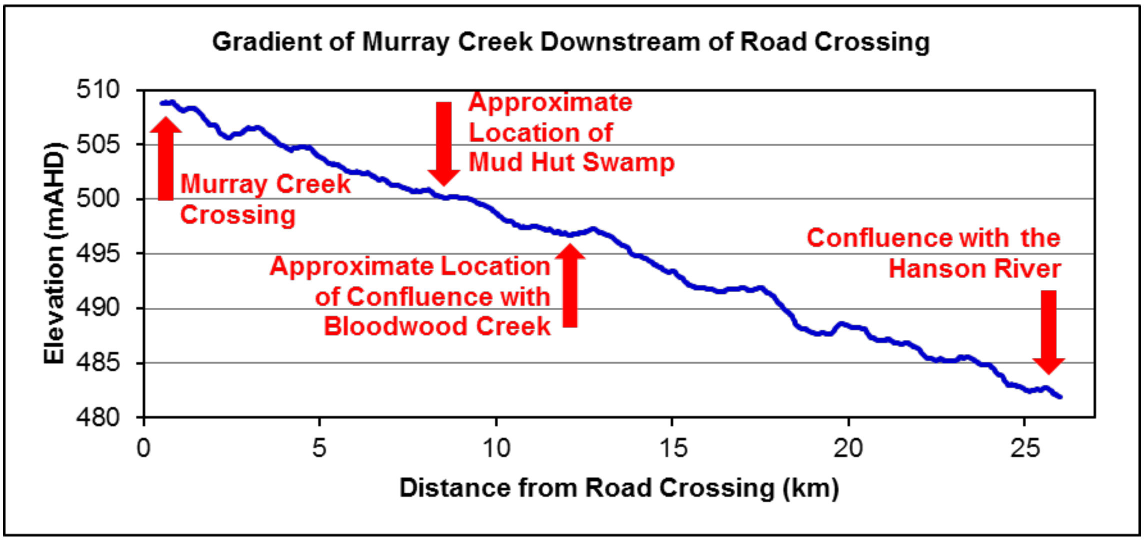

Figure 5-2 Gradient of Murray Creek

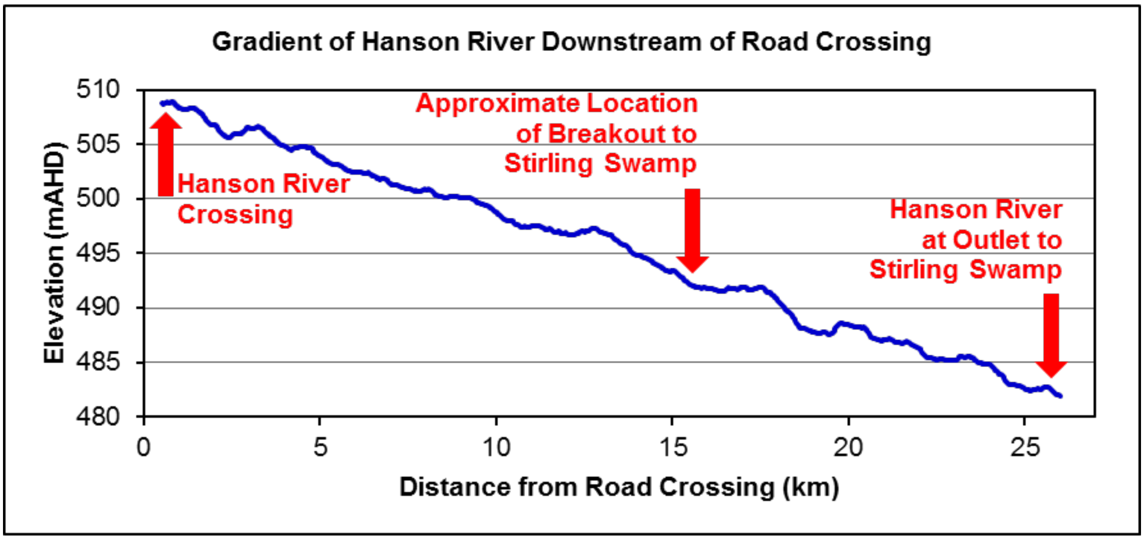

Figure 5-3 Gradient of Hanson River

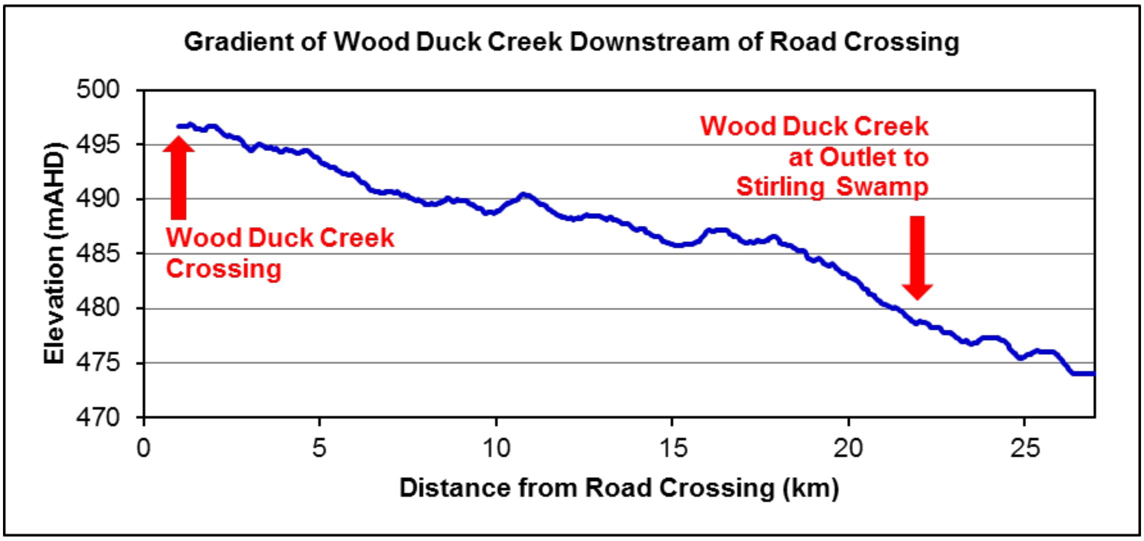

Figure 5-4 Gradient of Wood Duck Creek

It is noted from these gradients that, although channel flow velocities may be low, there seems to be sufficient elevation difference to prevent backwater effects at the road crossings.

The SRTM data set is also sufficient for catchment delineation, the extents of which are shown in Figure 5-1 and the areas summarised in Table 5-1.

Table 5-1 Estimated catchment areas

Catchment	Catchment area (km^2)
Murray Creek	950
Hanson River	3,320
Wood Duck Creek	8,216

The Geoimage (2015) contours were generated from a Digital Surface Model which included terrain features such as vegetation, thereby introducing a vertical accuracy error. Hydraulic modelling requires a reasonable representation of ground elevation to predict water levels and flooding extents. Given that this is the only data set available that provides any definition of the geometry of the main waterways, cross sections of the channel geometries were extracted for hydraulic modelling.

5.3 Flood peak estimation

5.3.1 Approach

The assessment of access road floodway hydraulics and mine site flood risk entailed the estimation of runoff flows generated from the associated upstream catchments. The *Australian Rainfall and Runoff* (ARR) is a national guideline on the procedures for estimating design flood characteristics in Australia (Institution of Engineers, Australia 1987). The ARR is concerned primarily with the hydrological aspects of flood estimation, including the derivation of design rainfall events, selection of flood estimation methods and design standards, as well as the estimation of design peak discharges and flood hydrographs. However, guidelines for the arid interior region of Northern Territory were noted to be very limited.

Given the limitations of the elevation datasets, a relatively simple Rational Method hydraulic modelling approach was adopted. It is noted that runoff from the catchments of the proposed access road floodways and Murray Creek adjacent to the mine site is not measured.

Accordingly, the characteristics of rainfall-runoff response from these target ungauged catchments had to be estimated from similar gauged catchments.

This approach involved a flood frequency analysis of the records from a number of streamflow gauging stations in the arid interior of the Northern Territory. The analysis results were then used to ascertain the catchment parameters required for flood peak estimation using the Rational Method at these gauged sites.

An assessment of the catchment characteristics of both the gauged and target catchments was undertaken to determine appropriate parameters for use at the target catchments. Estimates of peak discharges and durations were then determined for the target catchments. Flow depths and velocities were then determined using the Manning's equation.

The outcomes of this assessment should be treated as highly indicative given the nature of the methodology. Detailed modelling of the catchment hydrology will be required for future design stages of the corridor.

5.3.2 Selection of flow gauges

Streamflow data were sourced from the Northern Territory Department of Land Resource Management's Water Data Portal[1] for frequency analysis. The data were extracted in hourly intervals for selected gauging stations, with consideration being given to their proximity to the Project site and the similarity of catchment characteristics.

Details of the gauging stations and associated records identified for analysis are summarised in Table 5-2, the locations of which are depicted in Figure 5-5. A streamflow record of greater than 20 years is required for frequency analysis, so four of these records could not be considered further (stations G0050116, G0050117, G0050140 and G0280004). Two further stations have significant periods of record missing (stations G0010005 and G0290004) which may provide unreliable analysis results and so were also not considered.

Key catchment characteristics considered for the assessment of parameter transfer were:

- Catchment area (determined from the SRTM elevation data set);
- Length of the longest flow path (derived from a drainage path assessment of the SRTM elevation dataset);
- Catchment topography and slopes (derived from the Multi-resolution Valley Bottom Flatness index); and
- Mean annual rainfall (provide by the Bureau of Meteorology).

A summary of these catchment characteristics is provided in Table 5-3 for the remaining gauged catchments and the target catchments.

The Multi-resolution Valley Bottom Flatness (MrVBF) is a topographic index to represent the degree of deposition within a landscape dominated by colluvial and alluvial processes. This information was derived by the CSIRO and provides an indication of the terrain steepness. The index ranges from 0 to 9. A value of 0 represents steep erosional slopes and a value of 9 refers to extensive depositional basins. A weighted average of the MrVBF was used as an indicator of catchment topography, and therefore runoff-response.

[1] http://lrm.nt.gov.au/water/water-data-portal

Table 5-2 Summary of gauging stations and records[2]

Station ID	Station name	Catchment area (km^2)	Record period[3]			% record available
			Start date	End date	Duration (years)	
G0010005	Ranken River Soudan Homestead	4,360	06/12/65	03/03/11	45.2	27.3%
G0050115	Hugh River South Road Crossing	3,140	18/05/72	05/10/15	43.4	99.4%
G0050116	Finke River South Road Crossing	7,500	021/2/04	05/10/15	11.6	96.8%
G0050117	Palmer River South Road Crossing	6,100	11/04/10	13/01/15	5.5	41.1%
G0050140	Finke River Railway Bridge	15,100	25/11/09	14/10/15	5.9	95.1%
G0060041	Todd River Rocky Hill	2,500	26/09/78	05/10/15	37.0	96.0%
G0280004	Allungra Creek Allungra Waterhole	432	15/12/01	10/02/15	13.2	10.9%
G0280010	Woodforde River Arden Soak	393	30/05/74	28/04/15	40.9	73.1%
G0290004	Playford River Alroy Downs Homestead	6,620	19/11/75	03/02/11	35.2	34.2%

Table 5-3 Catchment characteristics[4]

Catchment	Catchment area (km^2)	Longest flow path length (km)	Mean MrVBF[5] index	Mean annual rainfall (mm)[6]
Murray Creek	950	53	4.26	337
Hanson River	3,320	100	4.10	328
Wood Duck Creek	8,216	141	5.22	319
G0050115	3,140	129	1.88	292
G0060041	2,500	78	3.26	308
G0280010	393	47	2.93	322

2 Red shading indicates records omitted from analysis due to short length of records or missing data
3 Record period as extracted on 6 Oct 2015.
4 Red shading indicates record omitted from analysis due to low MrVBF
5 https://data.csiro.au/dap/landingpage?pid=csiro:5681
6 http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp?period=an&area=nt

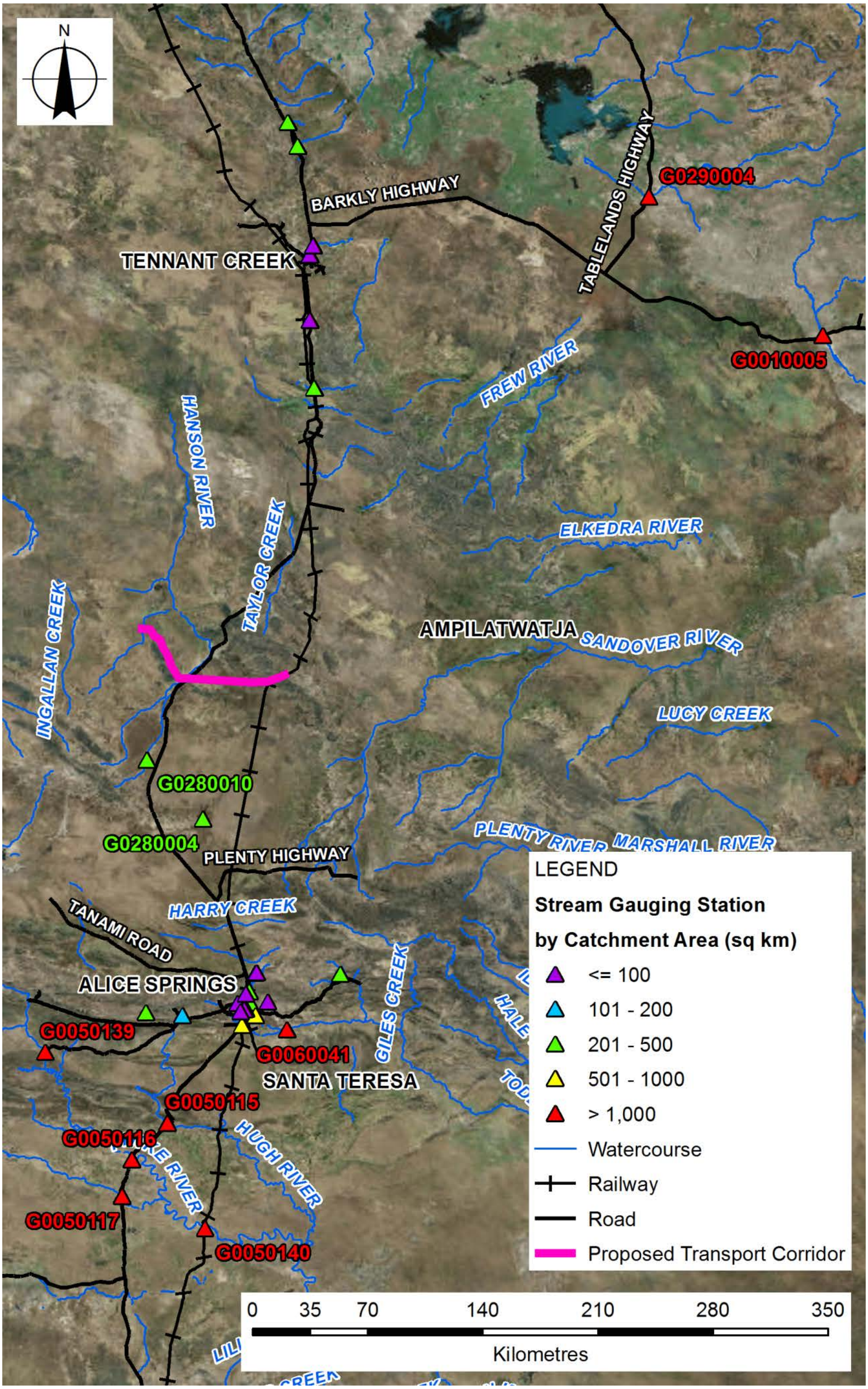

Figure 5-5 Location of streamflow gauging stations

It is noted that the weighted average MrVBF index for the catchment upstream of station G0050115 is substantially lower than those determined for the three target catchments. Accordingly, use of the parameters from this station may result in an overestimate in runoff response to rainfall in the target catchments, so this record was also not considered further.

The catchment parameters for the station G0280010 were applied to the Murray Creek catchment given the similar orders of catchment area and flow path length, noting that the weighted average MrVBF index is slightly lower than that of the target catchment. The catchment parameters for the station G0060041 were applied to the Hanson River and Wood Duck Creek catchments given the similar orders of catchment area, flow path length and weighted average MrVBF indices.

5.3.3 Flood frequency analysis

For each selected station, an Annual Maximum Series of the gauged streamflow was created. Each series were subsequently subjected to a frequency analysis using TUFLOW FLIKE[7], which is an extreme value analysis package. TUFLOW FLIKE is compliant with the recent major revision of ARR and is considered to be the most robust and defensible approach available to frequency analysis.

Frequency analyses were performed individually for each station using various combinations of inference methods and probability models. The analysis was done until a reasonable fit of the probability model to the gauged streamflow data is achieved. Table 5-4 summarises the results of the analysis, which inform the estimated peak discharge at each station for varying Average Recurrence Intervals[8] (ARI). Results of the frequency analysis were extended to the 50-year ARI. Probability plots demonstrating the accuracy of the frequency analysis can also be found in Appendix B.

Table 5-4 Frequency analysis results

Station ID	Peak discharge (m^3/s) by ARI		
	10-year	20-year	50-year
G0060041	219	394	725
G0280010	22	74	125

5.3.4 Estimation of peak discharges

The Rational Method was employed to estimate the peak discharges at the access road floodways and Murray Creek adjacent to the mine site. This entailed the determination of runoff coefficients for application in the Rational Method, followed by the estimation of peak discharges at the target sites by parameter transfer.

Runoff coefficients for the Rational Method were determined based on the frequency analysis results and catchment hydrological details of the streamflow gauging stations reported in Section 5.3.3. The hydrological characteristics of the gauged catchments are summarised in Table 5-5 and Table 5-6 lists the associated runoff coefficients.

7 http://www.tuflow.com/flike.aspx
8 The average, or expected, period between exceedances of a given discharge value.

Table 5-5 Hydrological characteristics of gauged catchments

Station ID	Catchment area (km^2)	Longest flow path		Time of concentration (hours)
		Length (km)	Slope	
G0060041	2,500	78	0.38%	26.5
G0280010	393	47	0.40%	19.0

Table 5-6 Runoff coefficients of gauged catchments

Station ID	Runoff coefficient by ARI		
	10-year	20-year	50-year
G0060041	0.07	0.10	0.15
G0280010	0.03	0.09	0.12

Peak discharges were estimated at the access road floodways across Murray Creek, Hanson River and Wood Duck Creek. The hydrological characteristics that describe these catchments are summarised in Table 5-7. The peak discharges from these catchments estimated using the Rational Method are tabulated in Table 5-8.

Table 5-7 Hydrological characteristics of target catchments

Target catchment	Catchment area (km^2)	Longest flow path		Time of concentration (hours)
		Length (km)	Slope	
Murray Creek	950	53	1.24%	24.7
Hanson River	3,320	100	2.38%	57.3
Wood Duck Creek	8,216	141	0.81%	91.4

Table 5-8 Estimated peak discharges at target catchments

Target catchment	Peak discharge (m^3/s) by ARI		
	10-year	20-year	50-year
Murray Creek	44	148	247
Hanson River	173	309	562
Wood Duck Creek	281	502	916

5.3.5 Estimation of peak floodway flow depths

The proposed floodways have been conceptualised as transverse tracks across existing watercourses with minimal changes or intervention to the existing surface levels. Consequently, the existing topography was used to approximate the geometry of the floodway cross sections.

The floodway flow depths at the Hanson River and Wood Duck Creek crossings were estimated using Manning's equation with the peak discharges estimated in Table 5-8. The following criteria were applied:

- Uniform flow conditions were assumed;
- The channel slopes at the floodways were estimated to be approximately 0.12% based on the Geoimage (2015) contours; and
- A Manning's roughness coefficient of 0.030 was adopted to represent bare earth channels with some weeds or gravel.

The floodway flow depths at the Murray Creek crossing were estimated using the HEC-RAS 1-D hydraulic model of the US Army Corps of Engineers. The reason for this different approach is that an assessment of the potential downstream flood extents in the vicinity of the mine site was required, which would not be practical by using Manning's equation at multiple cross sections. As a result, the 1-D hydraulic model was applied to determine both flood depths and extents (see Section 5.3.7 for further details).

The resulting peak floodway flow depths are summarised in Table 5-9. Cross sections depicting the floodway shape and predicted peak water depths are shown in Figure 5-6, Figure 5-7 and Figure 5-8 for Murray Creek, Hanson River and Wood Duck Creek respectively. It should be noted that the estimated flow depths for Wood Duck Creek may be lower than those estimated since the catchment time of concentration (~91 hours) is longer than the storm duration itself. The ARR does not prescribe rainfall temporal patterns greater than the 72-hour duration.

Table 5-9   Estimated peak flow depths at floodways

Target catchment	Peak flow depths (m) by ARI		
	10-year	20-year	50-year
Murray Creek	0.42	0.76	0.99
Hanson River	1.44	1.81	2.15
Wood Duck Creek	0.37	0.51	0.71

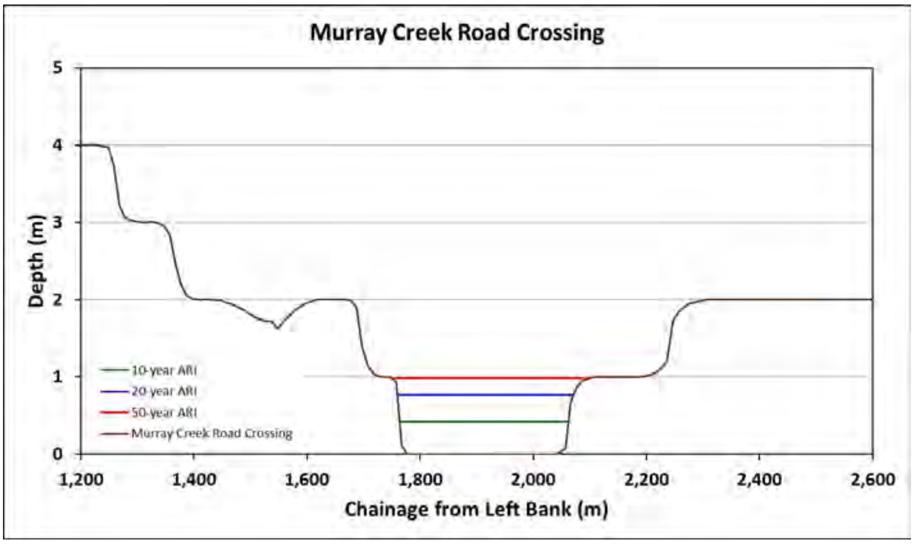

Figure 5-6   Predicted floodway flow depths across Murray Creek

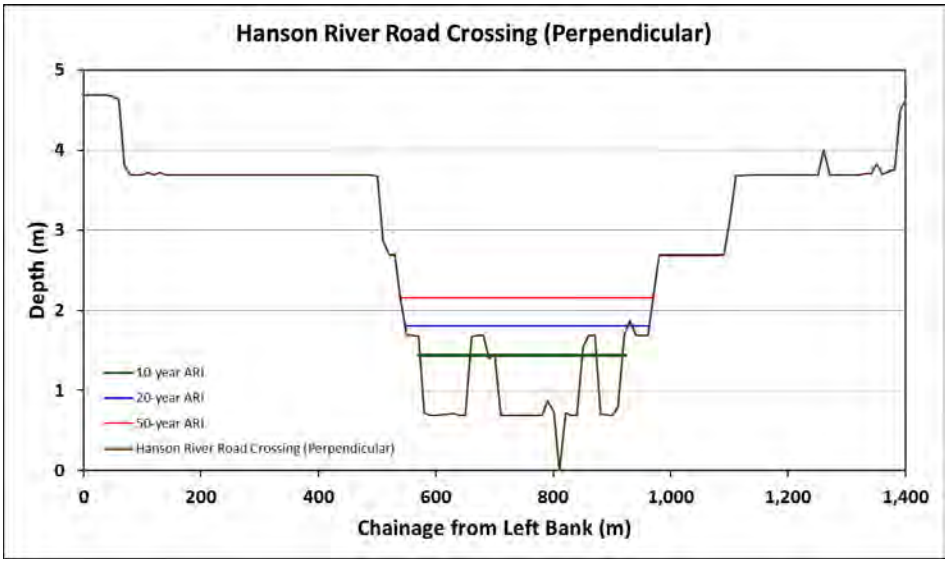

Figure 5-7 Predicted floodway flow depths across Hanson River

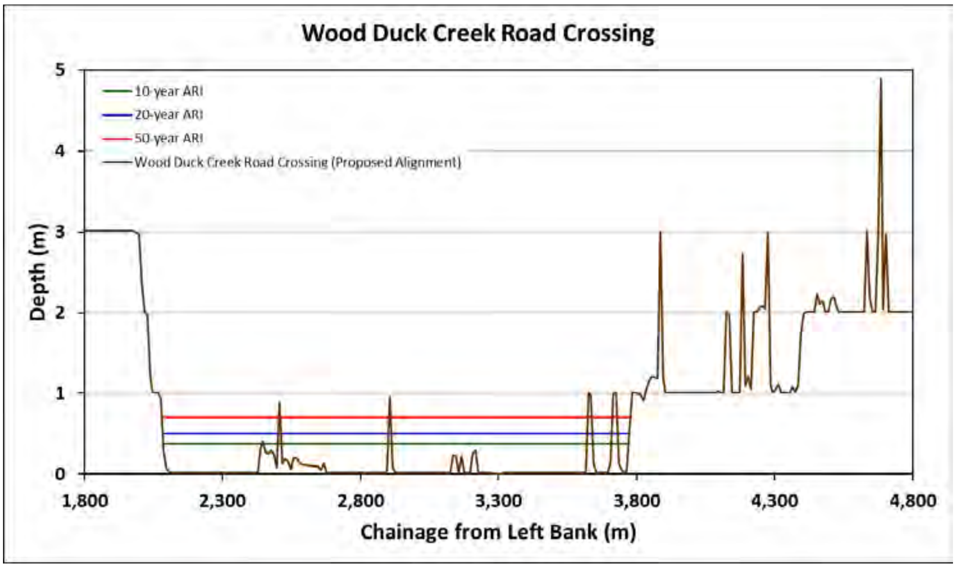

Figure 5-8 Predicted floodway flow depths across Wood Duck Creek

It should be noted that the drainage lines of the Murray Creek and Hanson River are reasonably well defined and relatively narrow (~300 m and ~400 m respectively) so may be suitable for floodway type crossings. Such crossings would not be expected to interrupt natural streamflow and geomorphological processes, but would require ongoing maintenance to ensure accessibility.

There is no evidence of a single specific drainage line associated with Wood Duck Creek and surface flows in this vicinity are likely to present as sheet flow. Given the relatively long length of the crossing (~1,800 m) and the likely long duration of standing water, regularly spaced culverts may be more suitable than a floodway.

The preliminary nature of this assessment and the limited adequacy of the elevation data are noted and all results should be considered indicative only. Further topographical surveys and hydraulic assessments will be required to validate these findings.

5.3.6 Estimation of floodway flow durations

An assessment of the flow durations at the proposed floodway crossings was undertaken to provide an indication of the serviceability of the access road. Flow durations were estimated through derivation of flood hydrographs (showing the predicted discharge rates over a storm duration), which entailed the use of the Extended/Modified Rational Method (ERM). The ERM was selected it reproduces the same peak discharge rates as the standard Rational Method (reported in Section 5.3.4), whilst generating a flood hydrograph through the time-area method. Hydrographs were estimated for the 24-hour, 48-hour and 72-hour storm durations and the 10-year, 20-year and 50-year ARIs using rainfall temporal patterns from the ARR as inputs.

The flow-duration hydrographs were then converted to depth-duration hydrographs in order to determine the amount of time that water levels at the proposed crossings exceed a given threshold value. This conversion involved the application of rating curves that represent the channel shapes shown in Figure 5-6, Figure 5-7 and Figure 5-8 respectively. Assuming that a flow depth of less than 0.2 m would be trafficable, the durations for flows in excess of 0.2 m are summarised in Table 5-10.

Table 5-10 Estimated flow durations for depths >0.2 m

Target catchment	Storm duration (hours)	Flow duration (hours) by ARI		
		10-year	20-year	50-year
Murray Creek	24	25	35	43
	48	26	51	66
	72	27	51	86
Hanson River	24	81	81	81
	48	105	105	105
	72	129	129	129
Wood Duck Creek	24	93	98	107
	48	99	109	129
	72	104	117	148

5.3.7 Estimation of Murray Creek flood extents

The delineation of flood extents entailed the use of HEC-RAS model as the Manning's equation is not appropriate for the estimation of water surface profile along an extended length of watercourse. HEC-RAS is a simulation model designed for one-dimensional hydraulic calculations for a full network of natural and/or constructed channels. In this assessment, HEC-RAS was employed for steady flow water surface profile computations.

The resulting flooding extents along Murray Creek in the vicinity of the mine site are mapped in Figure 5-9. The results indicate that the mine site is not expected to experience any significant flooding for events up to the 50-year ARI. However, it is noted that there is a bench of lower lying topography in the vicinity of the proposed mine pit that may be prone to flooding during more extreme events. Cross sections depicting the floodway shape and predicted peak water depths at this location are shown in Figure 5-10. Inspection of aerial imagery indicates vegetation change across this area, which could also be indicative of periodic flooding. Further investigation is required to establish the need for flood protection measures in this vicinity.

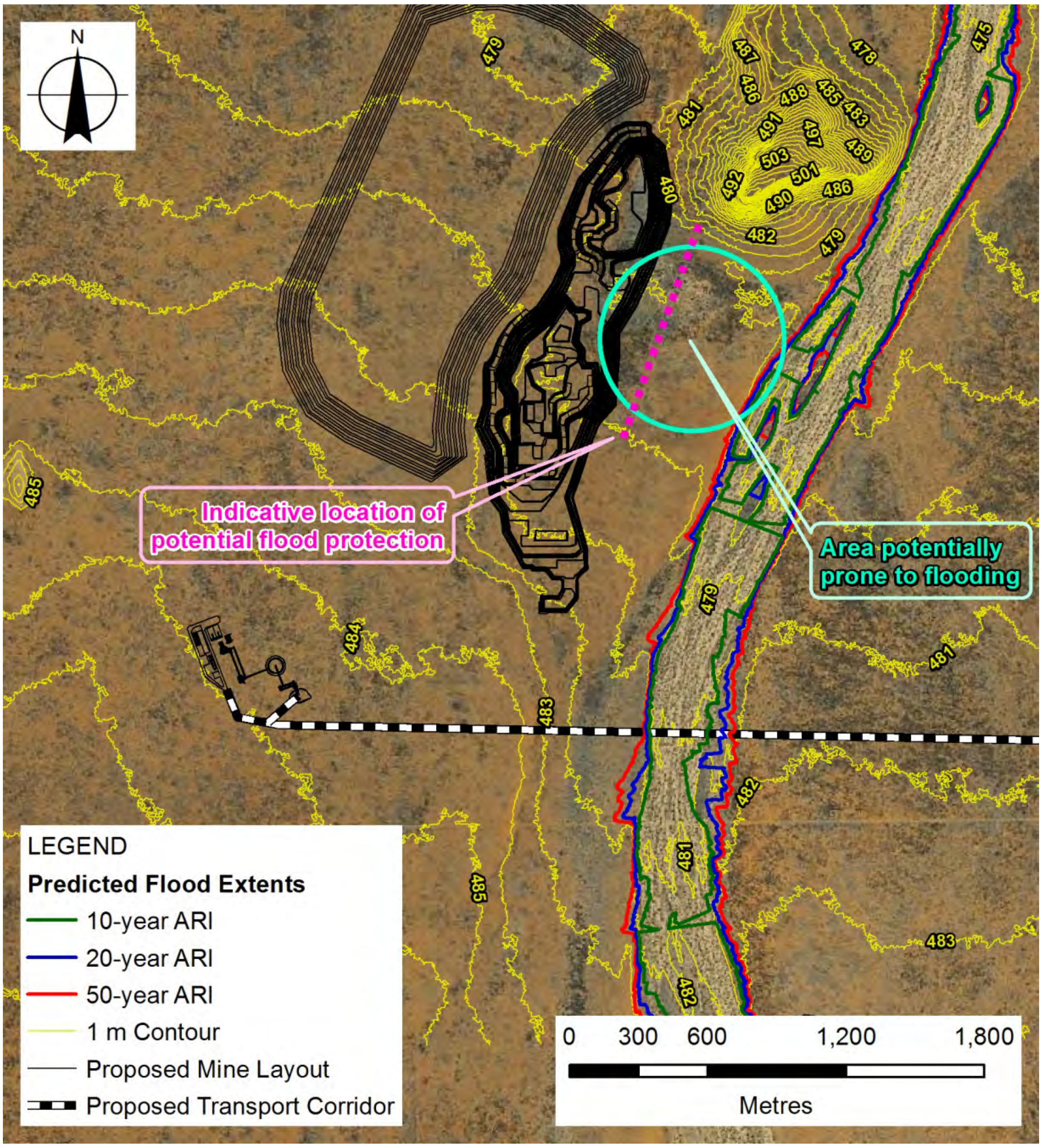

Figure 5-9 Predicted flood extents along Murray Creek

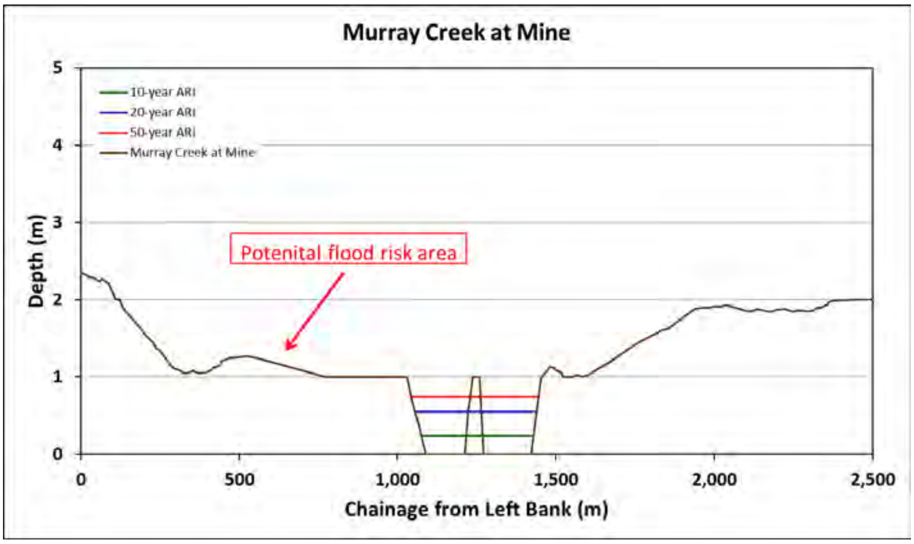

Figure 5-10 Predicted flow depths in the vicinity of the mine site

The limitations in the elevation data and the preliminary nature of this assessment should again be noted and further surveys and assessment will be required to validate these findings.

5.4 Sheet flow

Inspection of the elevation data and aerial imagery indicated that there are areas where sheet flow may be the dominant surface water runoff response. A site visit revealed the existence of extensive tracts of Mulga (*Acacia aneura)* dominating the shrublands associated with the alluvial plains to the east of the Stuart Highway. These species are an indicator of sheetflow processes.

The elevation profile along the proposed access road alignment is provided in Figure 5-11, which indicates the locations of the main water course crossings as well as areas where sheet flow may be present. No specific drainage lines were noted in the areas of potential sheet flow and regularly spaced culverts are recommended to prevent the creation of sheetflow shadow zones downgradient of proposed access road.

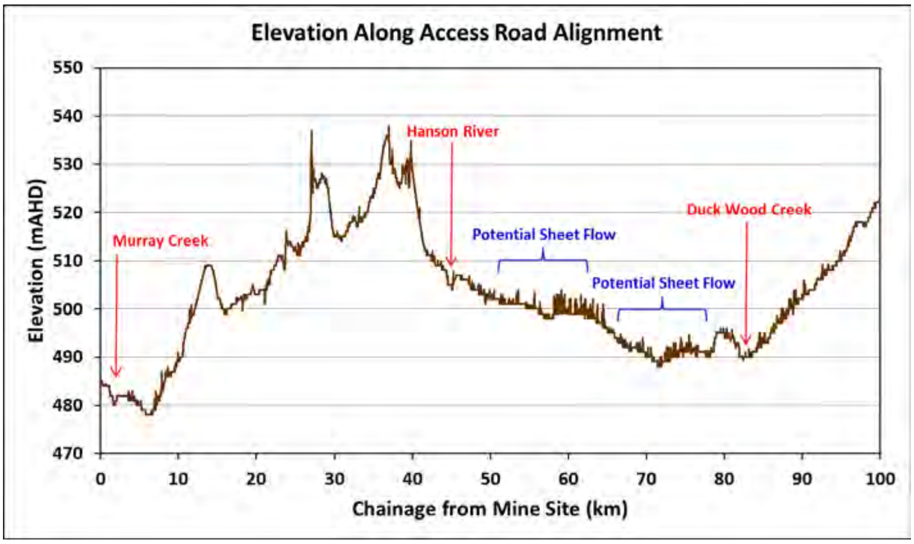

Figure 5-11 Elevation profile along access road

5.5 Water Quality

5.5.1 Approach

Sediment sampling was undertaken to characterise sediment quality as a proxy for water quality given the infrequent nature of flow events within the region as outlined in Section 4.4. The accumulation of elements in the sediment will provide an indicator of baseline sediment quality, as well as an indicator of surface water quality and contaminant progression within the vicinity of the proposed project site, and at upstream and downstream locations.

Sediment sampling locations were selected based on an initial desktop assessment considering the mine plan, transport corridor and environmental site characteristics, and were verified by a site visit in January 2013. Locations were selected such that they are unlikely to be disturbed by mining activities and the monitoring points would remain active throughout the life of the mine. Sediment sampling locations and brief descriptions are depicted in Figure 5-12 and are as follows:

- Site SS-01: Murray Creek upstream of the Project site;
- Site SS-02: Murray Creek downstream of the Project site;
- Site SS-03: Bloodwood Creek discharge channel to Mud Hut Swamp;
- Site SS-04: Hanson River near Middle Well;
- Site SS-05: Hanson River near Junction Well;

- Site SS-06: Hanson River near Camel Soak bore;
- Site SS-07: Hanson River at floodout to Stirling Swamp;
- Site SS-08: Mud Hut Swamp;
- Site SS-09: Unnamed creek near Gingers Bore; and
- Site SS-10: Unnamed creek discharging into Stirling Swamp near Merino Well.

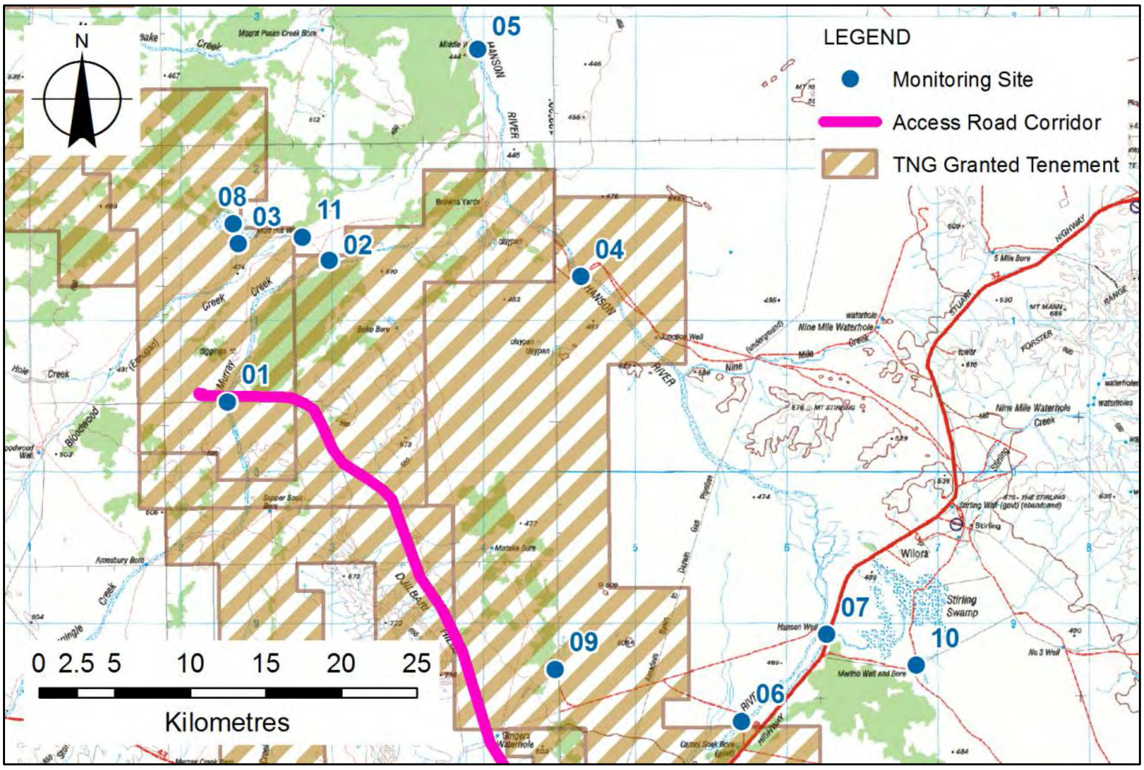

Figure 5-12 Sediment monitoring locations

5.5.2 Sample and analysis methodology

Sampling of river bed sediments was based on the Australian Standard - Guide to the investigation and sampling of sites with potentially contaminated soil (AS 4482.1-2005). Laboratory testing of the sediment samples was carried out by ALS Environmental, a National Association of Testing Authorities (NATA) accredited testing laboratory. Analyte groupings tested were:

- Particle size distribution and sediment classification;
- pH;
- Electrical conductivity;
- Moisture content;
- Metals and metalloids;
- Nutrients;
- Total recoverable hydrocarbons; and
- Total petroleum hydrocarbons in sediments.

In the absence of sufficient sediment quality data to determine background sediment concentrations, the ANZECC (2000) Sediment quality guidelines are used for comparative purposes. The Sediment quality guidelines are trigger values and are compared to total contaminant concentration in sediment. Where the total contaminant concentration exceeds the trigger value further investigation may be considered to determine the contaminant fraction that is bioavailable or can be transformed and mobilised in a bioavailable form (ANZECC 2000).

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

5.5.3 Analysis results

The laboratory analysis results are presented in Appendix C, which are discussed further in the following sections.

Particle size distribution

Particle size distribution relates to the amount of gravel, sand, silt and clay within the soil. Sandy soils have a smaller surface area and are typically less chemically and physically active than soils with a high clay content. Sediment soil classification at the sample locations are:

- SS-01 Sand and gravel;
- SS-02 Sand and gravel;
- SS-03 Sand;
- SS-04 Sand;
- SS-05 Sand;
- SS-06 Sand;
- SS-07 Sand;
- SS-08 Sand and fines;
- SS-09 Sand;
- SS-10 Fines and sand; and
- SS-11 Sand and fines.

The fluvial sediments are predominantly sandy, with two sites (SS-08 and SS-11) having approximately 20% fines (<75um) and one site (SS-10) with predominantly fines (52% <75um).

pH

Sediment pH is depicted in Figure 5-13, which is seen to range from neutral (pH 7.2, SS-03) to very strongly acid (pH 3.2, SS-05). The sediment pH of the majority of sediment samples (excluding sediment sample SS-03) is considered strongly acid to very strongly acid based on the interpretation of sediment pH (1:5 soil/water ratio) by Bruce and Rayment (1982). Bruce and Rayment (1982) note that with increasing acidity cadmium and heavy metals become available.

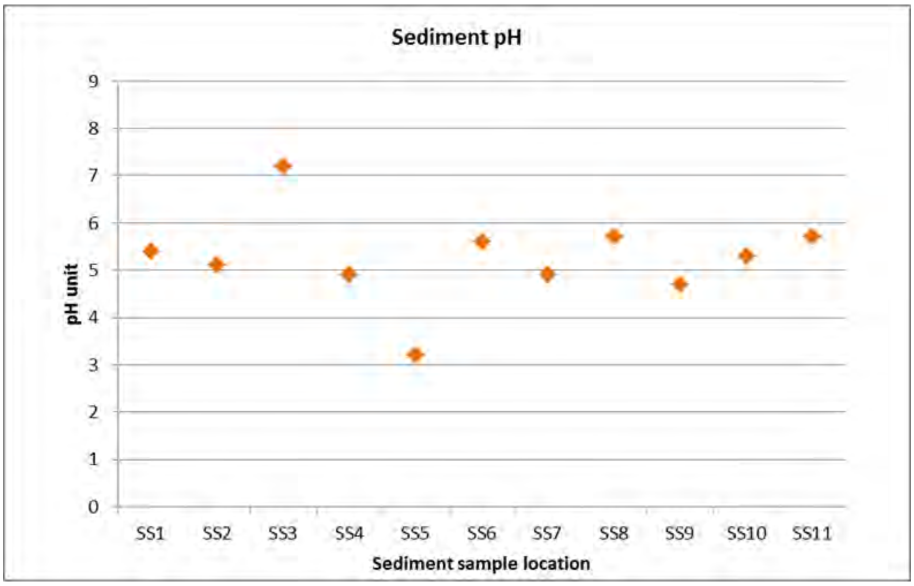

Figure 5-13 Sediment pH

Electrical conductivity

Electrical conductivity (EC), which is a measure of sediment salinity level, is presented in Figure 5-14. EC levels at all sites was very low (3 uS/cm, SS-06) to slight (70 uS/cm, SS-10), with the water classified as non-saline and suitable for drinking and irrigation (Rhoades *et al*. 1992).

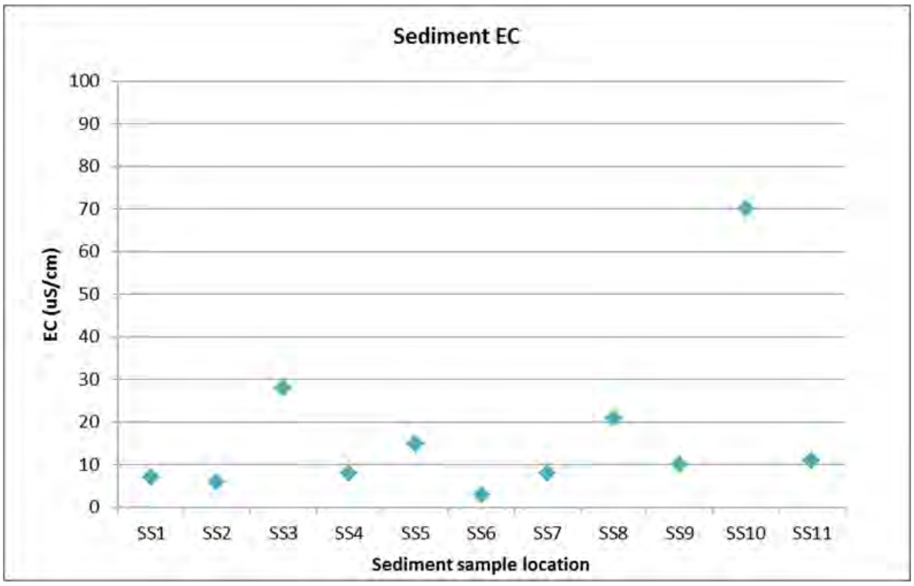

Figure 5-14 Sediment electrical conductivity

Metals and metalloids

ANZECC sediment guidelines for metals are available for several of the analytes sampled:

- Arsenic: Low 20 mg/kg High 70;
- Cadmium: Low 1.5 mg/kg High 10;
- Chromium: Low 80 mg/kg High 370.
- Copper: Low 65 mg/kg High 270;
- Lead: Low 50 mg/kg High 220;
- Nickel: Low 21 mg/kg High 52; and
- Zinc: Low 200 mg/kg High 410.

Inspection of the analysis results in Appendix C reveals that no samples exceeded the respective ANZECC metal guideline value. The following are also noted from these results:

- Sediment samples at all locations reported metal concentrations less than the limit of reporting for the following total metals:
  - Arsenic;
  - Beryllium;
  - Boron;
  - Cadmium;
  - Selenium; and
  - Mercury..
- Cobolt, copper and lead concentrations were reported above the limit of reporting (LOR) at site SS-10;
- Barium, nickel and zinc concentrations were reported above the LOR at sites SS-08 and SS-10;
- Uranium concentration was reported above the LOR in ten out of eleven samples collected, with concentrations ranging between <0.1 (LOR, SS-09) and 3.5 mg/kg (SS-10);
- Chromium concentration was reported between 4 mg/kg (SS-06) and 35 mg/kg (SS-10);
- Manganese concentration was reported between 10 mg/kg (SS-06) and 542 mg/kg (SS-10); and
- Vanadium concentration was reported between 6 mg/kg (SS-06) and 51 mg/kg (SS-10).

Where metals were detected at concentrations above the LOR in the fluvial samples, the concentrations were within the observed range of background levels reported for Australian soils (Hazelton and Murphy 2007). None of the sediment samples exceeded the respective ANZECC sediment guideline for metals where available. Concentrations of metal parameters were consistently reported highest at monitoring location SS-10, corresponding with the site with highest proportion of sediment fines.

Nutrients

Sediment total nitrogen concentrations ranged from <20 mg/kg (LOR, multiple sites) to 730 mg/kg (SS-10), with the majority of the total nitrogen concentration comprising total kjeldhal nitrogen (>90%).

Oxidised nitrogen concentrations (nitrite plus nitrate as N) ranged from 0.4 mg/kg (SS-02) to 9.5 mg/kg (SS-08).

Sediment total phosphorus concentrations ranged from 9 mg/kg (SS-06) to 306 mg/kg (SS-10). Filterable reactive phosphorus concentrations ranged from <0.1 mg/kg (LOR, SS-01 and SS-02) and 1.6 mg/kg (SS-10).

Consistent with metals detected, Site SS-10 also reported the highest soil total nutrient (nitrogen and phosphorus) concentrations, filterable reactive phosphorus concentration and EC value.

Total recoverable hydrocarbons

No total recoverable hydrocarbon analyte exceeded their respective LOR.

6. Groundwater resources setting

6.1 Regional geology

6.1.1 Overview

The Project area is located predominantly within the northern province of the Palaeoproterozoic Arunta Block, with the eastern area of the project (encompassing the eastern access road and rail node) being within the western margin of the neoproterozoic Georgina Basin.

The northern province of the Arunta Block contains various metasedimentary rocks and minor volcanics metamorphosed to a generally low-grade facies (Andrew *et al.* 1998). Within the Project area, there are various important unconformably overlying units within the Arunta Block region, such as Central Mount Stuart Formation which forms the high ground (Central Mount Stuart) to the South of the mine site and adjacent to the access road.

The Georgina Basin is comprised of a thick sequence of sedimentary units, typically ranging from pre-Cambrian to Cretaceous. They are predominately comprised of siliciclastic rocks.

These two broad geological regions form the main basement geology of the Project area and are most commonly observed forming the outcropping rocks of the ranges. More recent Quaternary and Tertiary aged deposits dominate the Projects areas surface geology and regolith and generally mask the underling Palaeozoic and Proterozoic units.

6.1.2 Mine site geology

The orebody target for the mine is the mineralised Mount Peake gabbros, which are generally found concealed beneath recent Quaternary sediments. The gabbro unit is located within outliers of Neoproterozoic sediments of the Georgina Basin. The Neoproterozoic sediments rest unconformably on metasediments and granites of the Aileron Province within the Lower Proterozoic Arunta Region.

Within the area of the mine site, the orebody gabbro occurs at relatively shallow depths of around 40 m, striking along a northwest trending sill around 1.3 km length, approximately 500 m wide and 100 m thick.

Within the immediate area of the mine site, Quaternary sediments are the dominant surface geological unit and regolith. The surficial deposits can generally be divided into two units either relating to the current cycle of weathering or erosion, or relating to earlier cycles of weathering. Generally within the area of the mine site, the more recent unit is present comprised of red earth soil (Qr unit), with alluvial deposits present in active channels and on floodplains (Qa unit).

Immediately to the northeast of the proposed pit, a small outcrop of the Mount Stuart Formation is present forming a small rise immediately adjacent to Murray Creek. The same unit also forms the high ground east of the proposed mine camp area. The unit is described as a basal tillite, grey arkosic conglomerate, grey green calcareous pelite and minor dolomitic limestone; grey pelite, grey arkose, and reddish purple coarse feldspar-quartz sandstone At the base of these units scree slopes and regolith are present (Donnellan 2008).

6.1.3 Borefield geology

The borefield is located on the western bank of the Hanson River. The dominant surface geological unit here is the alluvial deposits of relict fluvial system largely covered by sheet sand (Qas unit) and alluvial/red soil plain deposits (Qra unit).

As further discussed in the hydrogeology section below, the thickness of the alluvial units within the borefield locations are significantly thicker with comparison to the general alluvial units found on the plains. The increased thickness relates to the incised channels of the palaeodrainages of the Hanson River.

It is likely that the thickened alluvial units are geologically equivalent or related to the same units found at depth in the Ti Tree Basin, approximately 70 km to the south (see below). The Hanson River alluvials are possible equivalent to the upper Ti Tree basin facies (facies 4) which have been described as reddish brown mottled sediments deposited in a fluvial environment and of Miocene age (7-20 MYA) (Wischusen *et al.* 2012). The Ti Tree Basin is further discussed below.

6.1.4 Access road geology

The access road is approximately 100 km in length and transects various differing geologies and regolith units. The eastern half of the road alignment is predominately within the Georgina Basin, whereas the western half is within the Arunta Block. The alignment is located on the plains and therefore the surface geology and regolith is mainly comprised of alluvials. In the western area where the alignment is to the east of the ridge line formed from the Stuart Ranges, some localised scree and colluvial fan deposits are present.

In the eastern area of the alignment, the road passes through the palaeovalley associated with the Hanson River. In this location, older Cainozoic sediments are mapped, which are expected to include calcrete deposits.

Where the road alignment meets the existing rail line, the alluvial plain is relatively narrow with units of the Central Mount Stuart Formation being present both north and south of the road alignment.

6.2 Regional hydrogeology

6.2.1 Overview

In general the basement rocks of the Arunta and Georgina geological provinces are not well studied in terms of their groundwater potential, largely a result of the regions remoteness. The deep basins may offer groundwater resources, but groundwater drilling investigations have generally focused on providing water for communities or for stock watering. As such only relatively minor yields have been required so drilling of production bores would tend to cease at relatively shallow depths once sufficient yield was obtained (Ride 2007).

Regional aquifer mapping by the Department of Land Resources Management (Tickell 2013) summarises that the general Project area contains two predominant aquifer types that are termed local scale aquifers only:

- Fractured and weathered rocks with minor groundwater resources; and
- Fractured and weathered rocks.

The distribution of these two systems is illustrated in Figure 6-1. The fractured rock aquifers are likely to offer generally low groundwater yields. In addition to the two units that dominate the Project region, the Ti Tree basin is mapped as an aquifer of 'Unconsolidated sediments with intergranular porosity'. This unit is not mapped as continuing through the identified palaeovalley of the Hanson River (see further discussion below).

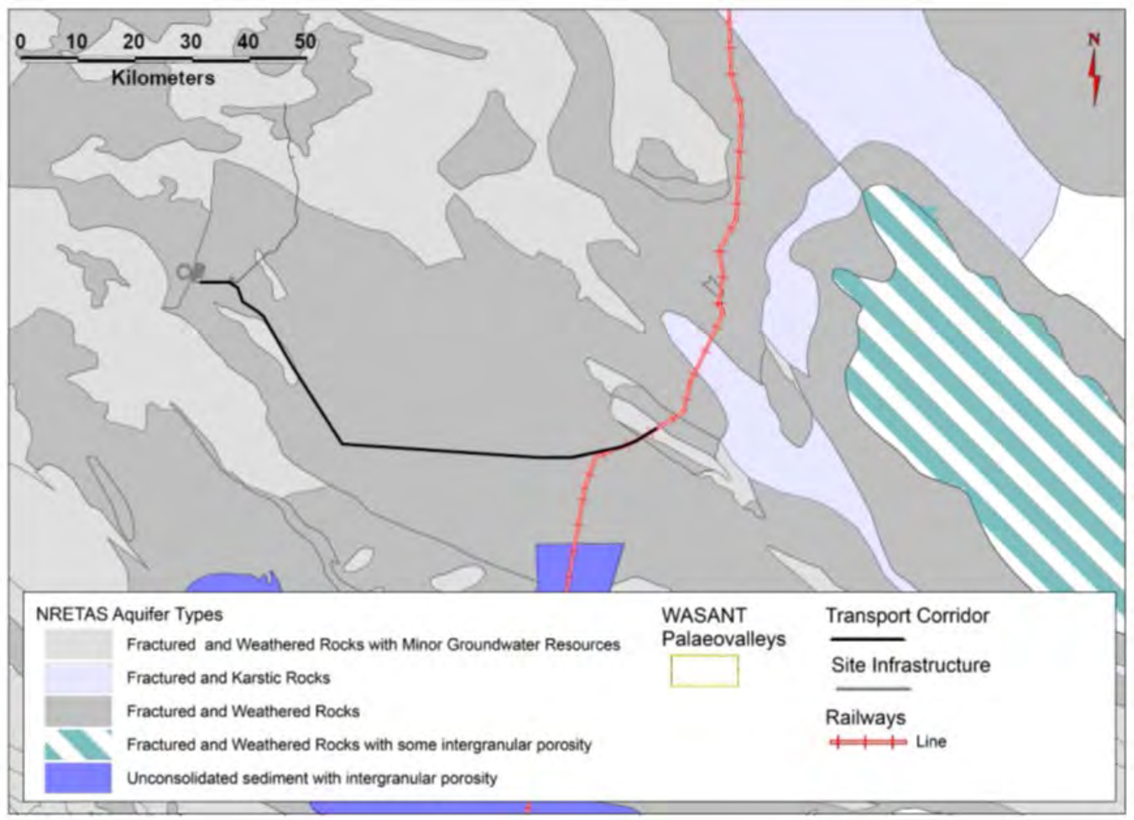

Figure 6-1 Regionally mapped aquifer systems[9]

6.2.2 Cainozoic basins and palaeovalley systems

In addition to the broad fractured rock systems that are possibly present throughout the study area, a number of significant Cainozoic basins and palaeovalley systems have been identified within or adjacent to the Project area (Tickell 2013). The palaeovalley and sedimentary basins are relict drainage features that formed between 2 and 65 million years ago. Aquifer systems are present within the river sands and gravels that formed the channel systems within these relict drainage features.

These systems have been mapped and described in the publication "Water for Australia's arid zone – identifying and assessing Australia's palaeovalley groundwater resources" (English *et al.* 2012). A brief summary of these systems is provided in the following sections.

6.2.3 Ti Tree Basin

The Ti Tree Basin is the most studied and the most exploited groundwater resource in the region. The groundwater potential of the basin has been the focus of various government reports and policies since the early 1960s (English *et al.* 2012). The Basin is an intracratonic Cainozoic basin that is infilled with up to several hundred metres of alluvial and lacustrine sediments.

The basin is approximately 100 km wide from east to west and 75 km north to south. The basin sediments are known to be in excess of 300 m in depth, however the upper 100 m of sediments is most commonly targeted for groundwater abstraction. The primary use of the groundwater is for horticultural purposes. Data indicates that abstraction from the Ti Tree went through a period of increasing demand up to around 2005 when a maximum of around 4 GL/annum was abstracted. Demand has reduced since 2005 with the current demand being less than 2 GL/annum.

9 Department of Land Resources Management, Like: 20150708 general GW aquifer FIGURE.wor

Groundwater within the basin generally flows from south to north, with discharge known to occur towards the Hanson River and Stirling Swamp. The Stirling Swamp area may be an expression of discharge from the Ti Tree aquifer where evapotranspiration could be a major component of the water balance for the aquifer (English *et al.* 2012).

6.2.4 Hanson River palaeovalley

The extent of the palaeovalley was determined through assessment of spatial data, including existing geological mapping, satellite imagery and available drilling data. It is recognised that within the Hanson River area, drilling data is relatively limited (Section 6.4), therefore the mapped extent of the palaeovalley could be highly speculative (Tickell 2013).

The Hanson River palaeovalley is mapped as continuing from the northern discharge of the Ti Tree Basin, passing through Stirling Swamp and connecting with the existing Hanson River Channel. The channel then passes through the Project area before continuing north for approximately 200 km before is merges with the Palparti palaeovalley. The Hanson River palaeovalley is generally identified as being around 4 km wide, but as narrow as 2 km and as wide as 10 km.

With the exception of work undertaken by TNG (Section 6.7), there has been no known groundwater investigative drilling undertaken in the area of the Hanson River palaeovalley. Drilling within the identified extents of the system has been limited to stock bores (further discussed in Section 6.4.1). Stock bores have generally been successful in terms of yield, and in some instances may have not fully intersected the aquifer.

Utilisation of the Hanson River palaeovalley is currently limited to the stock bores. The majority of bores being equipped with solar powered low volume shaft driven pumps, which are used to fill water tanks that keep cattle troughs filled.

6.2.5 Willowra Basin

The Willowra Basin and associated palaeovalley is located approximately 30 km west of the mine site at the junction of the Lander River and Ingallana Creek. Unlike the Hanson River palaeovalley, the Willowra Basin has been investigated for groundwater resources through a drilling program conducted by the Northern Territory Water Resources section in 1963. A total of 45 holes were drilled for a total of 1,424 metres drilling. The drilling locations were orientated on a grid basis in order to determine the extent of the basin and determine the profile of the potential groundwater resource.

The drilling investigation determined that around 25 km south of Willowra Homestead the palaeovalley is about 18 m deep and 3 km wide, deepening to 35 m just north of the homestead. The shape and sediment composition of the infill sequence indicates that it formed in a fluvial environment, with elongate sand and gravel channel lenses and clay and silty-clay sediments typical of floodplain overbank deposits. The main aquifer unit was identified as a Quaternary lower sand unit with some local confinement by clay rich floodplain deposits (Magee 2009).

The Quaternary alluvial aquifers have low volumes of groundwater storage after long periods of low flow, with the watertable depth in the Willowra Homestead bore, which penetrates 15 m of Quaternary sands known to vary from about 12 m (in dry periods) to near-surface immediately after streamflow.

The only known groundwater use within the Willowra Basin is for stock use. However the use of the groundwater resource for horticultural purposes was identified as having potential; however this has not been further pursued.

The drilling data for the Willowra Basin could offer an insight into the Hanson River palaeovalley system, with both systems expected to have formed under similar conditions.

6.3 Water control districts

6.3.1 Overview

The Department of Land Resource Management declares Water Control Districts in areas that need close management of water resources. Managing of the water resource will avoid stressing groundwater reserves, river flows or wetlands.

Each Water Control District is subject to water allocation planning that establishes a framework to share water between human and environmental needs. An allocation plan is declared to ensure that water is allocated to beneficial uses, as defined in the *Water Act 1992*. The defined beneficial uses of water include agriculture, public water supply, the environment, cultural needs, industrial needs, aquaculture and to provide water for stock and domestic purposes.

Of relevance to the Project are the Western Davenport Water Control District, and the Ti Tree Water Control District. These are summarised below and illustrated in Figure 4-4.

6.3.2 Western Davenport Water Control District

The Western Davenport Water Control District covers an area of almost 25,000 km^2, extending north from the Ti Tree Basin Water Control District for around 200 km, including the community of Mungkarta at its northern edge. From the west it includes the Hanson River and the proposed location of the borefield, and extends east to cover most of Murray Downs Station. The Stuart Highway bisects the District passing through Barrow Creek, Wycliffe Well and Wauchope.

The allocation plan (Department of Natural Resources 2009) recognises that there are currently no known or significant surface water extraction activities and the total of the current licensed and unlicensed groundwater extraction per annum is estimated to be less than 0.004% of estimated storage. The allocation plan and associated technical documentation also note that further scientific work needs to be undertaken to improve the knowledge about the areas water resources and estimation of their characteristics. In particular, more evenly spread and deeper groundwater drilling investigations are recommended to determine bore yields and consequential sustainable yields of aquifers. Identification and measurement of recharge mechanisms is also recommended.

As identified in Section 6.2, the regions aquifers are typically either low yielding fractured rock systems, or Cainozoic sedimentary aquifers. The technical assessment for the Western Davenport Water Control District estimates that groundwater storage in the Cainozoic or upper level aquifers in the larger regional scale aquifer is in the order of 12,800 GL and storage in the deeper fractured rock aquifers is in the order of 16,000 GL.

The allocation plan identifies that current licensed groundwater abstraction is limited, with the main uses for horticulture and community supply. An additional unlicensed volume is attributed to stock bores, which based on an estimation of bore numbers and stock is estimated to be in the region of 350 ML/year.

The Water Control District is separated into five management zones based on a consideration of topography, underlying geology, hydrogeochemistry and stratigraphy. The Territory Government has followed the principle that in the absence of adequate scientific information, total extraction of groundwater over a century should not exceed 80% of the estimated total aquifer storage. The Project area overlaps with part of the Southern Ranges management zone. A summary of this zone is provided below as Table 6-1.

Table 6-1 Southern Ranges management zones summary

Area	Estimated storage	Estimated annualised recharge	Available allocation
8498 km^2	147 GL	8.5 GL	6.8 GL/annum

6.3.3 Ti Tree Water Control District

The Ti Tree Water Control District covers an area of almost 15,000 km^2, covering the extent of the Ti Tree aquifer and its surface water catchments. The northern area of the district extends to Wilora and Stirling Station, and therefore includes a large section of the access road alignment and the rail siding.

Unlike the Western Davenport Water Control District, the Ti Tree area has a significant groundwater use, largely for horticultural purposes and public water supply. Abstraction occurs from the Ti Tree aquifer which is present at relatively shallow depths across the majority of the Water Control District. As a result of the demand and utilisation of the aquifer, a groundwater model has been developed, which has been used to develop allocations and sustainable water use volumes. The groundwater model is scheduled to be updated and refined every 5 years to take into account the latest abstraction data and incorporate any new hydrological or hydrogeological data that has been developed.

The Water Control District is separated into four management areas, with the Northern Zone being of relevance to the Project due to its overlap with the access road, the Hanson River and Stirling Swamp. The northern zone is relatively un-utilised in terms of abstraction compared to the other areas, with the only groundwater use by the Wilora community and Stirling Station. It is estimated that a total of 50 ML/year is currently used, with 10 ML/yr for Public Water Supply (licenced) and 40 ML/year for rural and domestic use (unlicensed).

6.4 Existing groundwater use within the Project area

As indicated in the above sections, there are relatively few existing users of groundwater within the Project area. However, an understanding of these existing groundwater users is required in order to identify them and protect them from potential adverse impacts. The following sections summarise the key known groundwater users within the Project area.

6.4.1 Stock bores

The pastoral lease of Stirling Station covers most of the Project area, with Anningie Station being immediately to the south of the Project area. The access road corridor follows the boundary of the two stations lying on the Stirling Station side of the boundary.

Both pastoral stations use stock bores and wells for year-round water supplies. The operational stock bores identified within and around the Project are shown on Figure 6-2. In general, stock bores are relatively evenly distributed around the Project area with typical distance between stock bores of around 10 km. The majority of the bores within the Project area are located along existing creek and drainage lines. For example, there are a series of stock bores along the western bank of the Hanson River Channel, with bores located at 10 km intervals between Hansons Bore on Stuart Highway to Prosperity Bore, some 90 km north down-stream.

The majority of stock bore and well locations are historic having been established early in the pastoral stations development. As such, some locations have since been re-drilled, or bores installed to replace old wells which were traditionally hand dug and relatively shallow. Due to the relatively low volumes of groundwater required at each location, bores tend to be relatively shallow and generally less than 40 m deep. Due to the widespread nature of these bores, they tend to target different units but are predominately targeting the fresher shallow groundwater associated with recent alluvial sediments.

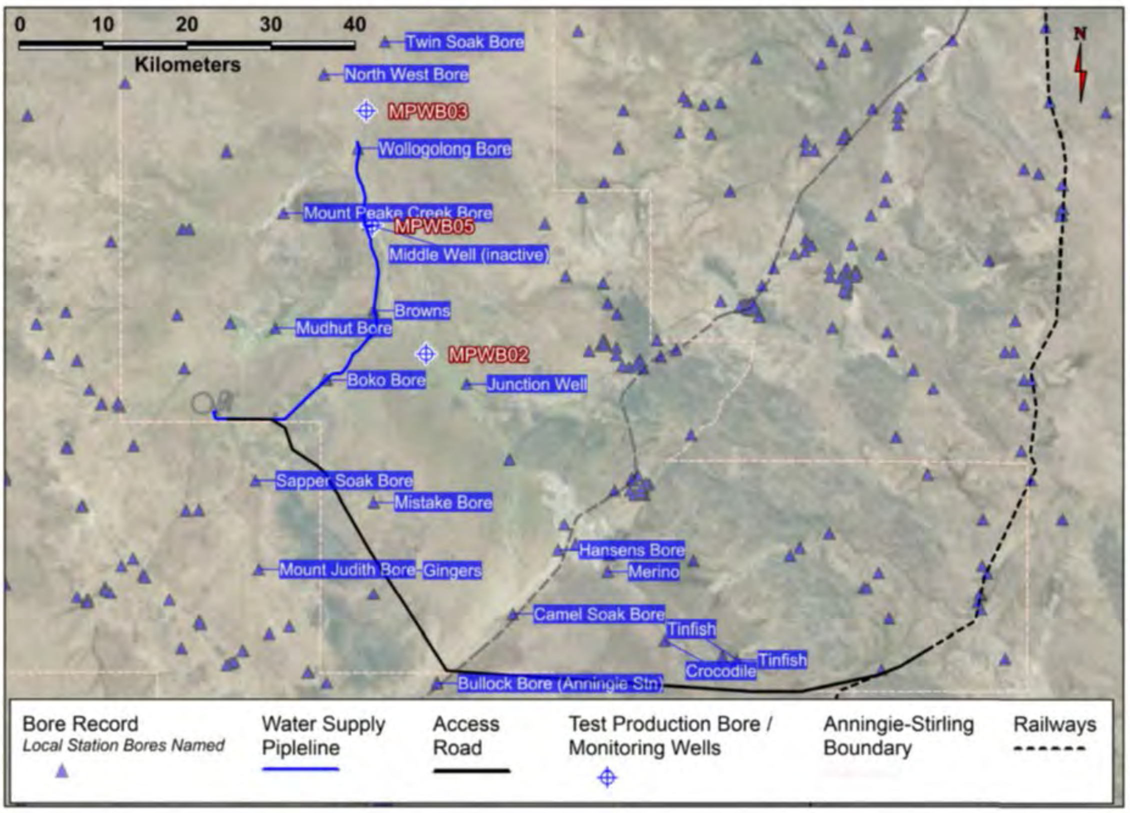

Figure 6-2 Stock bores within and around the Project

Most active stock bores will be equipped with either a wind powered shaft drive positive displacement pump, or a solar powered electric submersible pump. In general, wind powered bores will pump continuously when there is sufficient wind, whereas solar pumps will fill a tank and only pump when levels in the tank drop below a specified level.

Due to the relatively shallow nature of stock bores, they can have the potential to be impacted by any reduction in groundwater levels, therefore consideration of impacts on these bores will be a key factor when assessing drawdown impacts from the mine site and from the operational borefield.

6.4.2 Community and domestic supply

Within the Project area, there are a number of groundwater abstraction bores that are used for public water supply. These include supply for Stirling Station homestead, Barrow Creek and the Wilora community. All these locations have dedicated bores that provide a permanent water supply. The Wilora community is supplied with groundwater with an existing licence for 40 ML/year (issued to the Power and Water Corporation). Barrow Creek service station is licensed for 1 ML/year. No current licence data is available for Stirling Station homestead.

6.4.3 Groundwater dependent ecosystems

It was reported in Section 4.7 that Stirling Swamp (Anmatyerr North) and Mud Hut Swamp are Sites of Conservation Significance located within the Study Area. These wetland features have the potential to be maintained by groundwater.

Stirling Swamp, located north-west of the access road and rail node, comprises a large network of claypans, lignum swamp, semi-saline samphire and temporary open water, and the adjacent Hanson River. Stirling Swamp is thought to be connected to groundwater through a topographic low forming a 'window' to the relatively shallow Ti Tree aquifer water table. This area is therefore considered a discharge zone of the Ti Tree aquifer.

Mud Hut Swamp is located approximately 8 km north of the mine site. It is formed from a flood-out of the Bloodwood Creek and, based on its location as an outflow of the creek, it is unlikely that the swamp is maintained by groundwater.

There are no known permanent or semi-permanent water holes along the Hanson River, with any pools formed through surface water flow. These are relatively short lived as they are subject to evaporation and drain to the underlying aquifer.

6.5 Groundwater levels

6.5.1 Regional data

Development of an understanding of the baseline groundwater levels for the Project area is required in order to assist in determining any potential impacts that the Project operations may incur. It is important to understand the seasonal and temporal changes of groundwater levels.

The NRETAS bore database includes data on groundwater levels. An interrogation of this data highlighted the lack of bores within close proximity of the Project that have a good record of current and historic groundwater levels. Sites where groundwater level data is available are presented on Figure 6-3 and summarised in Table 6-2. Hydrographs for select wells are presented in Appendix D.

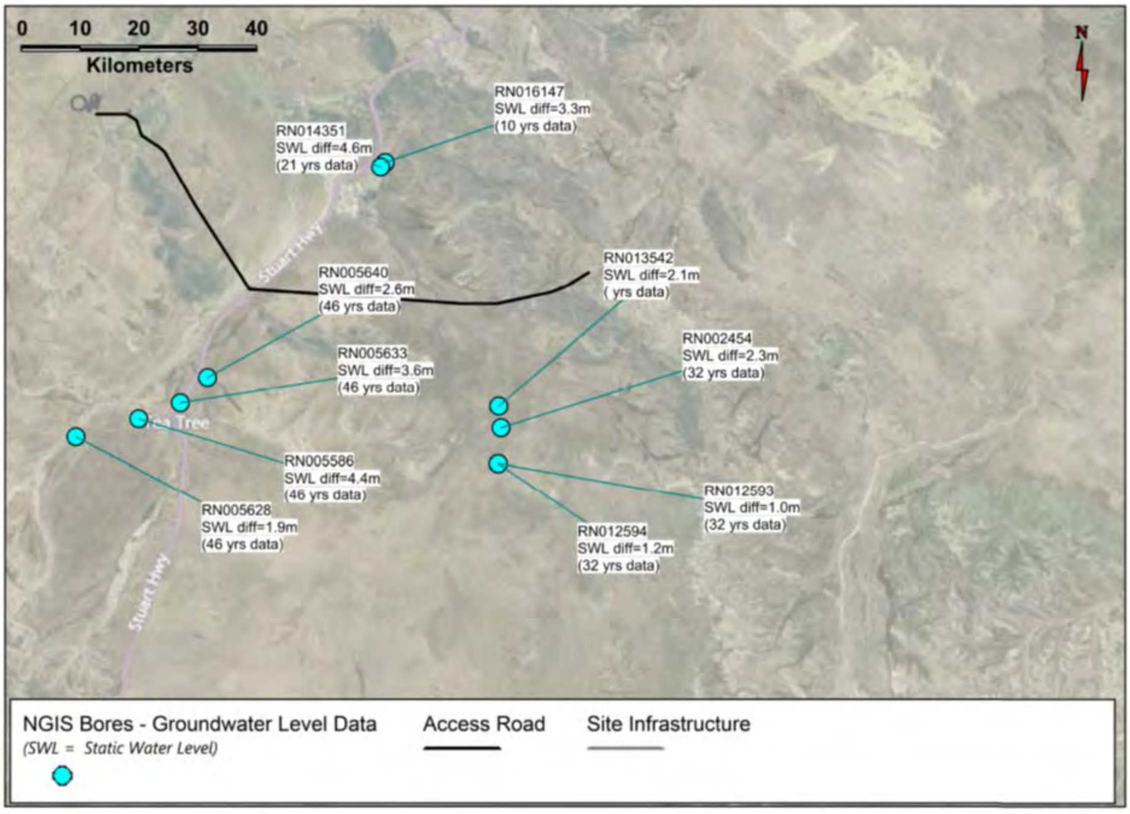

Figure 6-3 Sites with groundwater level data

Table 6-2 Groundwater level data summary

Site ID	Groundwater elevation range (mAHD)	Monitoring period	Comment
RN016147	474.8 to 478.1	10 years (1992-2002)	Located at Wilora. Generally increasing groundwater levels.
RN014351	472.9 to 477.5	21 years (1992-2003)	Located at Wilora. Record includes hourly data highlighting response of pumping.
RN005628	550.3 to 552.2	46 years (1967-2013)	Adjacent to Hanson River Channel. 2 m rise in levels between 1970-1979, with subsequent gradual reduction.
RN005586	543.6 to 548.0	46 years (1967-2013)	Adjacent to Hanson River Channel. General reduction in levels, with significant response to rainfall events/river flow.
RN005633	528.2 to 531.8	46 years (1967-2013)	Adjacent to Hanson River Channel. 2 m rise in levels between 1970-1979, with subsequent gradual reduction.
RN005640	519.1 to 521.7	46 years (1967-2013)	Adjacent to Hanson River Channel. 2 m rise in levels between 1970-1979, with subsequent gradual reduction.
RN012594	511.1 to 512.3	32 years (1981-2013)	Ti Tree Basin north. Significant rise in levels in 1991 and 2001.
RN012593	500.3 to 502.4	32 years (1981-2013)	Ti Tree Basin north. Significant rise in levels in 1991, 2001 and 2009.
RN013542	505.3 to 507.6	32 years (1981-2013)	Ti Tree Basin north. Significant rise in levels in 1991, 2000 and 2010.

As highlighted by the data, there are two sites at Wilora with a historic record of groundwater levels and several sites south of the Project area in the north of the Ti Tree Basin and along the Hanson River. For some of these sites a good record of groundwater levels is available. Groundwater levels tend to vary by between 2 and 4 m, with the data highlighting the response of the aquifers to large rainfall river flow/flood events.

For example, at monitoring well RN005586 (52 m deep), located 6 km west of Stuart Highway near Ti Tree, and on the southern edge of the Hanson River floodplain, groundwater levels increase by up to 2 m after significant flood events, and then recede until the following flood event. A gradual decrease in levels is noted between the summer of 1984 (when over 150 mm of rainfall was recorded in one day at Barrow Creek) until the summer of 1991 when another large rainfall event was recorded. During this seven year period, groundwater levels reduce by around 2.5 m.

Data from the available NRETAS bores indicates that groundwater between these locations has a gradient to the north, comparable to the general topographic elevations.

6.5.2 Site specific data

Groundwater and resource drilling for the Project has provided additional groundwater level data, albeit for a limited monitoring period. Groundwater level data was collated after completion of the 2015 drilling program (Section 6.7). The data indicated groundwater levels being relatively consistent between sites along the Hanson River palaeochannel at a depth of around 10 mbgl.

An assessment of resource drilling in the pit area in 2014 highlighted that depth to water was typically 20 to 22 mbgl.

6.6 Recharge

Aquifer recharge predominantly occurs from direct infiltration of rainfall. Due to the sporadic and minimal amount of rainfall typical of the region, this volume is quite low. Previous studies in the region, most notably for the Ti Tree Basin, have used an average long term recharge of 2 mm (Wischusen *et al.* 2012).

Whereas regional recharge is relatively low, large rainfall and subsequent flood events are known to significantly increase groundwater levels in areas close to active flow channels. However, a lack of monitoring data for the Hanson River channel means that recharge volumes for this system cannot be accurately quantified.

6.7 Summary of TNG groundwater investigations

Two initial stages of field based groundwater specific investigations have been undertaken for the Project. These are summarised in the following two sections, with the data from them incorporated into the general understanding of the site and the development of the site conceptual and numerical groundwater model.

6.7.1 Airlift investigation – March 2014

An investigation of the groundwater potential in the area of the pit was undertaken in March 2014 through airlifting of existing exploration holes. The airlifting program aimed to determine the likely groundwater in-flow to the pit area and whether there may be sufficient volumes of water available for mine site water use, for example using the potential dewater for ore processing water and dust suppression.

A total of eleven holes were assessed at locations both within and adjacent to the pit area. Groundwater was measured at a depth around 20 to 22 mbgl with salinity generally between 6000 and 8000 mg/L TDS.

During air-lifting of the exploration holes, low volumes of groundwater were able to be purged with only a low flow volume sustained in five of the sites at rates less than 12 L per minute. The air-lifting tests also allowed the determination of indicative aquifer parameters through the analysis of groundwater recovery data at each test site.

The testing demonstrated that the pit area will not be subject to significant groundwater inflow, and as such, there is no indication the pit will require substantial dewatering infrastructure. Alternative sources of water would be required as there will be insufficient volumes available from the pit to meet Project requirements.

6.7.2 Groundwater drilling and test pumping – March 2015

A drilling and testing program was undertaken in March 2015 to assess the groundwater supply potential of the Hanson River palaeovalley. Drilling locations were determined by TNG at targeted locations along the existing Hanson River and at maximum distances from existing stock bores. Drilling locations and field results are presented on Figure 6-4.

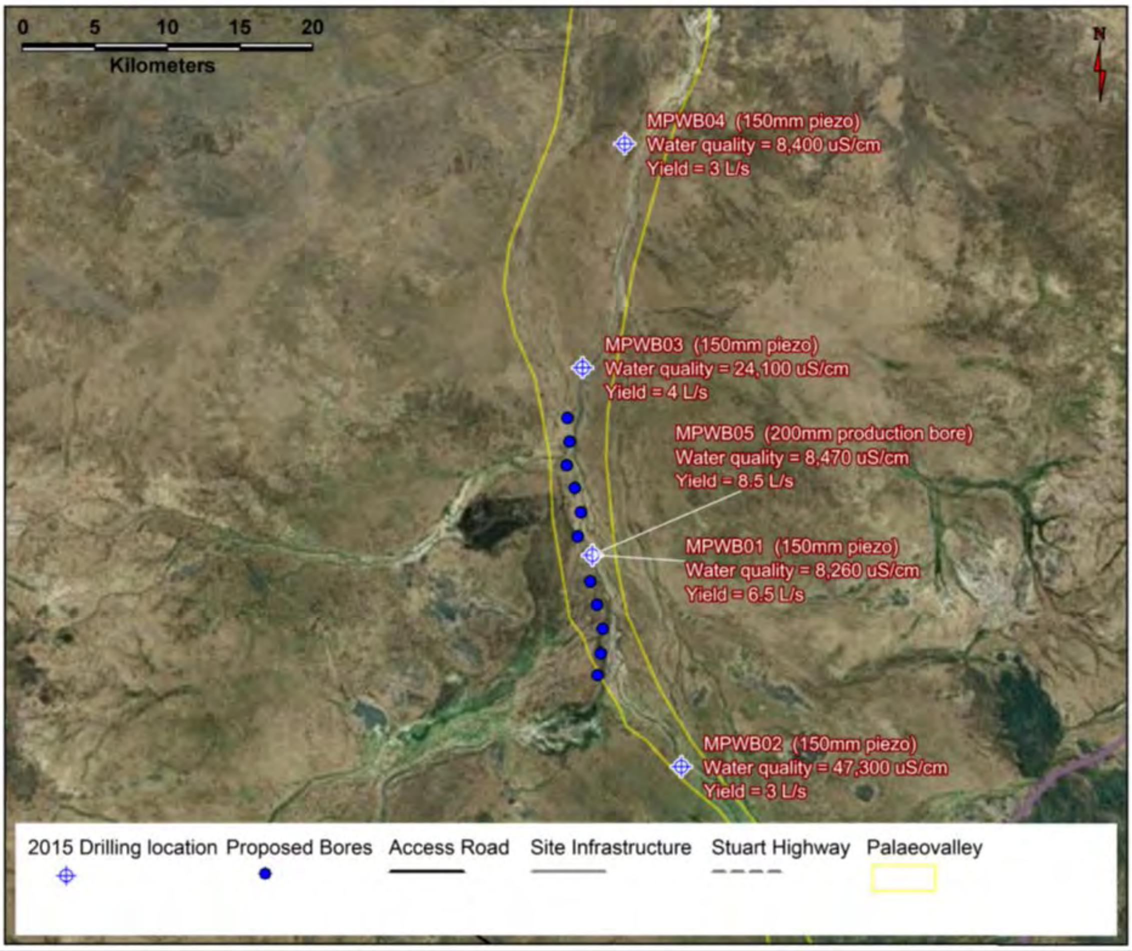

Figure 6-4 2015 groundwater drilling program locations

All drilled bores intersected a sequence of sands and gravels to varying thicknesses overlying a variable basement. In general, an upper silty unit was identified above a coarser grained sand and gravel unit (main aquifer). All bores produced significant water during drilling and 150 mm wells were constructed and pump tested at all sites. Highest high yields were found at WB01 and as a result a test production bore was installed at this location (WB05).

A test pumping program was completed on the constructed bores following completion of the drilling program. The key pumping test was for the test production well (WB05), which included monitoring of the adjacent monitoring well (WB01). The analysis of the 48-hour pump test data allowed the determination of aquifer properties and recommendations for operational pump rates for the production bore.

The drilling program confirmed the presence of the Hanson River palaeovalley aquifer, highlighting its broad extent (i.e. identified at all drilled locations) and relatively prospective groundwater yields. The water quality was found to be brackish to saline, however this was not an issue due to the proposed main use of water for ore processing (no salinity restrictions). Due to the favourable drilling results, an indicative borefield location was chosen which is highlighted on Figure 6-4 and further discussed in Section 3.2 and Section 7.

7. Groundwater modelling

7.1 Purpose of groundwater modelling

The main purpose of the groundwater flow modelling is to assess the potential cumulative impact of the operation of the borefield as well as that of the mine operation and post mine closure on the nearby groundwater users (stock bores and potential groundwater dependent ecosystems).

7.2 Conceptual hydrogeological model

A conceptual hydrogeological model was developed based on the available data, maps and reports. The conceptual model provides a framework for the numerical model development. Based on the regional scale of the model, a broad two layer system has been proposed encompassing the two key modelling areas. This can be summarised as:

- mine-site - weathered rock underlain by the fresh rock; and
- palaeovalley area - and silty/sandy clay underlain by silty sand/gravel aquifer.

Based on this two layer concept, a four layer numerical model is considered most appropriate to predict the potential cumulative impact of mine dewatering and water supply. The proposed model thicknesses, hydraulic properties of the each of the four layers and rational for using a four layer model is discussed below in Section 7.3.3. The four layer model has been graphically conceptualised and is presented below as Figure 7-1.

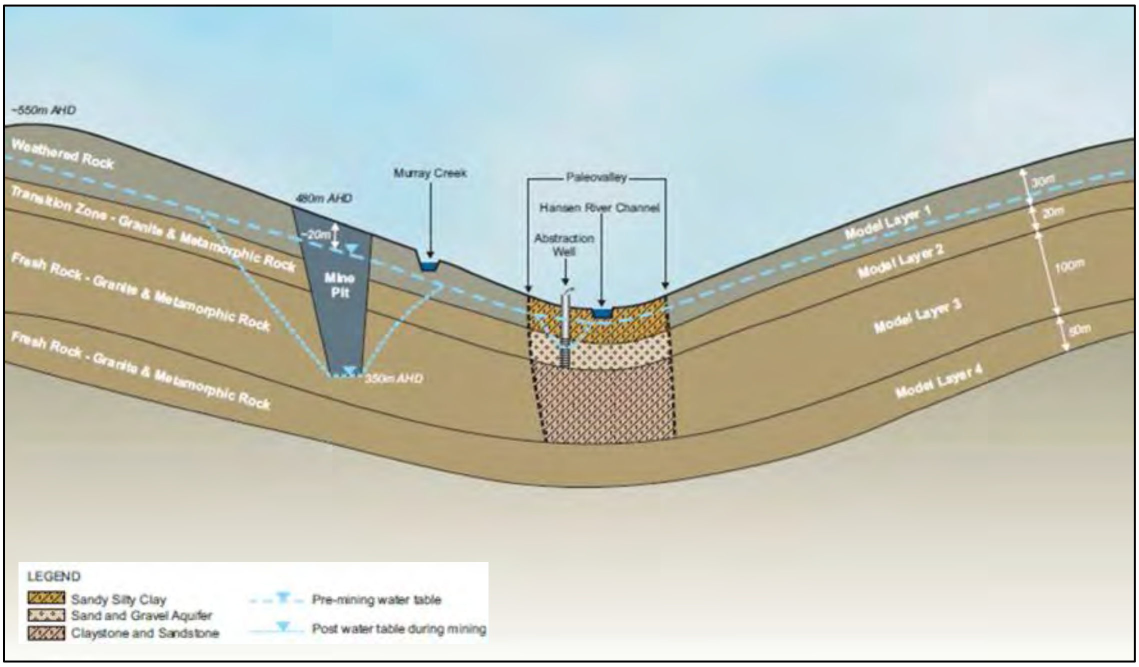

Figure 7-1 Conceptual hydrogeological model

7.3 Model set up

7.3.1 Approach

The industry standard numerical groundwater flow modelling code MODFLOW-USG (Pandey *at el.* 2013) has been selected for modelling of groundwater flow for the Project. Groundwater Modelling System (GMS v 10.1) has been used as a graphical user interface (GUI) for pre and post processing of the data.

MODFLOW-USG is a relatively new compared to other versions of MODFLOW (e.g. MODFLOW-96, MODFLOW-200 and MODFLOW-2005). However, it has distinct advantages over other versions of MODFLOW, in particular, refining the grid at an area of interest without having to refine entire rows or columns as was in the case of previous versions of MODFLOW.

In the case of mine dewatering and associated impact assessment cases (like this one), the model grid can be refined around the mine and/or around the proposed bore-field and a coarse grid can be assigned outside towards the boundary leading to fewer nodes to solve which in turn results in saving computer memory as well as faster model run times.

7.3.2 Model dimension, extent and grid design

A three-dimensional model (3D) has been chosen for this project, as groundwater flow is anticipated in all three directions. Whilst a one or two dimensional model could offer simplified results, taking into account the overall considerations of the Project, a more detailed and defensible 3D model will better address the overall project requirements. The model extends approximately 84 km in the east-west direction and 92 km in the north-south direction. The model extent is shown in Figure 7-2.

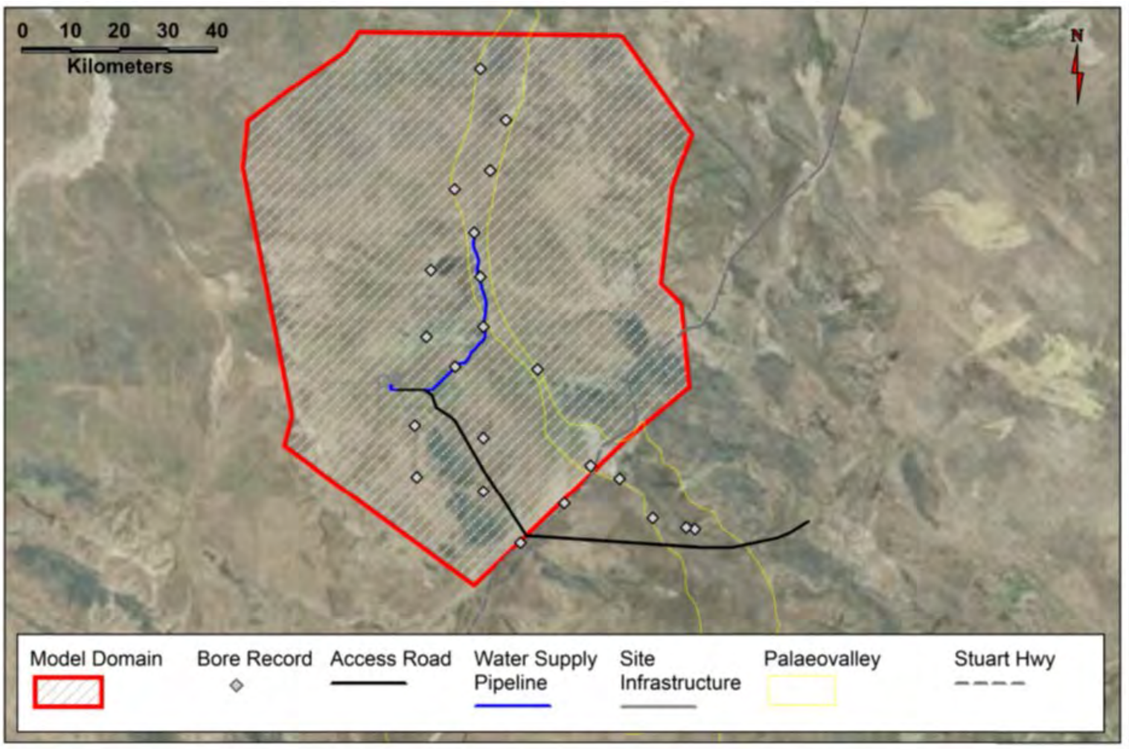

Figure 7-2 Groundwater model domain

The grid size was chosen to be 50 m in the area of the proposed mine location, 200 m in the area of proposed bore field and 800 m towards the boundaries. This should provide enough resolution to assess potential impacts at key locations. A Quadtree/Octree method was used for grid refinement. All model layers were refined to the same resolution at a particular location. This resulted in a total 95,028 model cells for the four model layers.

7.3.3 Model layers

A four layer model has been developed to represent the geology and hydrogeology around the mine pit as well as to account for the potential vertical flow coming from beneath the pit. The depth/thickness of each layer was determined following assessment of available drilling data, including:

- Resource drilling within and around the mine site;
- Groundwater drilling and testing in the palaeovalley; and
- Lithology data from historic drilling within the model domain.

A summary of the layers and initial hydraulic properties of the units is presented in Table 7-1.

Table 7-1 Model layer and proposed initial hydraulic properties

Layer	Description	Outside Palaeovalley		Palaeovalley	
		Kh (m/d)	Kv (m/d)	Kh (m/d)	Kv (m/d)
Layer 1	Weathered bedrock outside palaeovalley and sandy silt layer in the palaeovalley.	0.1	0.01	0.5	0.05
Layer 2	Transition zone outside palaeovalley and lower sand and gravel aquifer in the palaeovalley	0.01	0.01	5.0	0.5
Layer 3	Fresh bedrock	0.002	0.002	0.002	0.002
Layer 4	Fresh bedrock	0.001	0.001	0.001	0.001

The uppermost layer (Layer 1) is represented by the extent of the weathered zone in the bedrock outside of the palaeovalley and sandy-silt layer in the palaeovalley. Layer 1 has been modelled as 30 m thick based on the average thickness of the weathered zone and sandy silt layer.

The second layer (Layer 2) represents a transition zone between the weathered bedrock and fresh bedrock in the area outside of the palaeovalley and lower sand aquifer in the palaeovalley. Layer 2 has been modelled as 20 m thick based the average thickness of the sand and gravel aquifer in the palaeovalley area.

The third layer (Layer 3) represents fresh bedrock (igneous and metamorphic) in the area outside of the palaeovalley and sedimentary rock (claystone/sandstone) in the palaeovalley. Layer 3 has been assigned a nominal thickness of 100 m to capture the base of the proposed mine pit.

The fourth layer (Layer 4) represents fresh bedrock throughout the model domain in order to account for the potential vertical flow into proposed mine pit. A nominal thickness of the 50 m has been assigned for this layer.

The model base elevation has been derived from the topographic data by subtracting appropriate thickness for each of the four model layers. The topography elevation is based on SRTM-derived 1-second (near mine site with 1 km buffer) and 9-second (outside of the mine) Digital Elevation Models.

7.3.4 Boundary conditions

The following boundary conditions are applied in the model:

- Eastern and western boundaries: No-flow in all layers (assuming no water coming from or going to model) with the exception of the three locations where General head boundary (GHB) has been applied to account for groundwater inflow into the model domain;
- Southern boundary: GHB condition in all layers in the area of the palaeovalley (representing groundwater inflow from the Ti Tree Basin) and no-flow boundary to the rest of the area; and
- Northern boundary: GHB in all layers (representing groundwater outflow from the model domain to the north) in the area of palaeovalley and no-flow boundary to the rest of the area.

The head values applied in the GHB are approximately 10 m below topography in the palaeovalley area and approximately 20 m below topography at the rest of the GHB locations.

7.3.5 Temporal discretisation

No temporal discretisation is needed for a steady state model. The transient model which is used to predict the impact of groundwater pumping from the palaeovalley and pit is assigned with stress periods ranging from 1 year (with 12 time steps) to 60 years (with 30 time steps) and are discussed further in the Section 7.5.

7.3.6 Initial conditions

For the steady state model runs, initial conditions are assigned as topographic elevations, to provide the model with an initial guess which are subsequently changed during model calibration. For all transient simulations, the initial heads are derived from the corresponding steady state simulations.

7.4 Model calibration

7.4.1 Introduction

Calibration is a process in which model parameters are adjusted until model predictions fit historical measurements or observations. This is required in order that the model can be accepted as a good representation of the physical system of interest. This process is also known as model fitting, history matching, parameter estimation and the inverse problem. Calibration is generally followed by sensitivity analysis to test robustness of the model to changes in parameters during the calibration (Barnet *et al*. 2012).

Following the steady state calibration a sensitivity analysis on model parameters is generally undertaken to provide a realistic bounds of parameters to be used in the prediction and uncertainty analysis.

7.4.2 Steady state flow model calibration

During the steady state calibration, model parameters and boundary conditions were changed to match the measured head with the modelled head. The steady state model calibration was undertaken by trial and error (also known as manual calibration) by changing the recharge and boundary conditions.

7.4.3 Steady state flow model calibration results

After several calibration attempts, the combinations of recharge and boundary conditions identified in Table 7-2 provided a reasonable fit between observed head with modelled head. The modelled hydraulic conductivity values are provided in Table 7-3 along with the calibration statistics from the steady state calibration.

Table 7-2 Recharge and boundary conditions from steady state calibration

Model Run ID	Recharge rate mm/year (% of average annual rainfall)[10]			General head boundary elevation in palaeovalley (m AHD)[11]	
	Current Hanson River channel	Palaeovalley	Weathered zone	Southern boundary	Northern boundary
Cum_2_016	1.3 (0.36%)	0.5 (0.14%)	0.004 (0.001%)	472	385

Table 7-3 Calibration statistics from the steady state model calibration

Model run ID	Absolute residual mean (m)	Root Mean Squared (m)	SRMS (%)[12]	Mass balance error (%)	Maximum residual (m)
Cum_2_016	1.16	1.52	2.2	0.2	4.7[13]

A relatively high conductance value (>100 m^2/d) has been assigned along the general head boundary both to the south (inflow) and to the north (outflow). This means aquifer hydraulic conductivity will control the inflow and outflow rather than the conductance of the general head boundary.

A scatter plot showing computed versus observed head is presented below in Figure 7-3. Groundwater contours for the steady state model calibration are presented in Figure 7-4. The steady state modelled groundwater contours (initial conditions) highlight a generally consistent groundwater gradient across the model domain, with groundwater elevations increasing with distance to the south (i.e. groundwater flowing in a northerly direction). Over the model domain, head differences are over 100 m between the southern inflow areas and the northern outflow areas (over a distance of around 110 km).

When the head values are compared to the topographic elevation data, depth to groundwater is generally around 10 m in the area of the palaeovalley, and increases with distance from the palaeovalley. Of note, depth to groundwater in the area of Mud Hut Swamp is modelled as being around 15 to 20 m below ground level (i.e. conceptually the swamp is not connected to the regional groundwater system).

According to Barnet *et al.* (2012) a models acceptance should be based on a number of measures that are not specifically related to model calibration. These are required to demonstrate that a model is robust, simulates the water balance as required and is consistent with the conceptual model on which it is based. The performance measures of the steady state calibration are provided in Table 7-4.

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10 Stirling station (no 15572) with an average annual rainfall of 355 mm was used in the calculation of rainfall recharge %

11 General head boundary head values were assigned to 512 m AHD outside of the palaeovalley area to account for groundwater inflow into the model domain

12 SRMS (%) stands for scaled root mean square error and values below 5 to 10% are considered appropriate for a model calibration

13 At Boko Bore

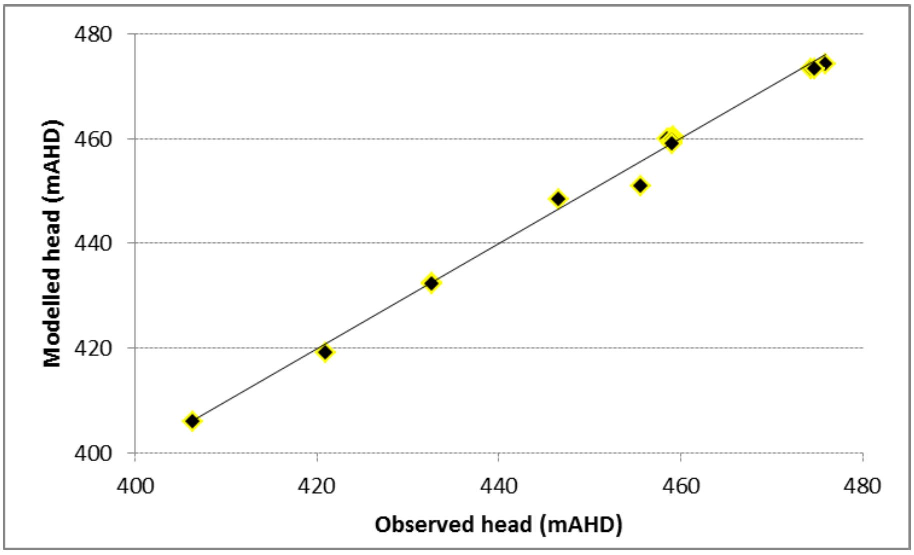

Figure 7-3 Modelled versus observed groundwater head (mAHD)

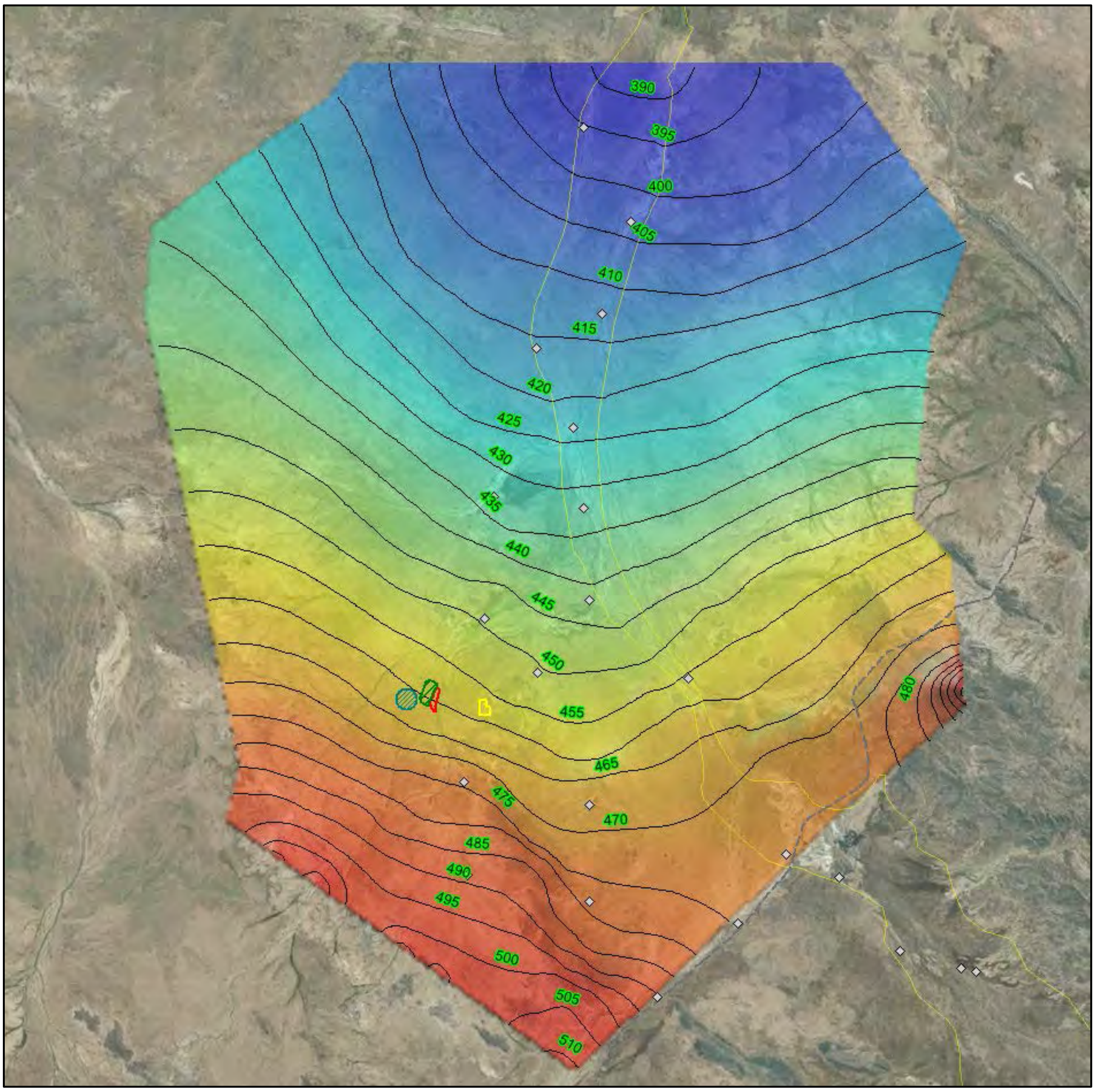

Figure 7-4 Steady state modelled groundwater contours

Table 7-4 Performance measures of steady state calibration-

Performance measure	Criteria	Criteria met (yes/no)
Model convergence The model must converge in the sense that the maximum change in heads between iterations is acceptably small.	The iteration convergence criteria should be one two orders smaller than the level of accuracy required in the head prediction. Typically of the order of centimetres or millimetres	Yes Convergence criteria used in the model was 0.001 m.
Water balance The model must demonstrate an accurate water balance, at all times and in steady state.	A value of less than 1% should be achieved and reported	Yes Water balance error was approximately 0.2%.
Qualitative measures The model results must make sense and be consistent with the conceptual model. Contours of heads, estimated parameters must make sense, and be consistent with the conceptual model with expectations based on similar hydrogeological setting.	There is no specific measure of success. A subjective assessment is required as to the reasonableness of model results, relative to observations and expectations.	Yes Modelled steady state contours show a small hydraulic gradient (0.001) towards the north, this is in line with current conceptual understanding of the area. The aquifer parameters are within the expected range of each of the lithological units.
Quantitative measures The goodness of fit between the model and historical measurements can be quantified, using statistics such as RMS, SRMS, MSR and SMSR for trial-and-error calibration and objective function in automated calibration.	Quantitative measures only apply during calibration. Statistics of goodness of fit are useful descriptors but should not necessarily be used to define targets. Targets such as SRMS <5% or SRMS <10% may be useful if model is similar to other existing models and there is good reason to believe that the target is achievable.	Yes SRMS was 2.2% which is less than 5% with relatively low value (1.52 m) of RMS. The maximum residual error was 4.7 m, at one location of Boko Bore, given the potential for error in measured groundwater elevation using STRM data, this error is not considered significant.

Since the steady state model has met the criteria for model convergence, water balance, qualitative measures and quantitative measures, the flow model can be considered calibrated and can be used in prediction.

7.5 Simulation scenarios (model prediction)

Following calibration in steady state, the model was used to predict the operation of the Project area, including mine pit development and operation of the water supply borefield.

The aquifer parameters used in the predictive model were derived from the aquifer testing, steady state calibration and a likely range of the parameters based on past experience and literature values of similar formations. The storage parameters used are presented in Table 7-5. The hydraulic conductivity and recharge values used in the prediction are the same as those used in the steady sate calibration as presented in Table 7-1 and Table 7-2 respectively.

Table 7-5 Storage parameters used in the prediction[14]

Layer	Description	Outside palaeovalley		Palaeovalley	
		Ss	Sy	Ss	Sy
1	Weathered bedrock outside palaeovalley, and sandy silt layer in the palaeovalley.	1E-5	0.01	1E-5	0.05
2	Transition zone outside palaeovalley and, lower sand and gravel aquifer in the palaeovalley	1E-5	0.005	1E-5	0.1
3	Fresh bedrock	1E-5	0.001	1E-5	0.001
4	Fresh bedrock	1E-5	0.001	1E-5	0.001

A transient prediction run was undertaken to model cumulative impacts from the borefield operation and the mine pit development. The scenario represents the operation of the borefield in the palaeovalley and development of the mine pit with incremental pit advancement.

This transient prediction model has been run for 100 years. This includes 17 years of abstraction (2 years mine pre-production, followed by 15 years of mining). Following cessation of mining, borefield abstraction stops and the model is run for a further 83 years to predict groundwater level recovery. Borefield operation has two stages with the first stage operating at an abstraction rate of 1.6 GL/year (51 L/s) for the first five years. For the second stage (from year 6 to 17), abstraction is increased to 2.6 GL/year (82 L/s).

This model has been set up with annual stress periods for the first 20 years with each stress period comprising 12 time steps followed by two stress periods of 10 year duration (with 10 time steps each) and the last stress period of 60 years duration with 20 time steps.

7.6 Simulation results

During mining

Transient model drawdown impacts for the model domain are illustrated for year 17 on Figure 7-5. The 17 year drawdown plot represents the maximum drawdown resulting from borefield operation and pit dewatering. As highlighted by Figure 7-5, drawdown at 17 years is concentrated around the borefield and at the mine pit. To highlight these two areas, individual plots for each area are presented as Figure 7-6 and Figure 7-7.

At 17 years, the maximum drawdown is modelled as being up to 12 m at the location of the operating bores in the centre of the borefield. Drawdown decreases significantly with depth away from the palaeovalley. The 1 m drawdown contour extends to around 6 km south of the borefield, still a considerable distance (approximately 28 km) from the inflow zone around Stirling Swamp.

[14] Ss: Specific Storage (1/m)
Sy: denotes Specific Yield

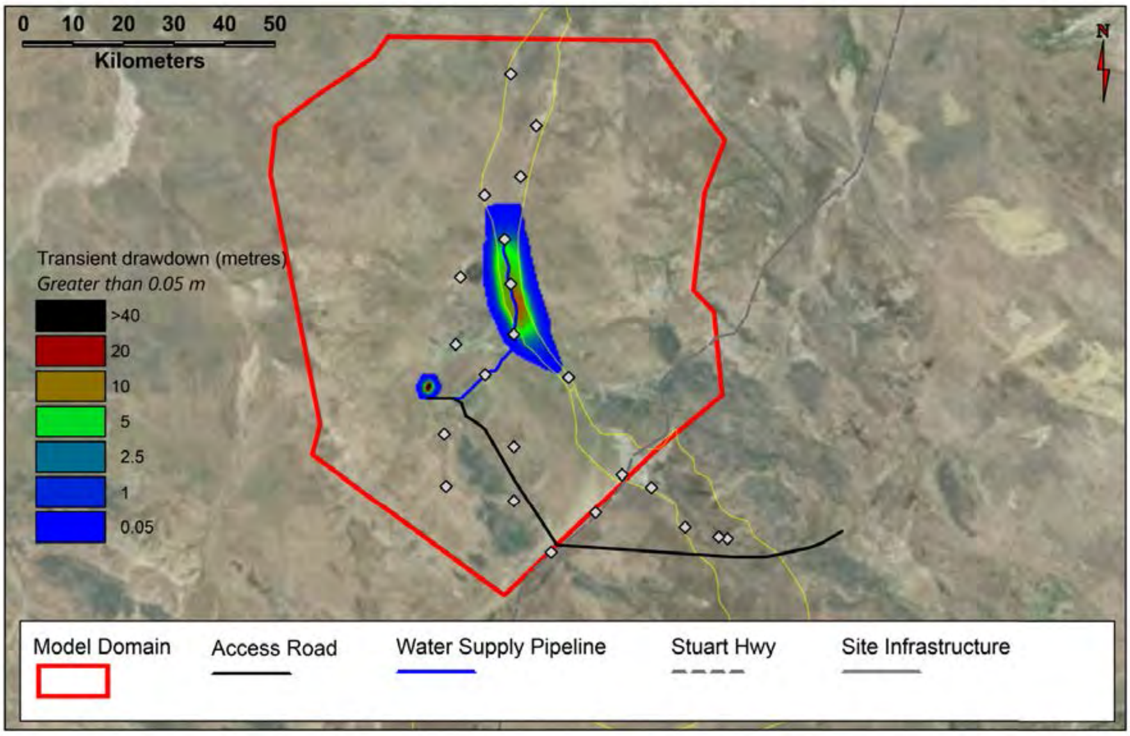

Figure 7-5 Simulated transient groundwater levels for year 17

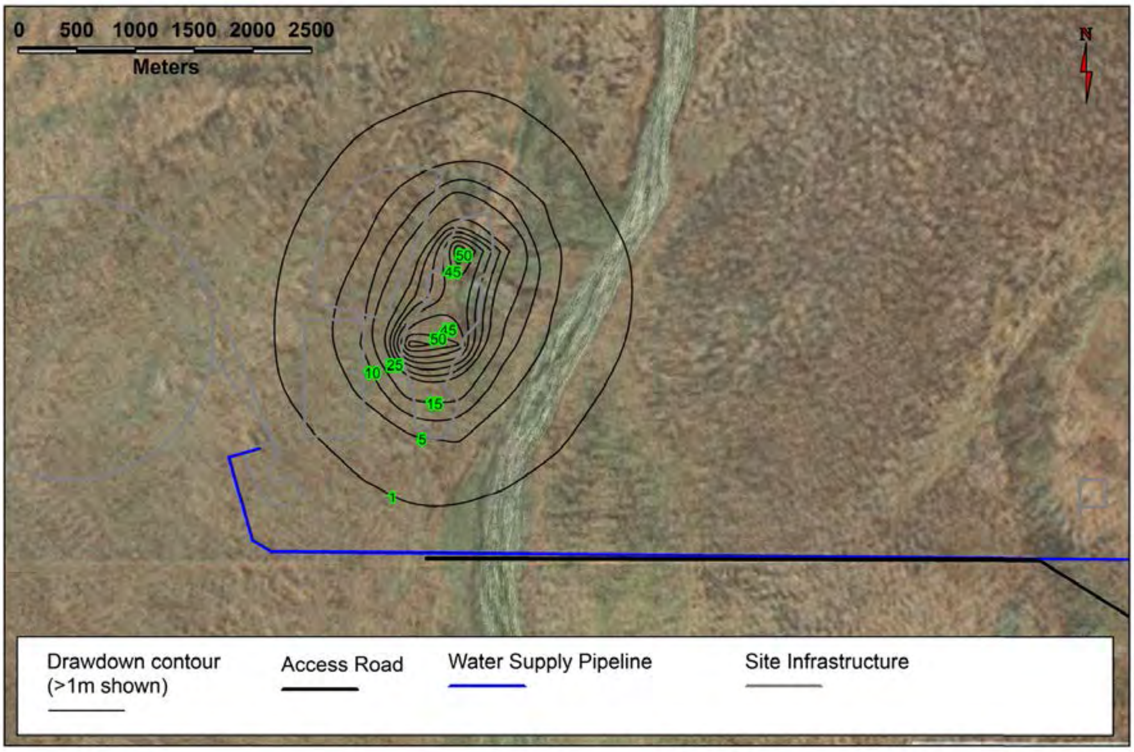

Figure 7-6 Simulated transient groundwater drawdown – mine site at 17 years (contours 1 m to 50 m shown)

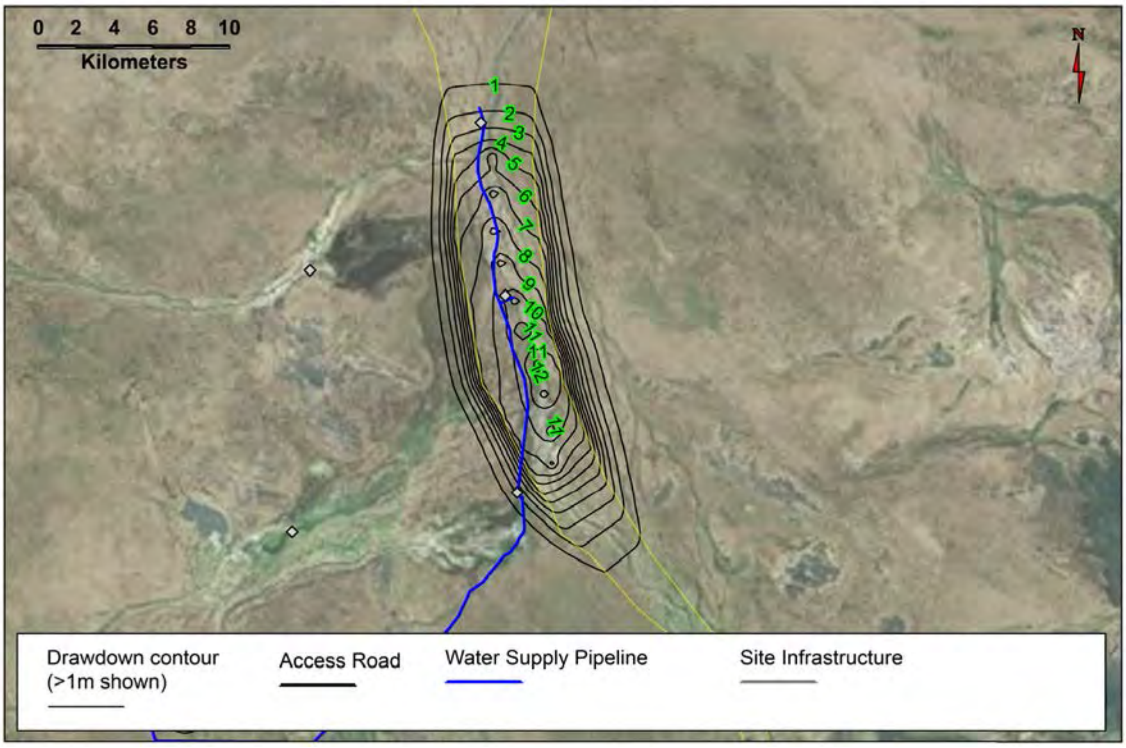

Figure 7-7 Simulated transient groundwater drawdown – borefield at 17 years

Plots for groundwater level changes over time (hydrographs) are presented in Figure 7-8 and Figure 7-9 which represent drawdown and recovery at a location between pumping bores and at a location on the edge of the palaeovalley aquifer respectively. As illustrated by these figures, groundwater levels are slow to recover, largely due to the modelling of conservatively low levels of recharge. For locations outside of the palaeovalley, some minor increased drawdown is expected after cessation of abstraction.

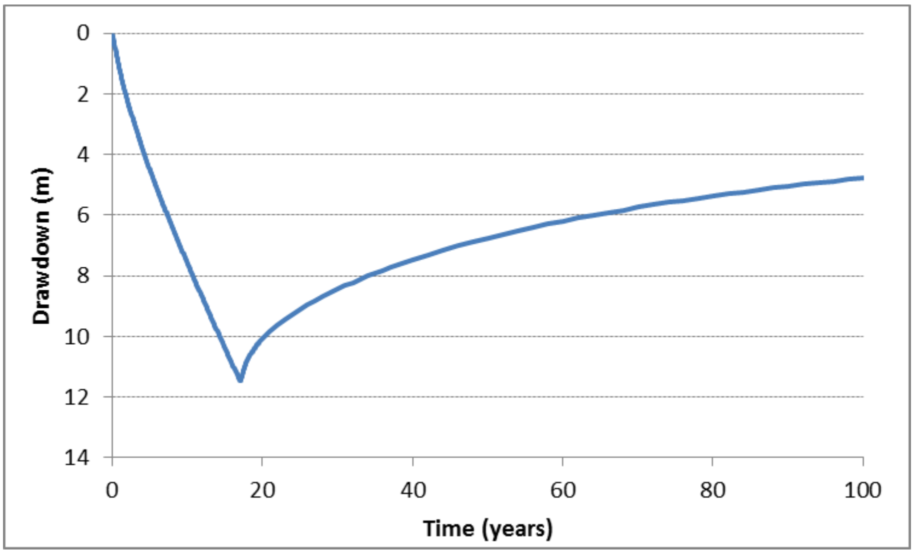

Figure 7-8 Drawdown and recovery between two pumping bores

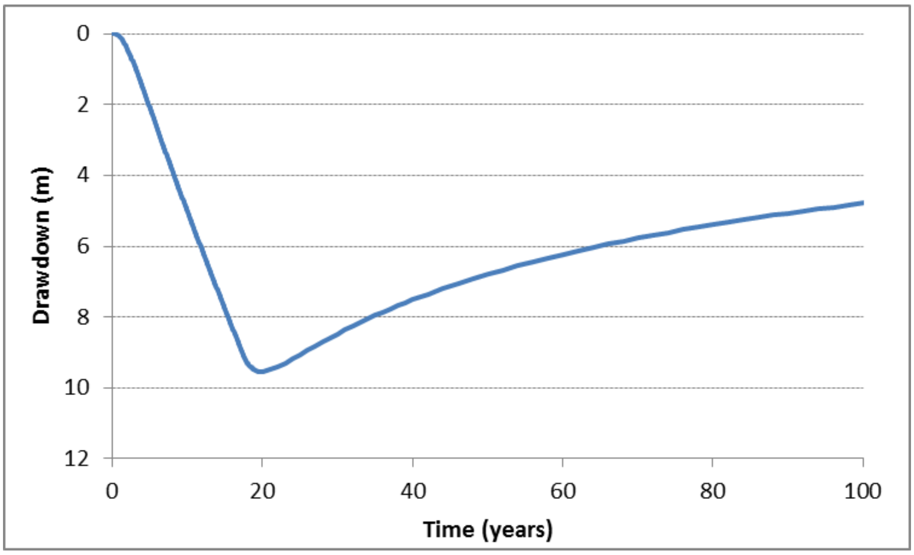

Figure 7-9 Drawdown and recovery at edge of palaeovalley aquifer

Predicated drawdown values at select pastoral bores are presented in Table 7-6. As highlighted by the data in the table, pastoral well impacts are predicted to occur at Browns and Wollogolong Bore's. These are the two closest pastoral bores to the borefield and are expected to have groundwater levels reduced by up to 3.2 m following 17 years of borefield abstraction.

At the mine site, drawdown contours less than 50 m have been plotted. Within the pit, drawdown under transient conditions reaches a drawdown at 17 years of up to around 100 m within the location of the pit, and rapidly decreases with distance from the pit. The 1 m drawdown contour is predicted as being around 1 km from the pit edge, and the approximate limit of drawdown (0.05 m) a further 1 km from this. As such, no drawdown impacts at 17 years are expected within the area of proximate receptors such as Mud Hut Swamp.

Table 7-6 Modelled drawdown at pastoral bores/wells

Bore/well	Distance from mine[15]	Distance from borefield[16]	Transient drawdown (17 yrs)	Transient drawdown (100 yrs)
Mudhut Bore	9	14	<0.05 m	<0.05 m
Boko Bore	11	12	<0.05 m	<0.05 m
Browns	19	2	2.4 m	3.4
Wollogolong Bore	33	2	3.2 m	2.9 m
Middle Well (inactive)	28	0	10.5 m	4.7 m
Mt Peake Creek Bore	22	9	<0.05 m	0.1 m
Mistake Bore	20	24	<0.05 m	<0.05 m
Junction Well	28	14	<0.05 m	1.1 m
Twin Soak Bore	45	15	<0.05 m	0.5 m

Post mining

Transient model drawdown impacts for the model domain are illustrated for year 100 on Figure 7-10. The 100 year drawdown plot represents the drawdown and subsequent recovery at the borefield and drawdown around the pit after cessation of mining/abstraction for 83 years.

15 Distance from centroid of drawdown cone at mine (km)
16 Distance from centroid of drawdown cone at borefield (km)

At 100 years, the drawdown within the area of the borefield has recovered from a maximum drawdown at 17 years, to a 100 year drawdown of generally less than 5 m. Whereas the amount of drawdown near the borefield is reduced, the extent of drawdown increases slightly as groundwater from storage drains to the area of the recovering borefield.

In the area of minesite, the extent of drawdown increases slightly with respect the 17 year drawdown. The 1 m drawdown contour extends to around 3.5 km from the mine pit. This indicates that impacts at 100 years are unlikely to reach the area of Mud Hut Swamp.

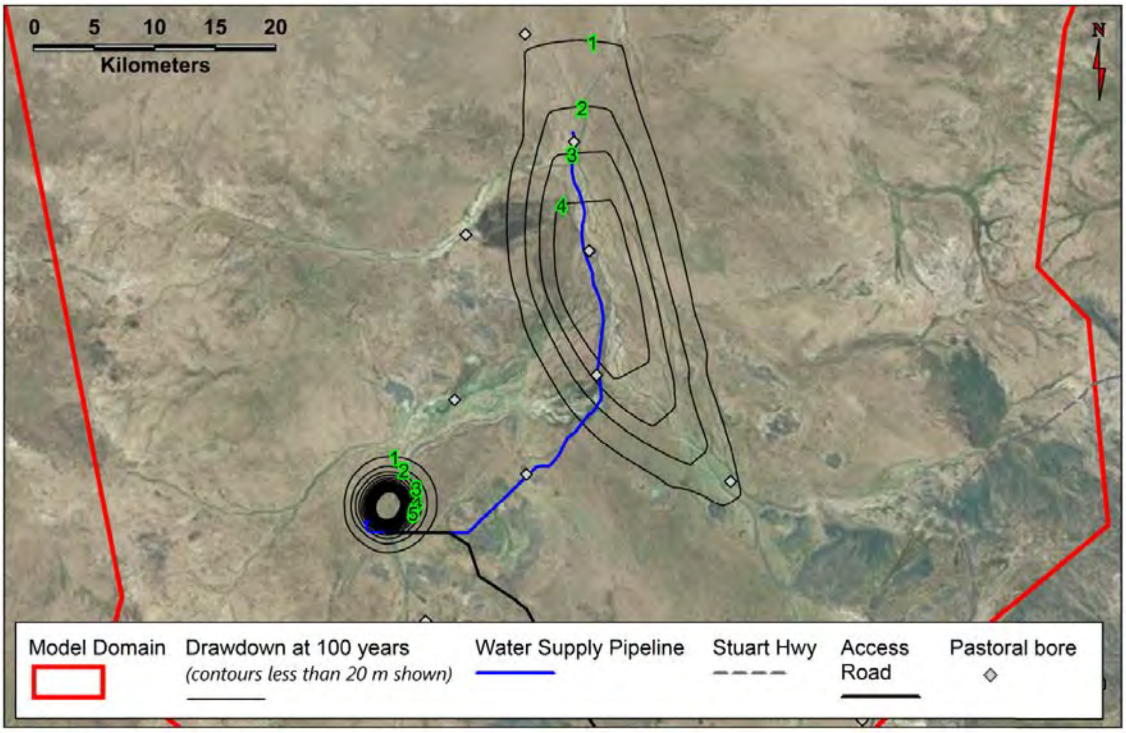

Figure 7-10 Drawdown at 100 years

7.7 Pit lake development

Following the completion of mining at 17 years (after 2 years pre-production and 15 years production), any in-pit dewatering will ceased which will result in groundwater ingress to the pit void. The predicted inflow to the pit is expected to be relatively low, reflective of the low permeability of the pit wall.

Modelling data indicates that groundwater inflow at year 17 is just over 100 m^3/d and reduces to about 70 m^3/d over the next 80 years. It should be noted that this volume is highly sensitive to the parameters used in the model, therefore could potentially change by orders of magnitude should actual parameters differ to model parameters.

The development of a pit lake was calculated, taking into consideration the parameters summarised in Table 7-7. The calculated data indicates that a pit lake would develop, with pit lake water levels stabilising after about a year (inflow becoming equal to evaporation). It is predicted that the pit lake would stabilise at around 365 mAHD, equivalent to around 10 deep at its deepest part. The pit lake will become increasingly saline as salts from groundwater, surface water and rainfall accumulate. By around 7 years post-closure a salinity of around 35,000 mg/L is predicted.

Table 7-7 Parameters used for calculation of Pit lake development

Parameter	Value
Rainfall	355 mm/year based on Stirling Station data at a TDS concentration of 50 mg/L.
Evaporation	3,141 mm based on Alice Springs data with a Lake-Pan Evaporation Coefficient of 0.6.
Runoff	Nominal value of 1000 mg/L for TDS concentration, with a Runoff coefficient (between pit lake and pit wall) of 0.9.
Groundwater	96 m^3/d average inflow rate after 17 year from groundwater flow model. TDS of 000 mg/L based on levels found at in-pit exploration drill holes.

7.8 Model limitations

This model has been classified as Class 1 (low confidence model), based on steady state calibration followed by transient predictions (Barnett *et al.* 2012), hence its results should be treated in line with the expectation of a low confidence model.

The aquifer characteristics of the palaeovalley aquifer have been developed from a relatively limited drilling investigation. As such, the measured aquifer characteristics may not be representative of the whole of the borefield (i.e. additional bores could provide greater or smaller yields).

It is important to note that the extent (lateral and vertical) of the palaeovalley between the tested bores is currently unknown and has been assumed based on the limited available drilling data. A more (or less) extensive palaeovalley alluvial aquifer would have significant implications on the extent and amount of drawdown.

The model has taken a conservative approach to the recharge characteristics (i.e. low recharge value used) to allow for uncertainty in the recharge mechanisms that may be present along the active river channels. There is regional evidence that flood events can directly recharge the alluvial aquifer resulting in significant groundwater level increases that perpetuate for over a period of years to decades (Wischusen *et al.* 2012). Such events could result in a sudden recovery of groundwater levels that have declined from pumping, however this needs to be substantiated though on-site monitoring of levels and responses to flood/flow events. The infrequent nature of such flood events is also problematic to account for in prediction modelling.

7.9 Modelling conclusions

Maximum groundwater drawdown at the borefield at the end of mining is modelled as being up to 12 m at the location of the operating bores in the centre of the borefield. Drawdown decreases significantly with depth away from the palaeovalley. The 1 m drawdown contour extends to around 6 km south of the borefield.

The model predictions indicate that groundwater levels at the up-gradient model boundary, in the area adjacent to Stirling Swamp and outflow of the Ti Tree basin, are not impacted by abstraction from the borefield.

At the end of mining, drawdown under transient conditions reaches a maximum of around 100 m within the location of the pit, and rapidly decreases with distance from the pit. The 1 m drawdown contour is predicted as being around 1 km from the pit edge, and the approximate limit of drawdown (0.05 m) a further 1 km from this. No drawdown impacts at 17 years are expected at Mud Hut Swamp.

The transient prediction run and steady state prediction run indicate groundwater level impacts at some existing stock bores. Existing stock bores closest to the borefield are modelled as having a groundwater level reduction by up to around 3 m. Such a reduction in groundwater levels may lead to the existing stock bore infrastructure being inadequate to provide stock water supply.

At 100 years, the groundwater levels recover in the area of the borefield, with maximum drawdown reducing to less than 5 m. However the overall extent of drawdown does increase slightly as groundwater from storage drains to the recovering borefield.

Drawdown extent in the area of the mine site at 100 years increases to an extent of 3.5 km from the mine pit for 1 m drawdown. No drawdown impacts at 100 years are expected at Mud Hut Swamp.

The transient simulations indicate that groundwater level recovery is slow in the palaeovalley. The slow recovery is largely related to the recharge characteristics of the model, which are conservative. The details of the recharge characteristics within the river channel and flood plain have not been empirically quantified within the model area.

Following cessation of mining a shallow pit lake is predicted to form.

8. Potential for contamination

8.1 Contaminant sources and pathways

8.1.1 Contaminant sources

Potential contaminant sources may include activities and disturbances associated with the construction and operation of the following:

- Disturbed surfaces such as pre-strip;
- Waste landforms including waste rock dumps (WRD);
- Active mining areas;
- Run of mine (ROM) pad;
- Long term stockpiles;
- Concentrate stockpiles (at processing plant and Adnera loadout facility);
- Tailings storage facility (TSF);
- Concrete batch plant;
- Beneficiation associated with crushing, grinding and concentration;
- Haul roads and lay down areas;
- Access roads to mine site, Adnera loadout facility and borefield;
- Vehicle leaks/emissions;
- Vehicle washdown areas;
- Fuel farm and chemical storage and handling areas;
- Gas fired power station;
- Oily water containment and treatment systems;
- Accommodation village;
- Mine administrative buildings;
- Workshops and warehouse;
- Waste water disposal areas;
- Borefield and associated water transfer pipelines;
- Diesel generators and fuel tanks at the borefield;
- Process water dam;
- Raw water dam; and
- Waste treatment areas (water treatment plant, wastewater treatment plant, landfill).

8.1.2 Contaminants of concern

Potential contaminants of concern include:

- Sediment;
- Salinity;
- Hydrocarbons (fuels and oils);

- Acid drainage elements from potential exposure of sulphides in the mine pit, WRD or TSF leachate;
- Blast residues;
- Nutrients;
- Microbiological; and
- Chemicals and reagents used for process plant.

8.1.3 Release mechanisms

Potential release mechanisms for contamination include:

- Erosion of disturbed surfaces;
- Inadequate stormwater/runoff separation;
- Leaching from WRD and long term stockpiles;
- Seepage from the TSF;
- Construction and operation of borefield infrastructure within a floodway;
- Inadequate treatment of waste water prior to discharge; and
- Accidental spills.

8.1.4 Exposure pathways

Key exposure pathways include:

- Runoff from contaminated surfaces;
- Overflow of mine affected water from water storages;
- Leaching of contaminants from the pit, spoil stockpiles, WRD, TSF and mine affected water storages; and
- Dust from stockpiles, WRD, processing plant and vehicle movements.

8.1.5 Receptors and endpoints

The key environmental receptors and endpoints that are potentially sensitive to changes in water quality include:

- Receiving aquatic systems (waterways, wetlands, groundwater recharge zones, groundwater aquifers);
- Fauna and livestock (consumption); and
- Humans (recreation and consumption).

8.2 Ore and waste characterisation

8.2.1 Ore stockpiles

Extracted ore will be transported to the Run of Mine (ROM) pad for direct processing or to one of four long-term stockpiles. The stockpiles of ore will be established to build up and maintain inventory and to facilitate blending different grade ore material during processing. Material from primary crushing will be stored in a High Pressure Grinding Rolls (HPGR) stockpile.

The mineral resource is hosted by a mafic intrusive rock (a gabbro sill) and the orebody comprises the magnetite-rich portion of the sill. The intrusive is oxidised resulting in there being negligible magmatic sulphide within this material. Geological logging rarely encountered visible sulphides and, when so, comprises in the order of ~2% of the sample over a few metres. Generally the sulphides seen are associated with structural zones and faults/fractures.

Accordingly, the ore body is considered to be benign and the ore stockpiles should not pose any discernible risk to the identified receptors and endpoints. It is recommended that periodic testing of the stockpiled ore be conducted to confirm the absence of potentially acid forming (PAF) material during the mining operations. Further characterisation of the ore body should be conducted to determine salinity profiles.

8.2.2 Waste Rock Dump

The rock types that will contribute to the waste dumps exhibit oxidising conditions so are expected to have low sulphide content as follows:

- Surface overburden (pre-strip) comprises desert sand aeolian and colluvial/alluvial sediment, which is weathered material that formed at the surface under strongly oxidising conditions and will not contain sulphides;
- A small amount of overburden will be gabbro hanging wall (which is either weathered or fresh) containing some magnetite thereby indicating oxidising conditions and is likely to have low sulphide content; and
- Some waste adjacent to the orebody material comprises granite which may have a small sulphide component (up to 2%).

The material to be stockpiled in the WRD is likely to have a sulphide content well below 1 wt% sulphide content, while the gabbro ore has a lower sulphide content (less than 0.5 wt% sulphide). This sulphide content will not generate a significant Acid Mine Drainage (AMD) issue. Therefore, the WRD should not pose any discernible risk to the identified receptors and endpoints.

As with the ore stockpiles, it is recommended that periodic testing of the WRD be conducted to confirm the benign nature of this material. Further characterisation of the waste materials should be conducted to determine the salinity profiles of the waste materials

8.2.3 Concentrate stockpiles

The Project will produce magnetite concentrate which will be stored in stockpiles at the processing plant and at the Adnera Loadout Facility. Material Safety Data Sheet (Midas METS 2014) identifies that the magnetite (Fe_3O_4) product exhibits low risk with regards to health, flammability, reactivity and contact. Key hazards relate to high level prolonged exposure to dust which may cause lung or airway irritation. The magnetite concentrate is non-toxic to flora and fauna, insoluble, chemically stable and not regulated for transport (Midas METS 2014).

Dust generated from processing, handling and transport of the concentrate will be controlled by:

- The ore having an inherent moisture level prior to processing;
- Use of sprays and dust collection systems in crushers and at material transfer points;
- Maintaining moisture levels in the concentrate; and
- Covering concentrate loads during transport (truck and train).

The concentrate is inert and non-toxic and does not constitute a threat to identified receptors and endpoints.

8.2.4 Tailings

The tailings stream will consist of non-magnetic silts and sands. Geochemical testing of the tailings has been completed by Outotec Laboratory (2015) and identifies that the non-magnetic tailings are composed of silicate wastes. The chemical composition includes:

- 13% Fe;
- 44% SiO_2;
- 12% MgO;
- 12% Al_2O_3; and
- 1% TiO_2.

The tailings stream will dewatered with a tailings thickener where flocculant will be added to settle the fine solids. Other than the flocculant, the tailings stream has no additional chemicals or reagents and therefore is considered to pose no adverse risk to the identified receptors and endpoints. The flocculant will be stored and handled appropriately onsite (Section 8.7.2).

Nalco 83372 (or similar) is indicated to be used as the flocculant in the process plant. Material Safety Data Sheet for Nalco Optimer 83372 powder flocculant identifies that the potential hazard of the product to humans is low, the product has no known ecotoxicological effects and based on the hazard characterisation the potential environmental hazard is low.

The environmental fate of flocculant within the environment was estimated, with release expected to distribute to the air, water and soil / sediment in the respective approximate percentages <5 %, <5 % and > 90%. The MSDS notes that no bioaccumulation will occur, as the large size of the polymer is incompatible with transport across cellular membranes.

It is recommended that periodic testing of the tailings stream be conducted to confirm the stability of the material during the mining operations.

8.3 Ore and waste management

8.3.1 Ore stockpiles

Ore stockpiles will be established on levelled terrain and will be stacked and retrieved using a front end loader and tip trucks. It is recommended that runoff separation be established through appropriate bunding and drainage ditches to retain runoff from the stockpiles and to prevent inflow of external drainage to the sites. Runoff from ore stockpiles should be contained and directed to appropriately sized sedimentation ponds for managed release to the environment. Details of these management measures should be established as part of an Erosion and Sediment Control Plan (ESCP).

8.3.2 Waste rock dump

One WRD will be developed for the life of mine and located between Murray Creek and Bloodwood Creek within a zone characterised by flat topography. The landform is to be designed to be safe, geotechnically stable and non-erodible. The WRD will feature benches to collect stormwater drainage and provide access for closure cover installation, reclamation activities and maintenance. Stormwater collected on benches will be conveyed to a surface water collection and sedimentation ditch/pond, which will collect and treat runoff prior to discharge to the environment. It is recommended that the nature and sizing of the sedimentation ditch/pond should be addressed in an ESCP.

8.3.3 Concentrate stockpiles

It is noted from Section 8.2.3 that moisture levels in the magnetite concentrate will be important and will require appropriate management. It is recommended that runoff from the magnetite concentrate stock piles be contained and that drainage water be recovered and recycled for dust suppression or processing purposes. Details of the requisite management measures should be determined as part of a site Water Management Plan.

8.3.4 Tailings storage facility

The non-magnetic tailings will be disposed to a tailings storage facility (TSF). The thickened tailings will be pumped to a central discharge area along an access ramp that will be progressively raised according to the staged development schedule. Tailings deposition will be via five outlet spigots placed around the perimeter of the central discharge area, allowing the formation of an even beach and effective draining and drying of the tailings. Water from the surface of the TSF will be decanted to a sump for transfer to the Process Water Dam.

All rainfall on the surface of the TSF and internal face of the bund wall will be contained and recovered via an underdrainage system. Runoff from rainfall on the external face of the bund wall will be collected in a drainage ditch and conveyed to an appropriately sized sedimentation pond for managed release to the environment. Details of these management measures should be established as part of an ESCP.

The TSF will be unlined but will be constructed with under-drains, toe drains and over drains connected into the sump. Some seepage loss will still occur, which has the potential to affect water quality and groundwater levels due to mounding. Boreholes will be constructed and monitored to assess the potential interaction between the TSF and the surrounding environment. Details of the requisite management measures associated with the operation of the TSF should be detailed in a site Water Management Plan.

Based on the non-toxic nature of the tailings, the impacts from seepage are expected to be negligible. However, it is noted in Section 3.2.5 that the waste water streams from the multi-media filters and the brackish water reverse osmosis plant to be used for water treatment will be discharged to the Process Water Dam. Accordingly, there is potential for salt concentrations to build up within the process water cycle resulting in the salinity of the tailings stream increasing over time. Further, cleaning agents used for the filters could also be present in the tailings stream, albeit at extremely low concentrations.

8.4 Saline drainage

8.4.1 Ambient conditions

It was noted in Section 5.5 that no surface water samples have been collected to date due to the ephemeral and event driven nature of surface water flows within the region and that sediment samples were collected as a proxy of surface water quality. Sediment samples from the Hanson River upstream of the transport corridor and Murray Creek upstream of the Project site reported electrical conductivity concentrations of 3 and 7 uS/cm respectively. Samples collected from the discharge channel to Mud Hut Swamp from Bloodwood Creek and the discharge channel to Stirling Swamp from the Hanson River reported electrical conductivity concentrations of 28 and 70 uS/cm respectively. Sediment samples from the Hanson River and Murray Creek downstream of the Project site reported electrical conductivity concentrations ranging from 6 to 15 uS/cm.

Groundwater quality monitoring indicates that the electrical conductivity of the existing bores sampled ranged between 3,630 and 6,880 uS/cm, with the electrical conductivity of new investigation bores ranging between 6,800 and 41,600 uS/cm. Two of these bores had elevated electrical conductivity values (bore MPWB02 upstream of the confluence of the Hanson River and Murray Creek and bore MPWB03 located downstream from Wollogolong Bore) and seem to be isolated locations of elevated salinity as the balance of bores had electrical conductivity values < 8,000 uS/cm.

8.4.2 Potential saline drainage

The potential for saline drainage from mine operations to downstream water resources will be a function of the following processes:

- Background catchment salinity levels;
- Potential saline leachate from waste landforms;
- Management of brine water discharge within mine water operations; and
- In-storage processes such as evaporation, mixing and stratification.

It is recommended that the various water storages be operated to ensure that they are well mixed and that any outflow to the environment considers the salinity of discharges. Stormwater separation and containment is a further key saline drainage management measure. These management measures should be detailed in a site Water Management Plan and ESCP.

8.5 Acid Mine Drainage

8.5.1 Ambient conditions

Sediment samples from the Hanson River upstream of the transport corridor and Murray Creek upstream of the Project site reported pH values of 5.6 and 5.4 respectively. Samples collected from the discharge channel to Mud Hut Swamp from Bloodwood Creek and the discharge channel to Stirling Swamp from the Hanson River reported pH values of 7.2 and 5.3 respectively. Sediment samples from the Hanson River and Murray Creek downstream of the Project site reported electrical conductivity concentrations ranging from 3.2 to 4.9 uS/cm. The sediment sample from Murray Creek downstream of the Project site had a pH value of 5.1. The sediment pH of the majority of sediment samples is considered strongly acid to very strongly acid.

Groundwater quality monitoring indicates ph values for the existing bores ranged from 7.4 to 8.1, and new investigation bores had pH values ranging from 7.5 to 8.1. Groundwater quality across the region is exhibits neutral pH.

8.5.2 Potential for AMD

It is noted in Section 8.2 that negligible magmatic sulphide is anticipated in the ore body and associated waste material. Accordingly, the risk of PAF material leaching from the waste landforms and stockpiles is considered to be negligible.

8.6 Dispersive soils

Dispersive soils are structurally unstable in water and tend to break down into their constituent particles which consequently cloud the water. Dispersive soils are highly susceptible to erosion on slopes and drains when exposed.

The potential existence of dispersive clays within the vicinity of the site was identified during a site visit to support the preliminary surface water assessment. Evidence of erosion from existing linear infrastructure (pipeline) and cattle grazing activities were observed in the vicinity of Mud Hut Swamp.

It is recommended that the design and construction of linear infrastructure corridors (access corridor, water pipeline) for the Project be undertaken to minimise changes to the hydrology and geomorphology of the rivers and creek lines, and to minimise the risk of exposure of dispersive soils. This should include rock armour protection from scour and erosion along the edges of causeways. Where dispersive soils are identified, these should be treated or buried under a layer of non-dispersive soil before attempting any further erosion control measures. Details of requisite management measures should be detailed in an ESCP.

8.7 Chemicals and hydrocarbons

8.7.1 Overview

The mine will store and use a variety of substances within the processing plant, water and wastewater treatment plants, as well as explosives and hydrocarbons. The Project will not use any environmentally hazardous chemicals that require special storage or handling.

8.7.2 Chemicals and reagents

Various chemicals and reagents will be stored on site for use in processing including sodium hypochlorite, flocculant and antiscalent. All chemicals and reagents will be handled and stored according to the information provided on the products MSDSs. Site personnel will have access to safety equipment essential for the correct handling of chemicals and reagents, and be trained in safe handling and spillage clean-up procedures for the different chemicals and reagents.

8.7.3 Hydrocarbons

Diesel will be stored on-site to fuel the mining and vehicle fleet, operation of diesel generators for the construction phase, operation of the borefield generators and backup generators for fire water protection facilities. Diesel at the mine site will be stored in 85,500 L self-bunded tanks with a total storage capacity of around 850,000 L. The tanks are effective storage solutions for type 1 or 2 combustible fluids. The tanks are manufactured to comply with Australian Standard AS1692 and when installed in compliance with AS1940 for Storage of Combustible Fluids easily meet regulatory requirements.

Lubricating oil will be stored in bulk containers inside a lined and bunded area with spill protection and recovery. Waste oil will be stored in a tank within a lined and bunded area to be held for collection by a contractor for reprocessing and recycling.

The borefield will comprise production bores powered by stand-alone diesel generators with 4,670 L diesel storage tanks. The key risk of contamination is presented by potential hydrocarbon spills. Risk of contamination is highest during flooding and both surface and groundwater contamination may occur depending on whether the river system is under gaining or losing conditions.

The design of the production bore infrastructure will need to consider the geomorphology of the alluvial bed within the Hanson River flood-out zone to minimise risk of inundation. The design should consider the ARI wet season rainfall event appropriate to the hazard category, and the geomorphology of the alluvial bed of the Hanson River flood-out zone to ensure the footings and structure can withstand moderate to high flow events that may result in morphological change.

To this end, it is recommended that elevated drill pads be constructed to ensure the well casings, headworks, generators and fuel tanks remain above the 100-year ARI level. Edges of the pads should be constructed at a slope that ensures stability under saturated conditions and should be protected against erosion. Generators and fuel tanks should be located within lined and bunded structures constructed on top of the drill pad. The bunded storage should be sufficient to accommodate simultaneously an appropriate ARI wet season rainfall event and failure of a full fuel tank.

8.7.4 Explosives

Explosives will be stored in a dedicated magazine, operated in accordance with Dangerous Goods regulations.

8.8 Contamination assessment and risk management

A preliminary assessment of the potential sources of contaminants, their likely composition and potential impacts is summarised in Table 8-1.

Table 8-1 Contamination assessment

Potential sources	Potential contaminants	Potential impacts
Pre-strip clearing Vegetation clearing Topsoil stripping Construction and maintenance of haul roads Earthmoving equipment	Sediments from disturbed areas Hydrocarbon spills from plant and equipment	Soil erosion at site Accumulation of sediments in receiving waters Accumulation of dust in receiving catchments Release of contaminants to receiving waters
Pre-strip excavation Overburden excavation Drill and blasting Construction and maintenance of haul roads Excavator/earthmoving equipment	Sediments from disturbed areas Hydrocarbon spills from plant and equipment Blast residues	Soil erosion at site Accumulation of sediments in receiving waters Accumulation of dust in receiving catchments Release of contaminants to receiving waters
Stockpiling of topsoil Placement of soil Earthmoving equipment	Sediments from exposed areas/dispersive materials Hydrocarbon spills from plant and equipment	Soil erosion at site Accumulation of sediments in receiving waters Accumulation of dust in receiving catchments Release of contaminants to receiving waters
Construction of linear infrastructure Vegetation clearing Topsoil stripping Winning construction material Construction and maintenance of roads and pipelines Earthmoving equipment	Sediments from exposed areas/dispersive materials Sediments from altered geomorphology at waterway crossings Hydrocarbon spills from plant and equipment	Soil erosion at site Accumulation of sediments in receiving waters Release of contaminants to receiving waters
Waste Rock Dump Placement of spoil and formation of dumps Construction and maintenance of haul roads Excavator/earthmoving equipment	Sediments from exposed areas/dispersive materials Hydrocarbon spills from plant and equipment	Soil erosion at site Accumulation of sediments in receiving waters Release of contaminants to receiving waters

Potential sources	Potential contaminants	Potential impacts
Mine Pit Earthmoving equipment Drill and blasting Transportation of ore (trucks)	Spillage of ore and fines during transport Windblown dust during mining and transport Hydrocarbon spills from plant and equipment	Release of contaminants to receiving waters Accumulation of dust in receiving catchments
Stockpiling and handing of ore Crushing Stacking and reclaiming stockpiles Contaminated hardstand areas Earthmoving equipment Loading and transportation of ore (trucks, conveyors, hoppers etc.)	Runoff of stormwater containing fines Windblown dust from stockpiles, conveyors etc. Hydrocarbon spills from plant and equipment	Accumulation of sediments in receiving waters Release of contaminants to receiving waters Accumulation of dust in receiving catchments
Hydrocarbon storage (site and borefield) Uncontained spills and leaks	Hydrocarbons	Release of contaminants to receiving waters
Chemical and reagent storage Uncontained spills and leaks	Chemicals and reagents (Identified chemicals and reagents not considered hazardous)	Release of contaminants to receiving waters
Workshops Contaminated hardstand areas Dust accumulation on roofs	Hydrocarbons Solvents, surfactants	Release of contaminants to receiving waters
Washdown areas Contaminated hardstand areas Contaminated washdown	Hydrocarbons Residues	Release of contaminants to receiving waters
Sediment ponds Discharge of sediments and water	Sediments from disturbed landforms	Accumulation of sediments in receiving waters
Water treatment plant Discharge of filter cleaning agents Discharge of brine reject	Cleaning agents Saline reject	Release of salt and contaminants to receiving waters
Wastewater treatment plant Spills of sewage Discharge on non-compliant treated wastewater	Microbial contaminants Nutrients	Release of contaminants to receiving waters
Oily water treatment systems Overflows/spills of untreated oily water	Hydrocarbons Sediments	Release of contaminants to receiving waters
Landfill Leaching or runoff of various contaminants	Various	Release of contaminants to receiving waters

8.9 Measures to manage and prevent contamination

The key to the management and prevention of contamination of the water resources and associated aquatic ecosystems is recognition of the various water streams arising from the site for which differing management interventions are required. Water separation and minimisation of impact footprints are the key strategies in this regard.

A preliminary assessment of the potential risk and proposed control measures is summarised in Table 8-2. The list is not considered exhaustive and is a point of departure for a more formal risk assessment process that should be undertaken by key stakeholders for the EIS.

Table 8-2 Risk management

Identified risk	Proposed control measure
Erosion of disturbed surfaces and waste landforms	• Preparation of a ESCP Plan in accordance with the Guidelines for best Practice Erosion and Sediment Control (IESC 2008). • The ESCP should provide a framework for managing the risk of erosion and release of sediments to receiving environment or the contamination of stormwater. • The ESCP will specify erosion control strategies and measures for the various phases of the Project including construction, operation and closure. Strategies may include: – Conduct risk assessment of identified land uses at risk of erosion and determine type and location of control measure. – Implementation of progressive rehabilitation of disturbed areas where possible. – Ongoing stabilisation and rehabilitation of waste landforms. – Regular inspection, management and maintenance of erosion and sediment control measures. – Monitoring of site and downstream water quality.
Saline drainage	• Characterisation of top soil and spoil materials to aid placement. • Siting of stockpiles away from natural drainage channels. • Delineation of runoff separation catchments, which should be defined in a site Water Management Plan.
Windblown magnetite concentrate dust during handling and transportation, and from stockpiles.	• Maintain inherent moisture levels in ore prior to processing. • Use of sprays and dust collection systems in crushers and at material transfer points. • Maintain moisture levels in the concentrate. • Cover concentrate loads during transport (truck and train).
Runoff of contaminated stormwater	• Preparation of a Water Management Plan for construction and operational activities. • Delineation of runoff separation catchments. • Mine affected water to be retained within mine water system and discharged through controlled release points. • Oily water separation and treatment. • Runoff from ROM pads, stockpiles and workshops directed to contaminated sediment basins.
Discharge of contaminated sediments and water from holding basins	• Appropriate design (sizing) criteria developed and applied. • Routine inspections and de-silting. • Spills directly to mine water storage.

Identified risk	Proposed control measure
Discharge of sediment from sediment basins	• Appropriate design (sizing) criteria developed and applied. • Routine inspections and de-silting.
Hydrocarbons spills from plant and equipment	• All mining equipment refuelled, serviced and repaired within designated areas outlined for such activity in the mine operations plan. • Personnel are trained in the use of spill kits and emergency response procedures. • Any soil contaminated by hydrocarbons will be managed and stored appropriately until transport to an appropriate disposal or treatment facility by an authorised transporter.
Hydrocarbon and chemical leaks and spills from holding storages	• All hydrocarbons will be stored and handled in accordance with the bunding requirements of AS 1940:2004: *The storage and handling of combustible and flammable liquids*. • Spill clean-up procedures developed and implemented. • Personnel are trained in the use of spill kits and emergency response procedures. • MSDS sheets shall be maintained near storage area. MSDS file shall be clearly identified. • Regular inspections of storages, tanks and bulk carriers and the integrity of bunded areas and containment systems. • Any soil contaminated by hydrocarbons will be managed and stored appropriately until transport to an appropriate disposal or treatment facility by an authorised transporter.
Overflows/spills of untreated oily water	• All water from wash-down, workshop and refuelling areas intercepted and channelled to oil/water separators and containment storage. • Routine inspections. • Operation and maintenance procedure.

9. Recommendations

9.1 Surface Water

Properly constructed floodways are recommended at Murray Creek and the Hanson River should the estimated disruption times be acceptable. Such crossings would not be expected to interrupt natural streamflow and geomorphological processes, but would require ongoing maintenance to ensure accessibility. There is no evidence of a single specific drainage line associated with Wood Duck Creek and surface flows in this vicinity are likely to present as sheet flow. Given the relatively long length of this crossing, regularly spaced and appropriately sized culverts are recommended at this location.

Sheetflow is likely to occur along the access road within the alluvial plains to the east of the Stuart Highway. No specific drainage lines have been defined and it is recommended that regularly spaced and appropriately sized culverts be installed across the access road to prevent the creation of sheetflow shadow zones.

A preliminary flood risk assessment indicates that the mine site is not expected to experience any significant flooding for events up to the 50-year ARI. However, the bench of lower lying topography in the vicinity of the proposed mine pit may be prone to flooding during more extreme events. Further investigation is required to establish the need for flood protection measures in this vicinity.

The limitations in the elevation data and the preliminary nature of this assessment should be noted and further surveys and assessment will be required to validate these findings.

Sediment sampling was undertaken to characterise sediment quality as a proxy for water quality given the infrequent nature of flow events within the region. It is recommended that the sediment sampling be repeated following the next significant runoff event to assess change in quality due to sediment migration. Opportunistic water samples should also be retrieved at accessible sites (if possible).

9.2 Groundwater

Based on results of the groundwater flow modelling, the following recommendations are made:

- The groundwater model should be revisited and updated following the completion of drilling the Stage 1 borefield. This will provide further data on aquifer parameters and aquifer extents. Additional details will allow the model to be refined and improve its confidence levels;
- The drilling program for Stage 1 should be scheduled as soon as practical in order to determine if the assumptions for supply are appropriate (i.e. the aquifer properties found in the existing production bore are similar to the proposed bores);
- A borefield monitoring plan (water level and quality) comprising of locations between pumping bores and at the extents of the borefield should be implemented to further assess baseline groundwater conditions and to monitor aquifer performance and to feed back into modelling data;
- A sensitivity and uncertainty analysis is recommended for both steady state and transient prediction runs utilising model parameters from this study as well as any previous study in the area (e.g. Ti Tree Basin Groundwater Model). This will provide a range of potential outcomes/impacts related to mine and borefield operation, and confidence in the model prediction; and

- Since a number of stock bores are likely to be impacted due to the operation of the mine and abstraction from the palaeovalley, a base line assessment of these bores and a make good agreement should be developed with the owners prior to the development of the mine and borefield. This could involve either the deepening of the existing bore, lowering the pump setting; drilling another bore next to existing bore; or by supplying the required water demand from external sources (e.g. pipeline offtake).

9.3 Contamination management

It is recommended that:

- Periodic testing of the waster rock and stockpiled ore be conducted to confirm the absence of potentially acid forming (PAF) material during the mining operations, and further characterisation of the ore body should be conducted to determine the salinity profiles thereof;
- Runoff from the ROM pad and ore stockpiles should be contained and directed to appropriately sized sedimentation ponds for managed release to the environment or for reuse around the site;
- The nature and sizing of the sedimentation ditch/pond at the WRD should be assessed;
- Runoff from the concentrate stockpiles should be contained and drainage water recovered and recycled for dust suppression or processing purposes;
- Runoff from rainfall on the external bund walls of the TSF should be collected and conveyed to an appropriately sized sedimentation ditch/pond for managed release to the environment;
- TSF monitoring bores should be sized to accommodate pumping for recovery of seepage water to the sump; and
- The operation of the various water storages should ensure mixing and that any outflow to the environment considers the salinity of discharges.

In summary, the key control measures for water management should include:

- Preparation of an Erosion and Sediment Control Plan to provide a framework for managing the risk of erosion and release of sediments to receiving environment or the contamination of stormwater (including delineation of runoff separation catchments);
- Preparation of a Water Management Plan for mine operation with a particular focus on mine affected water to be retained within mine water system and discharged through controlled release points; and
- Determination of design criteria for elevated drill pads for protection of well casings, headworks, generators and fuel tanks, which are stable under saturated conditions and protected against likely flooding and erosion.

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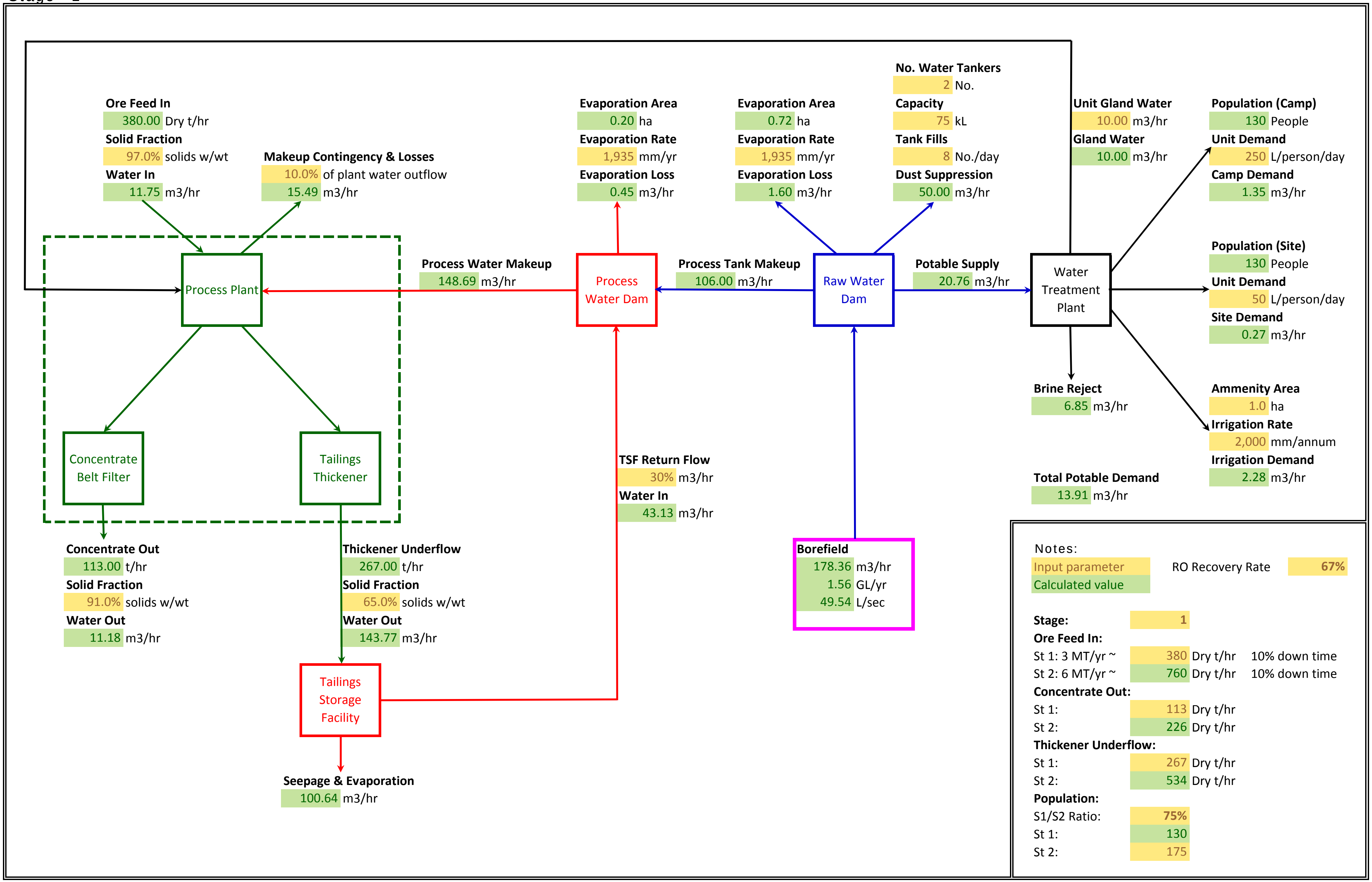
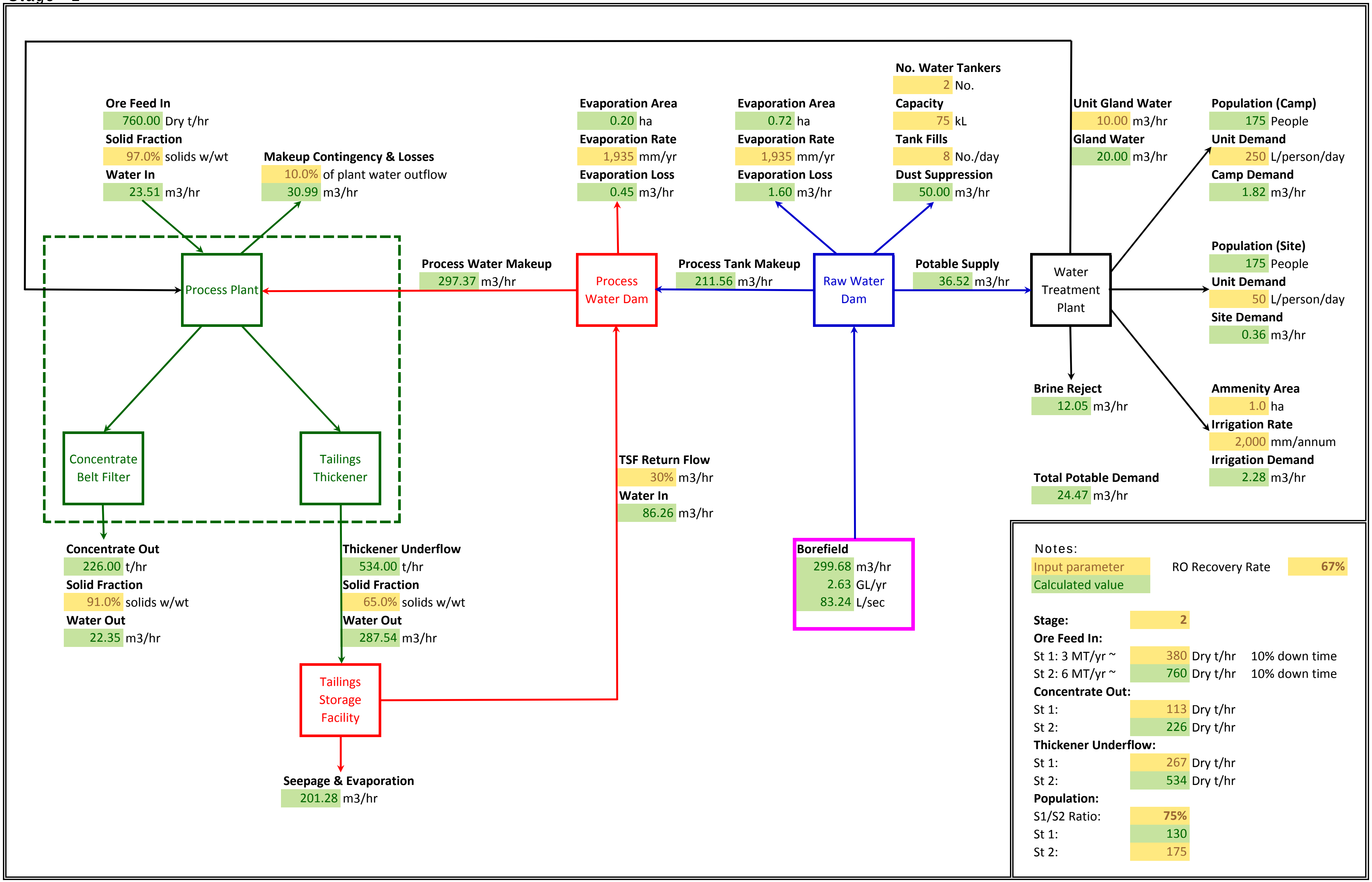
Appendices

Appendix A – Water balance

Mt Peake Preliminary Water Balance
Stage 1

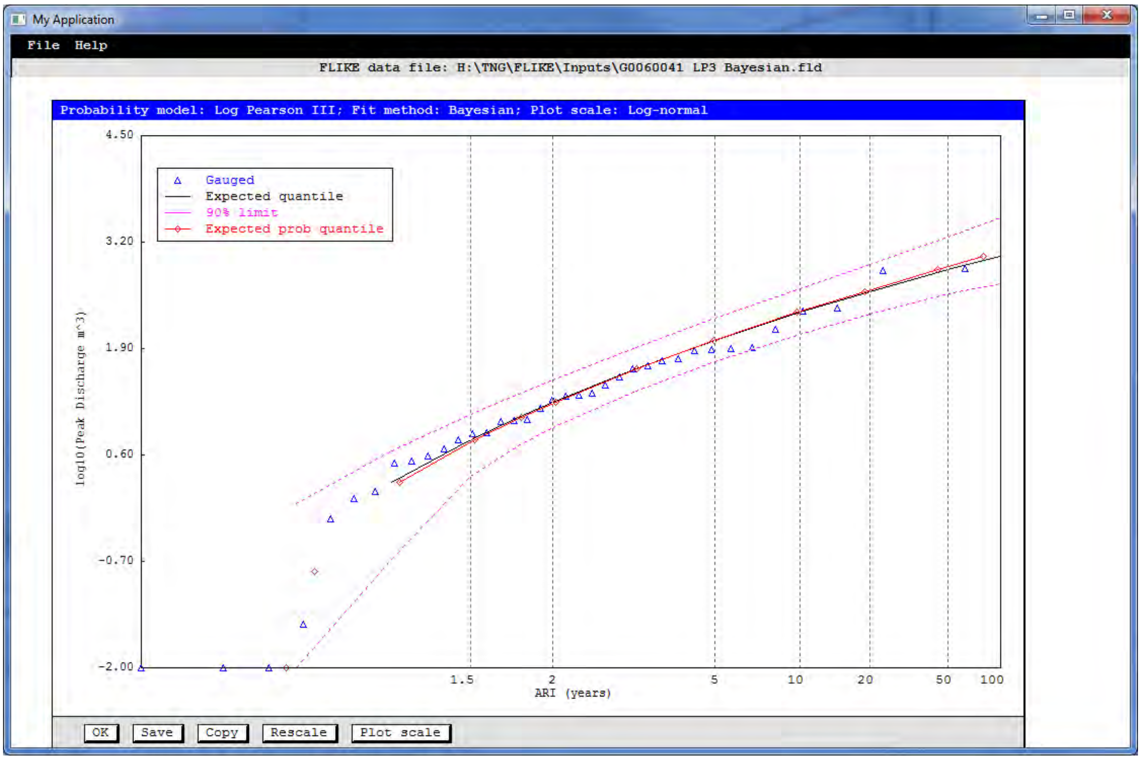


Mt Peake Preliminary Water Balance
Stage 2

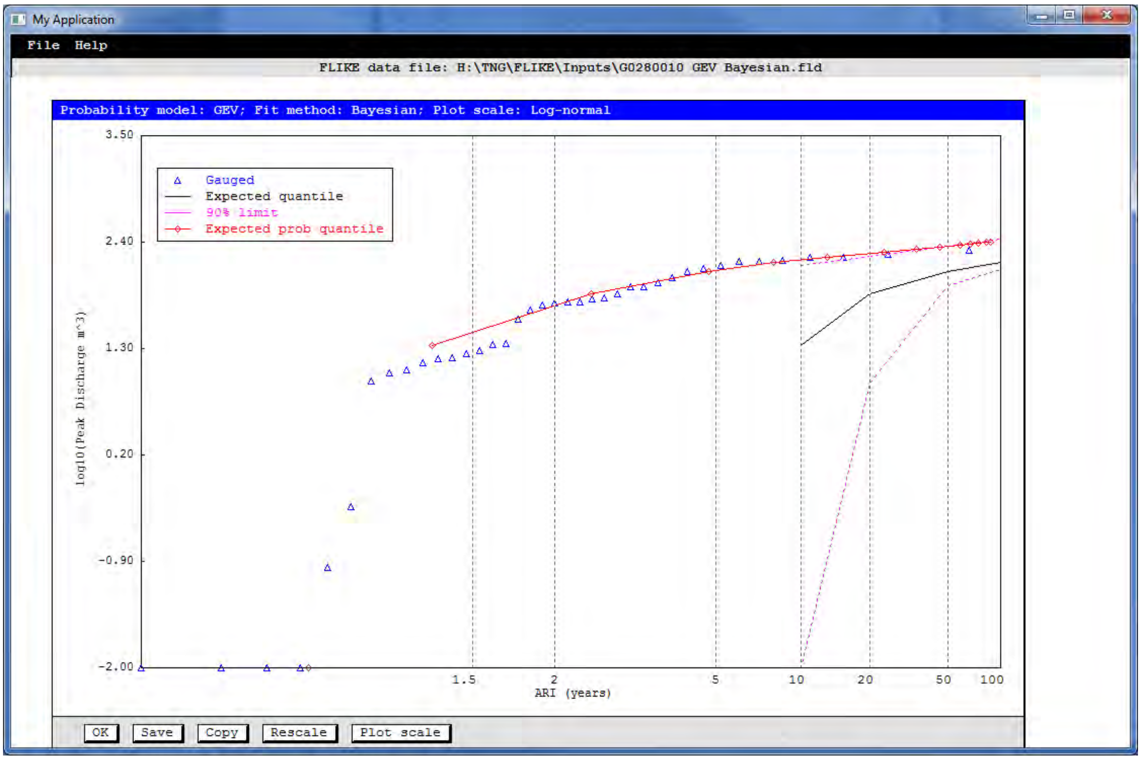


Appendix B – Frequency Analysis Results

Station G0060041 (Todd River – Rocky Hill)



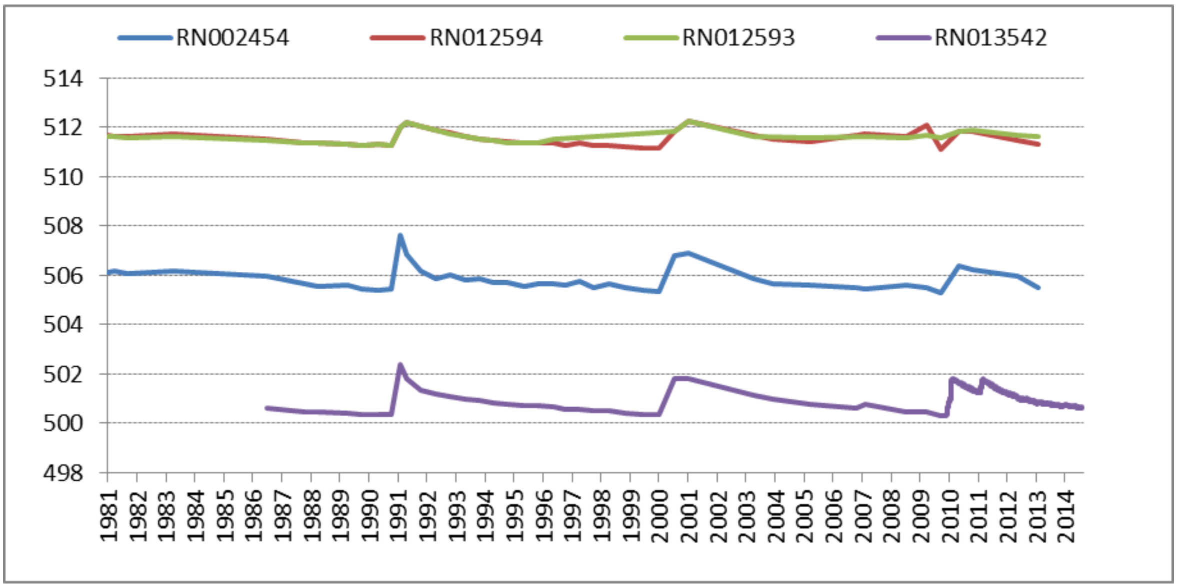
Station G0280010 (Woodforde River – Arden Soak)



Appendix C – Sediment Quality Analysis Results

Analyte grouping/Analyte			Units	LOR	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11
Physical properties	pH		pH Unit	0.1	5.4	5.1	7.2	4.9	3.2	5.6	4.9	5.7	4.7	5.3	5.7
	Electrical Conductivity @ 25°C		µS/cm	1	7	6	28	8	15	3	8	21	10	70	11
	Moisture Content (dried @ 103°C)		%	1	7.8	11.2	10.1	8.4	12.7	10	9.2	17.5	11.1	11.4	12.8
	Particle Sizing	+75µm	%	1	100	100	98	100	97	94	93	81	98	48	79
		+150µm	%	1	99	99	97	93	88	73	81	51	89	32	67
		+300µm	%	1	90	97	93	85	73	47	45	35	32	12	57
		+425µm	%	1	77	88	81	71	56	29	28	28	9	5	46
		+600µm	%	1	58	71	60	53	35	17	17	23	2	2	34
		+1180µm	%	1	32	37	24	22	12	6	7	13	<1	<1	14
		+2.36mm	%	1	16	12	7	6	3	4	4	2	<1	<1	3
		+4.75mm	%	1	5	2	2	2	<1	3	3	<1	<1	<1	<1
		+9.5mm	%	1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
		+19.0mm	%	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		+37.5mm	%	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		+75.0mm	%	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Soil Classification based on Particle Size	Fines (<75 µm)	%	1	<1	<1	2	<1	3	6	7	19	2	52	21
		Sand (>75 µm)	%	1	84	88	91	93	94	90	89	79	99	48	76
		Gravel (>2mm)	%	1	16	12	7	6	3	4	5	2	<1	<1	3
		Cobbles (>6cm)	%	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Metals	Arsenic		mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Barium		mg/kg	10	<10	<10	<10	<10	<10	<10	<10	10	<10	70	<10
	Beryllium		mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Boron		mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	Cadmium		mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Chromium		mg/kg	2	11	10	20	10	12	4	5	22	15	35	22
	Cobalt		mg/kg	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	12	<2
	Copper		mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	20	<5
	Lead		mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	12	<5
	Manganese		mg/kg	5	21	14	27	16	26	10	11	36	16	542	37
	Nickel		mg/kg	2	<2	<2	<2	<2	<2	<2	<2	2	<2	13	<2
	Selenium		mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Vanadium		mg/kg	5	8	8	16	10	11	6	7	24	12	51	16
	Zinc		mg/kg	5	<5	<5	<5	<5	<5	<5	<5	6	<5	32	<5
	Uranium		mg/kg	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.4	<0.1	3.5	0.3
	Total Recoverable Mercury		mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nutrients	Nitrite + Nitrate as N (Sol.)		mg/kg	0.1	0.7	0.4	5	0.8	2.5	0.5	0.7	9.5	2.8	8.7	2.3
	Total Kjeldahl Nitrogen as N		mg/kg	20	<20	<20	20	<20	<20	<20	<20	100	30	720	30
	Total Nitrogen as N		mg/kg	20	<20	<20	20	<20	<20	<20	<20	110	30	730	30
	Total Phosphorus as P		mg/kg	2	31	22	23	17	27	9	14	111	16	306	29
	Reactive Phosphorus as P		mg/kg	0.1	<0.1	<0.1	0.3	0.2	0.4	<0.1	0.1	0.5	0.1	1.6	0.5
Total Recoverable Hydrocarbons	>C10 - C16 Fraction		mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	>C16 - C34 Fraction		mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C34 - C40 Fraction		mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C10 - C40 Fraction (sum)		mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Total Petroleum Hydrocarbons in Soil	C10 - C14 Fraction		mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	C15 - C28 Fraction		mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	C29 - C36 Fraction		mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	C10 - C36 Fraction (sum)		mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Appendix D – Bore hydrographs



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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
	Wayne Schafer, Adam Osbaldeston	Ian McCardle		Ian McCardle		11/11/2015

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Appendix G

Flora and Vegetation Assessment Report

TNG Limited

Mount Peake Project

Flora and Vegetation Assessment Report

December 2015

Executive summary

TNG Limited is proposing to develop the Mount Peake Project (the Project) consisting of:

- The mining of a polymetallic ore body through an open-pit truck and shovel operation
- Processing of the ore to produce a magnetite concentrate
- Road haulage of the concentrate approximately 100 km to a new railway siding and loadout facility on the Alice Springs to Darwin railway near Adnera
- Rail transport of the concentrate to TNG's proposed Darwin Refinery at Middle Arm.

The proposed mine will be an open-pit truck and shovel operation. Extracted ore will be transported by haul truck from the mine pit and stockpiled on-site at a run of mine (ROM) pad prior to processing. Mining will commence with a "starter pit" accessing high grade and low strip ratio ore to feed a processing plant at a rate of up to 6 million tonnes per annum (Mtpa) and, following processing, will produce up to 1.8 Mtpa of magnetite concentrate. The life of the mine is expected to be 19 years inclusive of construction (2 years), mining and production (15 years), and closure and rehabilitation (2 years).

The mining area is located approximately 235 km north north-west of Alice Springs and approximately 50 km west of the Stuart Highway.

GHD was engaged by TNG to undertake a flora and vegetation assessment of the proposed mine site, accommodation village, access road and rail siding loading facility. The assessment is required to satisfy the requirements of the NT Environment Protection Authority Terms of Reference for the Project with regards to flora and vegetation.

The NT Government flora records for the study area (plus a 20 km buffer) contain 1,392 records of 494 species. These records include one threatened flora species (*Eleocharis papillosa)* listed as vulnerable under both the *Territory Parks and Wildlife Conservation Act 2006* (TPWC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Database records for the locality included 7 near threatened species, 6 endemic species and 14 species recorded as being data deficient. A total of 16 exotic species have also been recorded within the locality.

The current survey identified 238 flora species (233 native and five introduced) within the study area. No threatened flora species were recorded during the survey, although there is potential habitat within the study area for one threatened species (*Eleocharis papillosa*). This species is listed as vulnerable under both the TPWC Act and the EPBC Act.

Eight vegetation communities were mapped within the study area:

- Mulga shrubland on sandy red earths
- Riparian woodland along watercourses and drainage channels
- Triodia grassland on sandy plains
- Floodplains dominated by *Eucalyptus victrix*
- Open Corymbia woodland on loamy alluvial plains
- Low Acacia shrubland on rocky slopes
- Tall Acacia shrubland on stony quartz
- Low open Eucalyptus woodland on limestone.

All of these vegetation types are well represented at the local scale within the bioregion.

The proposal would result in the removal of approximately 1038 ha of native vegetation. None of the vegetation communities proposed to be removed has national or regional significance. The majority of the vegetation to be cleared for the project would be from two vegetation communities (Mulga shrubland on sandy red earths and Triodia grassland on sandy plains. Both of these communities are well represented at the local and regional scale.

The proposal has the potential to impact on flora and vegetation, or exacerbate existing threatening processes through:

- Clearing of vegetation and associated loss of habitat
- Erosion and sedimentation resulting from vegetation clearing
- Alteration of hydrological regimes associated with changes to land surface areas, changed to groundwater and/or impediments to surface flows
- Introduction and/or spread of invasive exotic flora species within and adjacent to the Project area
- Contamination of surface and/or ground water
- Changes to fire regimes, and
- Dust emissions generated by construction, mining and processing activities.

A range of mitigation measures would be implemented throughout the construction, operation and decommissioning phases of the Project to ameliorate potential impacts on vegetation and flora. The Project will result in unavoidable residual impacts to some elements of the natural environment. These residual impacts are not expected to impose a significant negative effect on local or regional occurrences of vegetation communities or flora species.

Mitigation measures would include:

- Avoidance and minimisation of clearing through the Project design
- A preclearance survey of the borefield, pipeline route and borrow pit areas prior to any clearing works in the area to assist in the final location of infrastructure and ensure that no threatened species or significant or sensitive vegetation communities would be impacted by clearing
- Incorporation of options for avoiding modification to surface water flows to minimise the risk of vegetation stress and loss, or the proliferation of introduced flora species
- Engineering controls that assist in maintaining surface water flows
- Development and implementation of a Construction Environmental Management Plan and Operations Environment Management Plan
- Development and implementation of a Soil and Water Management Plan
- Development and implementation of a Weed Management Plan
- Development and implementation of a Dust Management Plan Operation
- Development and implementation of a Fire Management Plan
- Development and progressive implementation of a rehabilitation measures
- Development and progressive implementation of a Mine Closure Plan as a component of the Mine Management Plan.

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Appendices

Abbreviations and Glossary

Term	Description
BOM	Bureau of Meteorology
DSEWPaC	Department of Sustainability, Environment, Water, Populations and Communities (now DotE)
DLRM	Department of Land Resource Management
DME	Department of Mines and Energy
DotE	Department of the Environment (formerly DSEWPaC)
EIS	Environmental Impact Statement
EN	Endangered
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GHD	GHD Pty Ltd
MSES	Matters of National Environmental Significance
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NVIS	National Vegetation Information System
PMST	Protected Matters Search Tool
SOCS	Sites of Conservation Significance
Subsp.	Subspecies
TPWC Act	*Territory Parks and Wildlife Conservation Act 2006*
var.	variety
V	Vulnerable
WM Act	*Weeds Management Act 2001*

1. Introduction

1.1 Project Description

TNG Limited (TNG) is proposing to develop the Mount Peake Project (the Project) consisting of:

- The mining of a polymetallic ore body through an open-pit truck and shovel operation
- Processing of the ore to produce a magnetite concentrate
- Road haulage of the concentrate approximately 100 km to a new railway siding and loadout facility on the Alice Springs to Darwin railway near Adnera
- Rail transport of the concentrate to TNG's proposed Darwin Refinery at Middle Arm.

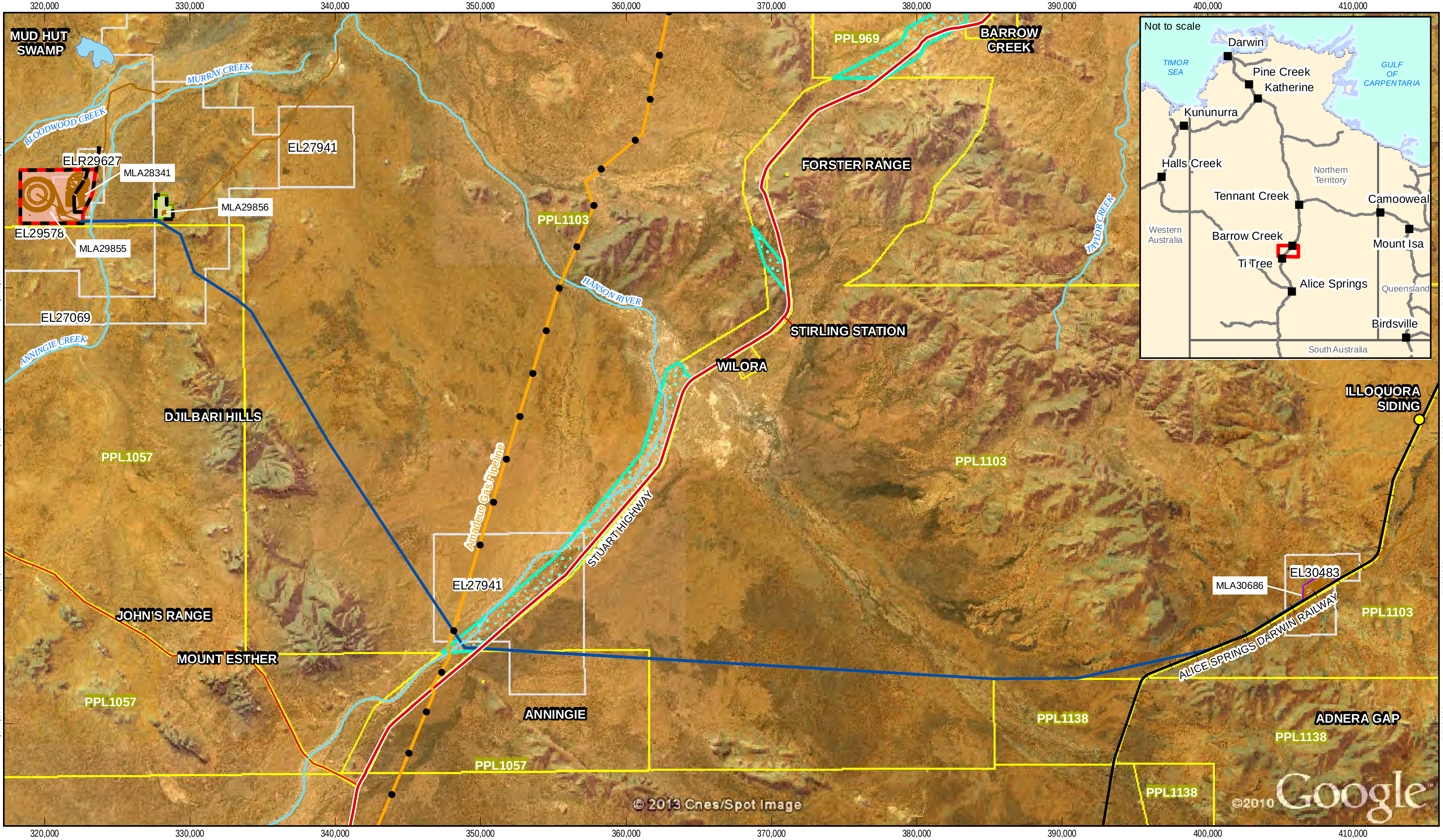
The proposed mine will be an open-pit truck and shovel operation. Extracted ore will be transported by haul truck from the mine pit and stockpiled on-site at a run of mine (ROM) pad prior to processing. Mining will commence with a "starter pit" accessing high grade and low strip ratio ore to feed a processing plant at a rate of up to 8.4 million tonnes per annum (Mtpa) and, following processing, will produce up to 1.8 Mtpa of magnetite concentrate. The life of the mine is expected to be 19 years inclusive of construction (2 years), mining and production (15 years), and closure and rehabilitation (2 years).

The project is located approximately 235 kilometres north-west of Alice Springs and approximately 50 km west of the Stuart Highway (Figure 1-1).

1.1.1 Key Project Components

New facilities proposed at the Mount Peake Project Area include (Figure 1-1 and Figure 1-2):

- Open cut mine
- Waste rock dump (WRD) with up to 70 Mt capacity
- Run of mine (ROM) pad
- Four long term stockpiles of up to 4 Mt capacity each
- Process plant
- Tailings storage facility (TSF) with up to 63.41 Mt capacity
- Access road between the mine site and Adnera Loadout Facility including an underpass of Stuart Highway (for concentrate trucks) and intersections with Stuart Highway (for mine site access)
- borefield and associated water pipeline
- Concentrate stockpiles
- Water and sewage treatment plants
- Gas fired power station
- Explosives and detonator magazines
- Accommodation village
- Administrative buildings, laboratory, workshops and warehouses
- Gatehouse and weighbridge
- Fuel farm
- Concentrate loadout facility and rail siding at Adnera.



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Kilometres

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

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LEGEND

- Illoquora Siding
- Principal Road
- Minor Road
- Major Watercourses
- Railway
- Amadeus Gas Pipeline
- Mine Site Facilities
- Mud Hut Swamp
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Crown Land
- Mount Peake Granted Tenements
- Mount Peake Mineral Leases
- Cadastral Boundaries
- Access Road
- Camp Facilities

TNG Ltd
Mount Peake EIS

Job Number	61-29057
Revision	A
Date	23 Oct 2015

Project Location
Mount Peake Project Area

Figure 1-1

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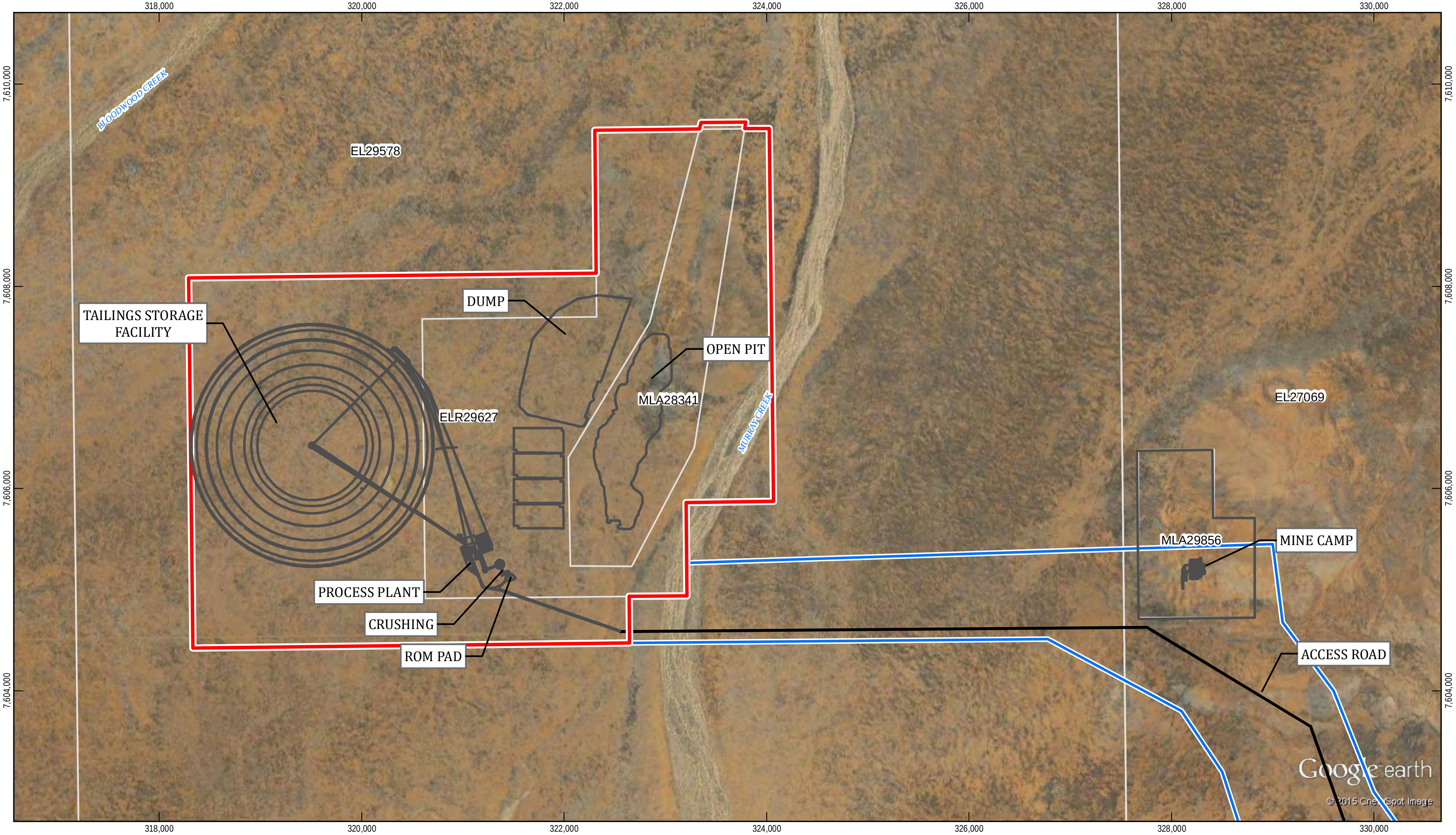
239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2015). Geoscience Australia - Waterways, mainland, placename, road (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). Created by: RB



Paper Size A4

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Kilometres

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

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LEGEND

- Mine Site Facilities
- Mount Peake Granted Tenements
- Mount Peake Mining Area
- Access Road
- Transport Study Corridor

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TNG Ltd
Mount Peake EIS

Job Number 61-29057
Revision A
Date 26 Oct 2015

Mine Site Detail
Mount Peake Project Area

Figure 1-2

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239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Google: Imagery - 20150910; TNG Ltd: Mine site facilities, access road, mining area,Tenure - 20151021

1.1.2 Timing

TNG proposes to commence construction in the late 2016 with mining commencing in 2018. The life of the project is expected to be 19 years inclusive of construction (2 years), mining and production (15 years), and closure and rehabilitation (2 years).

1.2 Objectives of the Assessment

GHD was engaged by TNG to undertake a flora and vegetation assessment of the Study area. This included assessment of the proposed mine site, access road and rail siding loading facility.

The purpose of this assessment is to satisfy the requirements of the Northern Territory Environment Protection Authority (EPA) Terms of Reference for the Project with regards to flora and vegetation.

In particular the objectives of this report are to:

- Describe and map vegetation communities occurring within the Study area
- Identify threatened vegetation communities and/or flora species, listed under *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and or *Territory Parks and Wildlife Conservation Act 2009* (TPWC Act) present or considered likely to occur within the Study area
- Provide a map of the Project footprint overlain with vegetation mapping that is sufficient to identify areas that have already been subject to clearing activities or disturbance previously (if any) and identify areas of vegetation that are proposed to be cleared
- Evaluate vegetation condition with regard to anthropogenic disturbance such as the presence of introduced flora, evidence of clearing or heavy livestock impact
- Map the extent exotic (weed) species listed under the *Weeds Management* (WM) *Act 2001* and/or other significant weed infestations within the Study area
- Assess the regional and national significance of the vegetation and flora species within the Study area
- Determine ways in which the proposed Project might impact on ecological values including threatened flora species
- Identify additional risks to local ecological values associated with the clearing of vegetation, edge effects and invasive species
- Identify measures to avoid, minimise, mitigate and offset potential impacts on ecological values within the Study area
- Determine any residual risks to vegetation and flora species.

1.3 The Project area

The Mount Peak Project Area (Project area) refers to the mining area, accommodation camp, borefield, access road and rail siding (Figure 1-1 and Figure 1-2).

The Project is located in central Northern Territory, within the Burt Plain Bioregion. The Project is primarily located on the Stirling pastoral station with a small component of the access road located on Anningie pastoral station subject to final design of the road. These stations have been used for pastoralism since the early 1880s.

Over the life of the project the area of disturbance is estimated to be 1,060 ha. A breakdown of disturbance areas is provided in Table 1-1. Borrow areas to provide road base for the access road have not yet been identified.

Table 1-1 Disturbance areas

Item	Disturbance Area (ha)
Pit	77
Waste Rock Dump	90
Long-term stockpiles	47
Mine facilities including ROM pad, process plant and associated stockpiles and ponds, mine offices and workshops, fuel storage facility, water treatment plant, power station and site roads	71
Tailings Storage Facility	475
Accommodation village	6
Access road	234
Adnera Loadout Facility	10
Borefield, delivery line and access road	50
Access road borrow areas	To be determined
Total	**1060**

Mining and processing will occur within the mining area, located within Mineral Lease Application (MLA) 28341 for the mine pit and MLA 29855 for all mining facilities. The accommodation facilities will be located within MLA 29856, 5 km to the east of the mine site (Figure 1-2).

The site access road runs 100 km south-east and then east from the mining area to a proposed new rail siding and load-out facility near Adnera.

The landscape within the Project area is dominated by mulga vegetation communities and rocky outcrops, with some areas of bloodwood, spinifex, coolabah, open shrubland and river red gums particularly along braided river bed systems.

1.4 Definitions

For the purposes of this assessment, the following definitions are employed:

Project area – refers to the mining area, accommodation camp facilities area, access road, borefield and rail loadout facility (Figure 1-1).

Study area – refers to the area that was surveyed for this assessment. It included MLA 28341, MLA 29855 and MLA 29856, an approximately 1 km wide corridor along the proposed site access road, the rail siding storage loading facility and the area within and immediately surrounding Mud Hut Swamp. The proposed borefield and associated delivery pipeline and access road were not surveyed during the site assessment as these were not part of the original project scope; however a broad assessment of potential impacts associated with these features has been undertaken using flora and vegetation data from similar landscape positions.

Locality – the area within a 20 km radius of the Study area.

1.5 Scope and limitations

This report has been prepared by GHD for TNG Limited and may only be used and relied on by TNG Limited for the purpose agreed between GHD and the TNG Limited as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than TNG Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect

GHD has prepared this report on the basis of information provided by TNG Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information

2. Existing Environment

2.1 Location

The Project area is located in the central Northern Territory, approximately 235 km north-north-west of Alice Springs (Figure 1-1).

The Project area is located in the Central Desert Shire and within the Burt Plain Bioregion.

The Project area spans a large area; the proposed mine area is approximately 50 km west of the Stuart Highway, while the existing Alice Springs to Darwin railway is approximately 50 km east of the highway. The Project area is primarily located on the Stirling pastoral station with a small component of the access road located on Anningie pastoral station. The closest town is Barrow Creek, approximately 60 km north east of the mining area.

2.2 Climate

The Study area is located within the southern extent of the Australian monsoonal belt, with a semi-arid climate characterised by significantly higher evaporation potential than annual rainfall.

The closest weather station to the site is located at the Territory Grape Farm, approximately 40 km from the Study area. The hottest months are November to March, with the monthly mean of daily maximum temperatures ranging from 36.2 to 34.3^{o}C, and monthly mean daily minimum temperatures ranging from 19.5 to 18.8^{o}C (Table 2-1). The coolest months are May to August, with the monthly mean daily maximum temperatures remaining at or below 25.3^{o}C, and monthly mean daily minimum temperatures not rising above 9.5^{o}C.

Table 2-1 Rainfall and temperature 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	115.7
95th %ile	154.7	255.0	97.7	93.2	100.4	49.5	21.6	27.9	41.8	52.5	82.8	96.6
Mean	57.2	68.0	21.9	17.7	23.7	9.3	4.6	5.0	10.9	16.5	31.9	46.6
5th %ile	3.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.2	8.6
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
Temp (°C)												
Maximum[1]	37.5	36.2	33.9	30.4	25.3	22.2	22.5	25.2	30.2	33.0	35.4	36.3
Minimum[2]	21.8	21.7	19.5	14.4	9.2	6.0	5.1	7.0	12.0	15.6	18.6	21.0

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

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

The mean annual rainfall is approximately 319.1 mm, with a reasonably strong seasonal pattern of more summer rainfall than winter rainfall. Average monthly rainfall totals range from 4.7 mm in August to 68.0 mm in February (Table 2-1). Average three-monthly rainfall totals range from 18.8 mm in June/July/August to 171.8 mm in December/January/February. However, any month can receive relatively large rainfall totals, or little or no rain at all.

The distinct seasonality of rainfall in the region is distinctly correlated with temporal and spatial fluctuations in species richness and abundance, with many ephemeral flora species only emerging for short periods following rain.

2.3 Bioregion

A bioregion represents a large area of land with generally consistent biophysical characteristics (i.e. the climate, landform, geology, soils, vegetation and animals).

The Study area occurs entirely within the Burt Plain bioregion, which is characterised by plains and low rocky ranges with extensive areas of mulga and other acacia woodlands (Figure 2-1). The bioregion covers an area of 73,605 square kilometres which represents approximately 5% of the Northern Territory (NRETAS 2005).

Pastoralism represents the major industry in the Burt Plain, with 37 pastoral leases within or intersecting the boundary of the bioregion, occupying approximately 82% of the land area (Neave *et al.* 2006).

The bioregion includes some of Australia's best established and most extensive mulga (*Acacia aneura*) woodlands. Less than 0.3% of the bioregion is reserved in National Parks or other conservation reserves, and most ecosystems are not well represented in the reserve network – particularly mulga woodlands (NRETAS 2005).

Geologically the bioregion lies over the Arunta Province, Tennant Inlier, and small areas of Georgina, Wiso and Ngalia Basins, with metamorphic, plutonic, and sedimentary rocks of Precambrian age. Soils are generally comprised of shallow sands and massive earths. Landforms range from undulating plains to rocky ranges, with elevations of 350 m to 1100 m respectively. The bioregion is dominated by undulating plains which are interrupted by major drainage lines associated with terraces and levees, and sporadic hills and rocky ranges. Several ephemeral rivers drain the rocky ranges and flow through the bioregion in a northerly direction into the Tanami Desert.

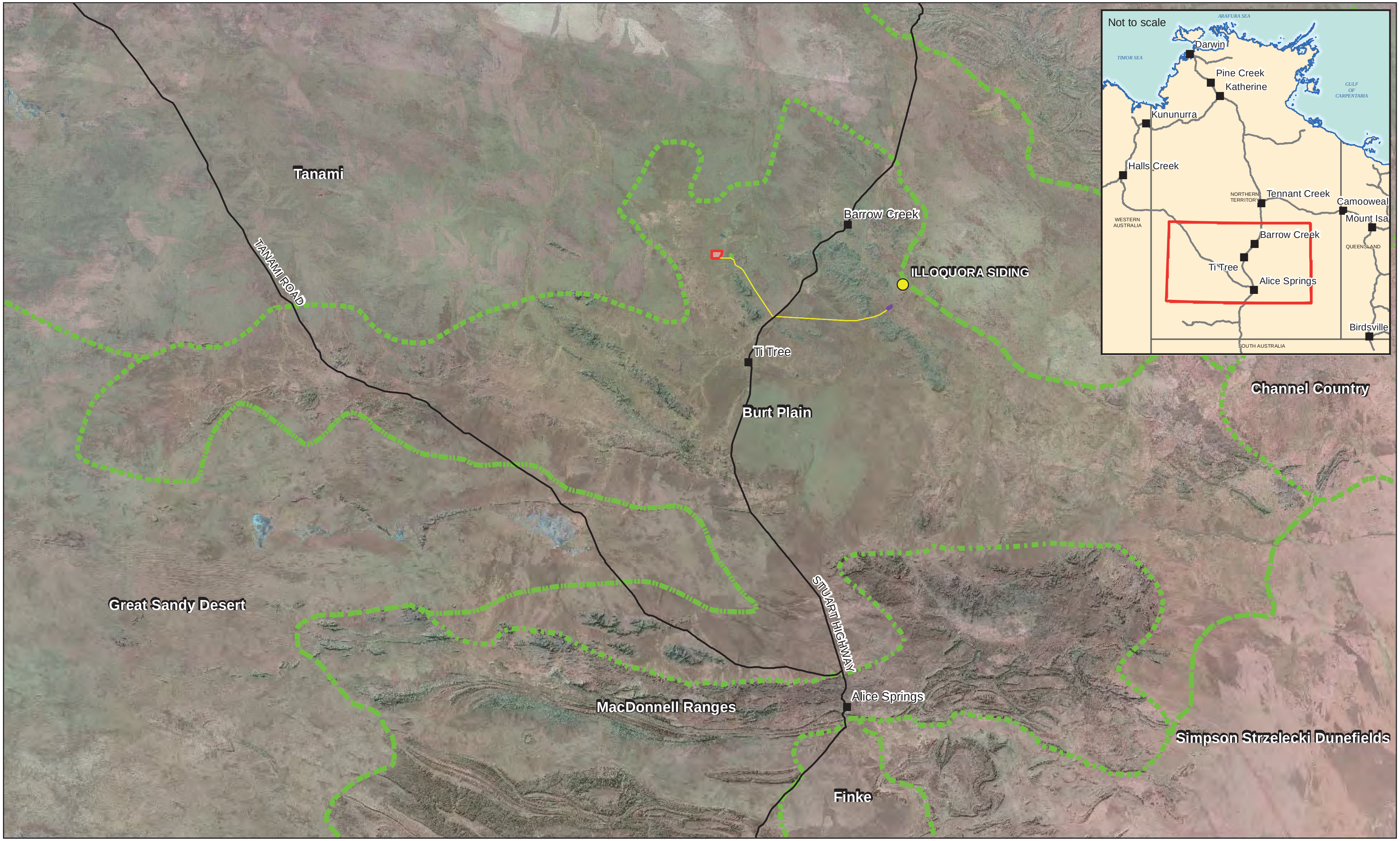
Five broad vegetation types have been mapped within the bioregion (Wilson *et al.* 1990), the most abundant being Acacia Woodland. Other broad vegetation types recorded include Eucalyptus low woodland with tussock grass understory, Eucalyptus woodland with Hummock grass understory, Hummock Grassland and Tussock Grassland (NRETAS 2005).

The bioregion is known to contain more than 1,100 flora species of which three species are listed as vulnerable under the TPWC Act, with one also listed as vulnerable under the EPBC Act. Additionally 64 species listed as data deficient, 41 listed as near threatened in the Northern Territory and seven listed as endemic to the bioregion have been recorded (Neave *et al.* 2006).

Wetlands occur within the Burt Plain bioregion, but none is listed in the 'Directory of Important Wetlands in Australia' (DIWA) or under the 'Convention on Wetlands of International Importance' (Ramsar Convention). Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River, and Wood Duck Swamp, located 10 km south of the access road, are listed as wetlands of national conservation significance (NRETAS 2009a).

The Burt Plain bioregion is recognised as a national priority bioregion for conservation planning. This is primarily due to the fact that it is one of the most poorly documented bioregions in the Northern Territory in terms of its biodiversity values (Neave *et al.* 2006).

There are 16 sites of botanical significance within the Burt Plain Bioregion, three of these (Anmatyerr North, Mud Hut Swamp and Wood Duck Swamp) occur within or near to the Study area (Neave *et al.* 2006) (Figure 4-2).



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Kilometres

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

N

LEGEND

- Towns
- Illoquora Siding
- Roads
- Bioregions
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Access Road Corridor

GHD

TNG Limited
Mount Peake EIS

Job Number	61-29057
Revision	0
Date	22 Oct 2015

Bioregions

Figure 2-1

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GHD House, 239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com W www.ghd.com

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Rail Siding Loading Facility (2013). Geoscience Australia - Place Names, Roads, States, Oceans (2008). DE - Bioregions (2008). Created by: CM

Potential and existing threats to biodiversity that have been identified within the bioregion include exotic flora, introduced animals, fire, erosion, land clearing, pastoralism and mining (Neave *et al.* 2006). Exotic predators are widespread and there are fifteen declared weed species currently listed under the *Northern Territory Weeds Management Act 2001* known to occur in the bioregion. Other exotic plants species, most notably buffel and couch grass, also pose significant threats to some habitats.

The Burt Plain bioregion is comprised of four sub-regions. The Study area occurs mostly within the Burt Pain 1 subregion with a small portion in the south of the Study area located within the Burt Plain 2 subregion. These subregions have been assessed as being in mostly good condition with native vegetation cover exceeding 90%. A high proportion of both subregions however, have been impacted by grazing and exotic flora species (particularly Buffel Grass) (Neave *et al.* 2006).

2.4 Geology and Soils

The Mount Peake Project area lies within the north-central portion of the Paleoproterozoic Arunta Province. The stratigraphy of the Arunta province comprises relics of 2,500 million year ago (Ma) Archaean basement, which is overlain by Paleoproterozoic that are older than 1,800 Ma, and comprise turbiditic sequences of greywacke, quartz, sandstone, siltstone and shale along with mafic rocks and their high-grade metamorphic equivalents. The Arunta Province also has minor calc-silicates and meta-felsic volcanic units.

The Mount Peake Project area lies within outliers of Neoproterozoic sediments of the Georgina Basin, which rest on metasediments of granites of the Aileron Province within the Lower Proterozoic Arunta Region (NRETAS 2009).

The Mount Peake orebody is located in a magnetite bearing gabbro occurring at a shallow depth of around 40 m, striking along a 1.3 km length, 500 m wide and over 150 m thick.

Soils within the proposed mining area primarily consist of shallow sands and massive earths.

2.5 Hydrology

The Project area is located within the Wiso Surface Water Management Basin, which comprises numerous ephemeral dendritic drainage systems across the region. Watercourses generally flow north, with a number of smaller watercourses originating out of rocky outcrops into the surrounding plains. Key water courses in the vicinity of the Project site include Murray and Bloodwood Creeks. These are tributaries of the Hanson River, the main watercourse draining the western part of the Ti Tree Basin.

The alluvial floodplains that separate the channels are referred to as floodouts, a term which has broad application and includes places where a drainage channel becomes subdivided, indistinct or disappears completely and water from the channel is dispersed across a plain or between dunes (Duguid *et al.* 2005). Several of the water courses are considered to be joined, with shared floodouts in large flood events.

A number of minor watercourses emanate from the Djilbari Hills in the vicinity of Mistake and Gingers Bores, flowing northwards before terminating a short distance later in the sandplain. Runoff is ephemeral and likely to be rapid in the foothills but slowing substantially on the plain.

Mud Hut Swamp, located in the floodout area of the Bloodwood Creek, Stirling Swamp (Anmatyerr North Site), an interim floodout area for the Hanson River, and Wood Duck Swamp, 10 km south of the acces road, are listed as wetlands of national conservation sigificance (NRETAS 2009a). The channel of the Hanson River becomes ill defined, or braided, in the vicinity of Stirling Swamp, before becoming more defined again downstream.

The Hanson River rises in the Reynolds Range (Anmatijira Range) to the south of the Project site, and flows north flooding out into the Tanami Desert, west of Tennant Creek. This floodout area is considered an important source for groundwater recharge (Duguid *et al.* 2005).

Flows in the Woodforde River, which runs east of the Hanson River upstream of Ti Tree, have been monitored continuously since 1975 (gauging station G0280010). However, these records are not considered reliable since only a few events have been recorded (Department of Infrastructure, Planning and Environment 2002). The Australian Natural Resources Atlas (ANRA) indicates that the Hanson River flows once in every 12 years on average (ANRA 2013). The Department of Infrastructure, Planning and Environment (2002) found that regional rivers located in the Ti Tree Groundwater Basin are only likely to flow when monthly rainfall exceeds 100 mm, with this threshold being achieved approximately once every two years on average.

2.6 Land System Classification

Land systems have been defined as "*a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation*" (Laily 1971).

The Project area is covered by land system mapping of the Alice Springs area which has been completed at a scale of 1:1,000,000 as part of surveys carried out by the Division of Land Research and Regional Survey between 1956 and 1957. A total of eight broad land systems have been mapped across the Project area (Table 2-2). The majority of the area is covered by two lands systems, the Singleton system which is characterised by spinifex sand plains and the Bushy Park system which primarily consist of mulga plains on red earths.

Table 2-2 Land Systems mapped within the Project area

Code	Land System	Landform	Soil Description	Vegetation
Bo (6)	Boen	Plains with convex interfluves and board shallow valleys	Red earths, lateritic in part	Mulga in groves over short grass or *Eragrostis eriopoda* (woollybutt)
Hu (47)	Huckitta	Mountain ranges with rounded foothills and spurs	Little soil	Spinifex or sparse grass
Wl (65)	Woolla	Low platforms and drainage floors	Shallow sandy calcareous earths and red earths	Sparse low trees over short grass; Some plains of red clayey sands and spinifex.
Sn (78)	Singleton	Parallel, reticulate and irregular sand dunes with stable flanks	Red dune sands and red clayey sands	Spinifex
Wo (82)	Woodduck	Fans with sandy plains	Red clayey sands	Spinifex or sparse low trees over short grass
Kr (31)	Krichauff	Bold plateaux, with rocky summits and steep dissected margins	Very stony and sandy soils	Sparse shrubs and low trees over spinifex or sparse grass
Ac (18)	Alcoota	Undulating plains Erosional and alluvial slopes	Red earths Textured-contrast soils, some stony	Mulga over short grasses. Spare low trees over short grass or *Eragrostis eriopoda* (woollybutt)
Bu (67)	Bushy Park	Plains	Red earths	*Acacia aneura* (Mulga) in groves over short grass or *Eragrostis eriopoda* (woollybutt).

3. Methods

3.1 Overview

Key tasks involved in the preparation of this flora and vegetation assessment included:

- Literature review of existing studies within or surrounding the Study area
- Desktop searches of government database information relating to flora distributions, including the Commonwealth Department of the Environment (formerly SEWPaC) Protected Matters Search Tool (PMST) and NT herbarium Holtz database
- Undertaking a systematic baseline flora survey of vegetation types within the Project area and providing an inventory of the flora species present
- Mapping the distribution of vegetation communities present in the Project area
- Identifying introduced flora (weeds) present in the Project area and mapping significant infestations;
- Describing the existing terrestrial environment of the Project area in terms of its ecological values, including type and condition of vegetation communities, their structure and floristic composition
- Determining the likelihood of occurrence of threatened flora species, populations and Threatened Ecological Communities (TECs) listed under the TPWC and /or EPBC Acts, based on the presence/absence of suitable habitat within the Project area
- Assessment of the significance of the Project area's vegetation in local and regional contexts
- Assessment of the potential impact of the proposal on the vegetation and flora present within the Project area
- Identifying measures to avoid, minimise, mitigate and offset potential impacts on ecological values within the Project area.

3.2 Desktop Assessment

Prior to completing field surveys a desktop literature and database review was undertaken to gain an understanding of the ecological context of the Project area. Data reviewed included existing broad scale vegetation mapping, land system data, land unit mapping and flora records from NT and Commonwealth ecological databases.

Results of the searches provide an overview of previous records, known distributional ranges and habitats types, and are used to provide an overview of species known or predicted to occur in the Project area. The following databases and literature sources were reviewed prior to conducting the field investigations:

- The NT Herbarium (Holtz) Database was used to identify flora species that have been previously recorded within a 20 km radius of the Project area (DLRM 2015)
- Department of the Environment (DotE) website search program, the Protected Matters Search Tool (PMST), was used to identify Matters of National Environmental Significance (*Environment Protection and Biodiversity Conservation Act 1999*) potentially occurring in the locality (20 km radius). Information was downloaded in the form of an Environmental Report in September 2015
- NT land systems/vegetation mapping of the Southern Alice Springs District was reviewed to determine the broad vegetation types previously mapped within the Project area

- Aerial imagery was used to create a preliminary vegetation map based on recurring vegetation patterns observed within the Study area. This preliminary mapping was used to help stratify the placement of flora quadrats throughout the Study area and refine the vegetation map
- Bureau of Meteorology online data was sourced to determine climatic conditions in the region (BOM 2015)
- Mapping of Sites of Conservation Significance in the NT was reviewed to determine any significant sites in the locality (DLRM 2013)
- Other literature relevant to the Project area that was reviewed as part of the desktop assessment included:
  - Vegetation survey of the Northern Territory Australia (Wilson, B., Brocklehurst, P., Clarn, M., and Dickinson, K. 1990)
  - Northern Territory Draft Parks Master Plan (NRETA 2005)
  - Northern Territory Bioregions – Assessment of Key Biodiversity Values and Threatened Species (Baker *et al.* 2005)
  - Neave, H., Sparrow, B., and Clifford, M. (2006) Preliminary Report: *Towards a resource assessment of the Burt Plain Bioregion for Conservation Planning*. Biodiversity Conservation Department of Natural Resources, Environment and the Arts;
  - Ward, S., and Harrison, L. (2009). *Recognising sites of conservation significance for biodiversity values in the Northern Territory*. Department of Natural Resources, Environment, the Arts and Sport, Darwin NT
  - Harrison, L., McGuire, L., Ward, S., Fisher, A., Pavey, C., Fegan, M., and Lynch, B. (2009). *An inventory of sites of international and national significance for biodiversity values in the Northern Territory*. Department of Natural Resources, Environment, the Arts and Sport, Darwin, NT.

3.3 Vegetation Surveys and Land Mapping

As is the case for the majority of the Northern Territory, existing vegetation mapping for the Project area and surrounding bioregions is very limited due to the lack of previous detailed vegetation survey. Vegetation mapping that does exist for the site includes vegetation mapping that has been completed for the whole Territory at 1:1,000,000 scale (Wilson *et al.* 1990).

Land system mapping in the in the Northern Territory includes broad scale mapping of regional landforms, soils and vegetation. The majority of the Project area is covered by land system mapping for the Alice Springs area which has been completed at a scale of 1:1,000,000 as part of the range condition assessment program that was completed by the Division of Land Research and Regional Survey completed by CSIRO between 1956 and 1957 (Perry *et al.* 1963).

This mapping was reviewed as part of the desktop assessment prior to field surveys.

3.4 Survey Design

A random-stratified approach was used to survey a representative range of environmental conditions and vegetation types across the Study area. The Study area was stratified into sampling units using existing vegetation mapping and aerial imagery in combination with an electronic lithology dataset derived from 1:1 000 000 geology mapping (Geosciences Australia 2015).Using the vegetation map produced during the preliminary assessment, the subject site was divided into relatively homogenous or discrete vegetation zones for assessment.

Using the geology map and aerial imagery, the Study area was divided into relatively homogenous or discrete vegetation zones for assessment.

Survey locations were distributed randomly between vegetation zones.

3.5 Field Survey

The vegetation and flora survey was conducted by two GHD botanists from 7 to 14 April 2013, in accordance with a TPWC Act permit issued to GHD by the Northern Territory Parks and Wildlife Commission (Permit number 40623, expiry date 30 April 2014). Flora survey techniques used in the baseline surveys were consistent with the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst *et al.* 2007).

The area surveyed included the proposed mine area, accommodation area, a 1 km wide corridor along the proposed access road and the proposed rail siding facility. Field survey of the proposed borefield and associated pipeline and access road were not undertaken as part of this assessment as the locations of these features were not known at the time of the survey. Similarly, the location of borrow pits to provide construction materials for the access road have not been surveyed as their location has not yet been determined.

Flora Quadrats

Survey sites for vegetation mapping and habitat characterisation included the collection of data from forty-five (45) 20 m x 20 m quadrats (or in the case of narrow riparian areas 10 x 40 m quadrats). For each quadrat surveyed the following data were recorded:

- Site location including GPS coordinates
- General site description
- Habitat information including patch size, aspect, drainage, geology, soil type and texture, estimated soil depth as well as percentage cover of:
  - Ground cover (pebbles/gravel/stones/small rocks/rocks/large rocks and boulders)
  - Litter
  - Bare earth
  - Ground layer vegetation
  - Crust
  - Exposed rock
  - Gravel
- Structural information for the tree, shrub and ground strata including estimated percentage cover, height range and average height for each stratum as well as average height and percentage cover of each growth form present within the quadrat (i.e. tree, shrub, tussock grass, forb etc.)
- Degree of site disturbance including grazing intensity and fire frequency
- A full inventory of all flora species present along with heights and projected foliage covers for each taxa.

A handheld Trimble Nomad GPS unit was used to record spatial locations of quadrats and site photograph was taken from the north-east corner of each quadrat. The location of each quadrat is shown in Figure 3-1.

Secondary Check sites

To assist with vegetation mapping, data was collected from 24 check sites according to methods described in Brocklehurst *et al.* (2007). At these sites dominant species in the canopy, mid and ground strata were recorded along with their average height and percentage cover. The location of each check site is shown in Figure 3-1.

Aerial Survey

Due to the large size of the Study area and the lack of access tracks, large sections of the Study area could not be accessed by vehicle. A helicopter was therefore used to assist with mapping vegetation across the site. The proposed route for the access road was assessed from a helicopter and notes taken on aerial imagery regarding vegetation types. To confirm vegetation types the helicopter landed within representative vegetation types and multiple flora quadrats were completed in each vegetation type observed from the air.

Opportunistic Collections

While walking from site to site, flora taxa not previously recorded within quadrats or check sites were noted. This ensured that a comprehensive species list was produced for the Study area.

Vegetation Mapping

Vegetation mapping is the delineation of plant communities into groups or associations. The distinctive characteristics of these groups or associations include features such as species dominance, stratum structure and species composition.

The classification of vegetation 'types' within the Study area was based on dominant flora species present within each structural layer (i.e. canopy, shrub and ground layers). Structural attributes were assigned to the groups in order to produce a structural vegetation type classification.

Vegetation types were described according to the National Vegetation Information System (NVIS), Level V: Association, which encompasses a description of the broad structural formation (e.g. woodland, canopy height and percentage cover) and the dominant species in three strata (Upper overstorey, Midstorey and Ground Layer) (Brocklehurst *et al.* 2007).

The NVIS description identifies the following characteristics of a community:

- Landform/lithology
- Dominant stratum (layer)
- Dominant species
- Average height and height range
- Cover (percentage canopy cover for upper layers (trees and shrubs) and percentage cover for ground vegetation)
- Growth form (e.g. tree, shrub, tussock grass, Brocklehurst *et al.* 2007).

Mapping of vegetation communities was undertaken at 1:50,000 scale (GDA94) by visually interpreting Google Earth aerial imagery captured at c. 1:10 000 scale (Google Earth 2013).

Paper Size A3

0 5 10

Kilometres

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

N

LEGEND

- Flora Survey Locations
- Check Sites
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Haul Road Corridor
- Tracks (Unverified)
- Major Watercourses
- Principal Road
- Minor Road

Vegetation Communities

1 Low open Eucalyptus woodland on limestone ridges
2 Mulga shrubland on sandy red earths
3 Riparian woodland along watercourses and drainage channels
4 Low Corymbia open woodland on loamy alluvial plains
5 Floodplains dominated by *Eucalyptus victrix*
6 Triodia grasslands and sandy plains
7 Low Acacia shrubland on rocky slopes
8 Tall Acacia shrubland on stony quartz

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Date 22 Oct 2015

Flora Survey Locations

Figure 3-1

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999 Hay Street, Perth WA 6000 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com W www.ghd.com

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2013). Geoscience Australia - Waterways (2008). Google Earth Pro - Imagery (Date extracted: 20/10/2015). GHD - Tracks, Flora Survey Sites, Vegetation Communities (2014). Created by: RB

3.5.1 Threatened Flora

Targeted surveys were undertaken for threatened flora species which could potentially occur within the Study area given known distributions, previous records in the locality and habitat requirements for each species. Random meander transects, according to the methods of Cropper (1993), were focused in areas of potentially suitable habitat. These random meander transects were conducted opportunistically whilst ground-truthing vegetation mapping and while travelling between quadrats.

3.5.2 Nomenclature

Identifications of flora were made in the field using CSIRO (2006), Jessop (1981), Latz (1995), Maslin (2001), Moore (2005), Sharp and Simon (2001), Wheeler (1992) and Woinarski *et al.* (2007).

The nomenclature applied is consistent with the Northern Territory Flora Checklist (Short *et al.* 2011), the NT Southern Region Flora Checklist (Albrecht *et al.* 2007) and the Mabberley update to family nomenclature adopted by the NT Herbarium. In some cases the most current plant species names are unpublished and were provided by P. Jobson and P. Latz (*pers. comm*.).

All plants observed were identified to species level where possible. The absence of certain diagnostic features (this is a function of the seasonal cycles of flora species) prevented identification of some plants to species level. These were identified to genus level. Samples of taxa where positive identification was not possible in the field were identified in the Alice Springs Herbarium with the assistance of P. Latz.

3.5.3 Introduced Flora

Locations of significant infestations of introduced flora species were marked on a Trimble GPS unit, including species present, and an estimate of the density and extent of infestations.

3.6 Assumptions and limitations

Mapping

Due to the size of the Study area and access limitations, the entire site could not be assessed during the field survey. To address this limitation a subset of the Study area was ground-truthed during the field survey. The remaining extent of vegetation communities was mapped by extrapolation and interpretation of aerial imagery.

The scope of the assessment did not allow for detailed validation of the spatial or attribute accuracy of the resultant vegetation map. Thus there may be minor inaccuracies in the vegetation mapping due to errors in identifying subtle variations in the aerial imagery. Furthermore, given the scale of the mapping, small patches of vegetation (typically less than 250 x 250 m) were generally not differentiated from the surrounding vegetation type.

Mapping of quadrat locations using handheld GPS was accurate to c. ± 20 m. Locations of the survey sites may be inaccurate to this extent.

Boundaries between vegetation communities usually form a transition zone or mosaic where the two communities meet. For the purpose of vegetation mapping a line needs to be drawn between two communities. Boundaries on the vegetation map are therefore not exact.

Field surveys of the proposed borefield and associated pipeline and access road were not included as part of this assessment as the locations of these features were not known at the time of the survey. Identification of potential impacts was undertaken through extrapolation of vegetation data from site with similar landscape position and site characteristics.

Similarly, the location of borrow pits to provide construction materials for the access road have not been surveyed as their location has not yet been determined. There is a possibility that borrow may need to be imported to site from existing sources.

Flowering Seasonality

Field surveys were conducted during 7-14 April 2013, after an extended period without rainfall in the locality. Rainfall for the 12 months prior to the survey (at Territory Grape Farm) totalled 131.8 mm, which is 181.2 mm below the long-term average (1987-2014) (BOM 2014). Due to the extremely dry conditions at the time of the survey, a lot of the ground cover vegetation had died off and several of the grass and forb species present were not able to be identified due to the lack of vegetative and flowering material. It is highly likely that the area supports a large number of short lived ephemeral flora species that were not identified during the survey period. These species are likely to be present on the site in stored energy (either in the soil seed bank or present as underground tubers).

4. Results

4.1 Desktop Results

4.1.1 Existing Flora Records

The Northern Territory Government flora records for the locality contain 1,392 records of 494 species (DLRM 2015). These records include one threatened flora species listed under the TPWC Act, *Eleocharis papillosa* that is also listed as vulnerable under the EPBC Act.

Database records for the locality include 7 near threatened species[1], 6 endemic species and 14 species recorded as being data deficient[2]. A total of 16 exotic species have also been recorded. Table 4-1 provides a list of threatened and data deficient species previously recorded in the locality. The locations of vulnerable and near threatened flora are shown on Figure 4-1.

Ten threatened plant taxa are known to occur in the Burt Plain bioregion. Eight of these are listed under the TPWC Act and four are listed under the EPBC Act. Based on an assessment of habitats present it is unlikely that any of these species would occur in the Project area.

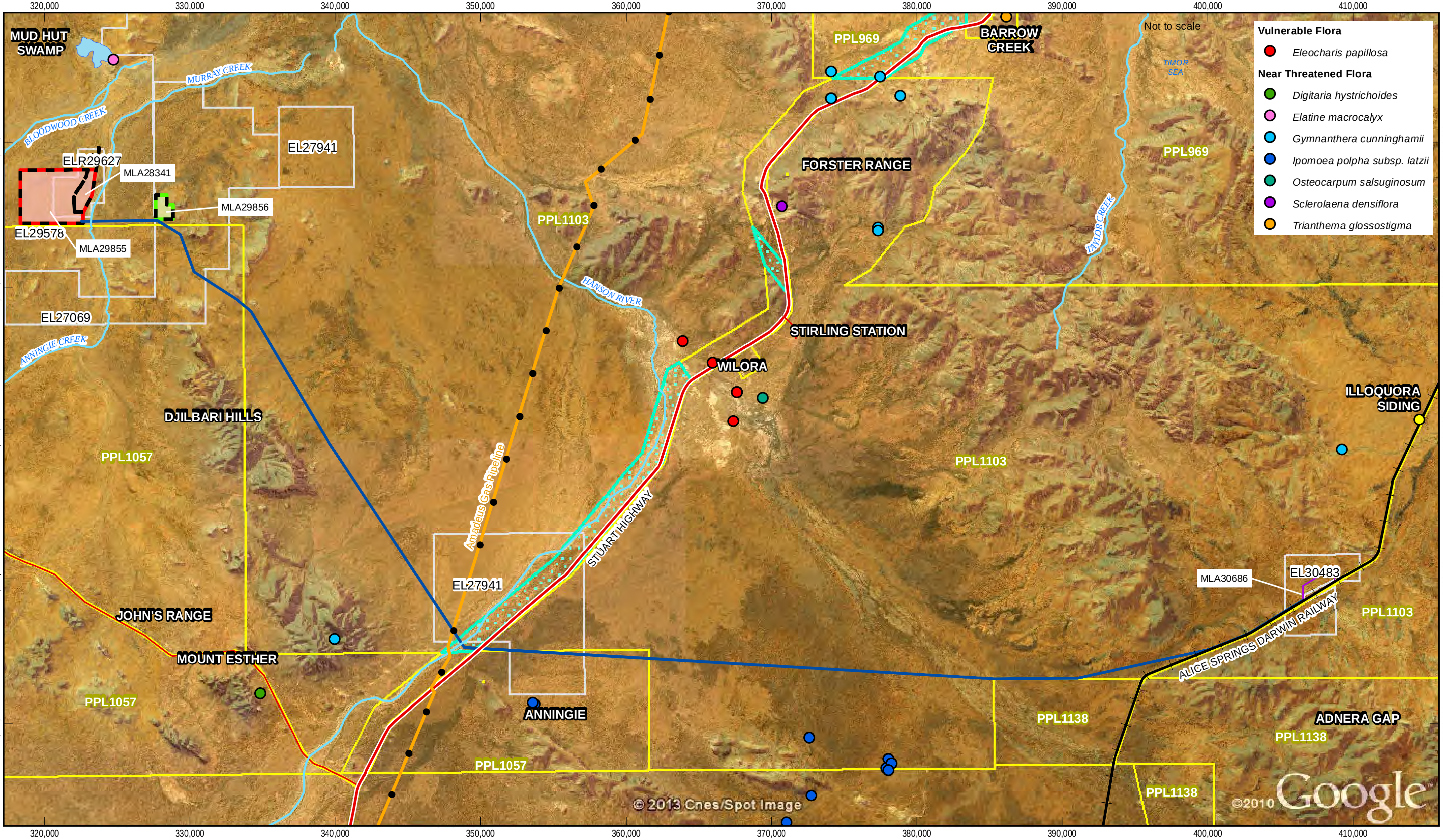
Table 4-1 Threatened flora records within the locality

Scientific Name	Common Name	TPWC Act Conservation Status	EPBC Act Conservation Status	Number of records within locality
Eleocharis papillosa	Dwarf Desert Spike Rush	V	V	5
Goodenia cylindrocarpa	-	dd	-	3
Lawrencia viridi-grisea	-	dd	-	2
Brachyscome ciliaris	Variable daisy	dd	-	13
Ectrosia schultzii var. schultzii	-	dd	-	3
Acacia oswaldii	Umbrella Wattle	dd	-	4
Acacia incurvaneura	-	dd		2
Acacia pteraneura	Mulga	dd		1
Eriachne sp Davernport Ranges		dd		3
Triumfetta chaetocarpa	Urchins	dd	-	2
Triumfetta deserticola		dd		1
Ixiochlamys nana		dd		2
Peplidium foecundum		dd		1
Swainsona acuticarinata		dd		1
Bulbostylis pyrifolmis		nt		1
Ipomoea polpha subsp. latzii	Giant Sweet Potato	nt	-	11
Gymnanthera cunninghamii	-	nt	-	-
Osteocarpum salsuginosum	-	nt	-	1
Sclerolaena densiflora	-	nt	-	1
Spartothamnella puberula		nt		2
Trianthema flossostigma		nt		2

Key: V = vulnerable, dd = data deficient, nt = near threatened

[1] Under IUCN criteria this conservation category is defined as taxa that do not meet the criteria for Critically Endangered, Endangered or Vulnerable at present but is close to qualifying for or is likely to quality for a threatened category in the near future.

[2] Under IUCN data deficient taxa are defined as species where there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.



Paper Size A4

0 2.5 5 7.5 10

Kilometres

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

N

LEGEND

- Illoquora Siding
- Principal Road
- Minor Road
- Major Watercourses
- Railway
- Amadeus Gas Pipeline
- Mud Hut Swamp
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Crown Land
- Mount Peake Granted Tenements
- Mount Peake Mineral Leases
- Cadastral Boundaries
- Access Road
- Camp Facilities

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Flora species of conservation significance recorded in locality

Figure 4-1

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239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: NRETAS - Vulnerable Flora 2013; TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2015). Geoscience Australia - Waterways, mainland, placename, road (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). Created by: RB

4.1.2 NVIS Vegetation Types

The available vegetation mapping covering the site is 1:1,000,000 scale mapping of the NT (mapped at NVIS Level IV: Sub-Formation, allows for description of one dominant genus for each stratum). Description of these vegetation types and occurrence is taken from the NT Government database (DRLM 2015). This product identifies four NVIS vegetation types within the Project area. These include:

- +Acacia tall open shrubland / Acacia sparse shrubland / Eragrostis low open tussock grassland
- +Acacia tall sparse shrubland / Acacia low sparse shrubland / Fimbristylis low grassland
- +Eucalyptus low open woodland / Acacia open shrubland / Chrysopogon (mixed) low grassland
- Acacia tall sparse shrubland / Acacia sparse shrubland / +Triodia low open hummock grassland.

4.1.3 EPBC Protected Matters Search Tool

The PMST results identify one flora taxon (*Eleocharis papillosa*) that is listed as vulnerable under the EPBC Act as potentially occurring in the locality. A copy of the PMST report is provided in Appendix A.

4.1.4 Threatened Ecological Communities

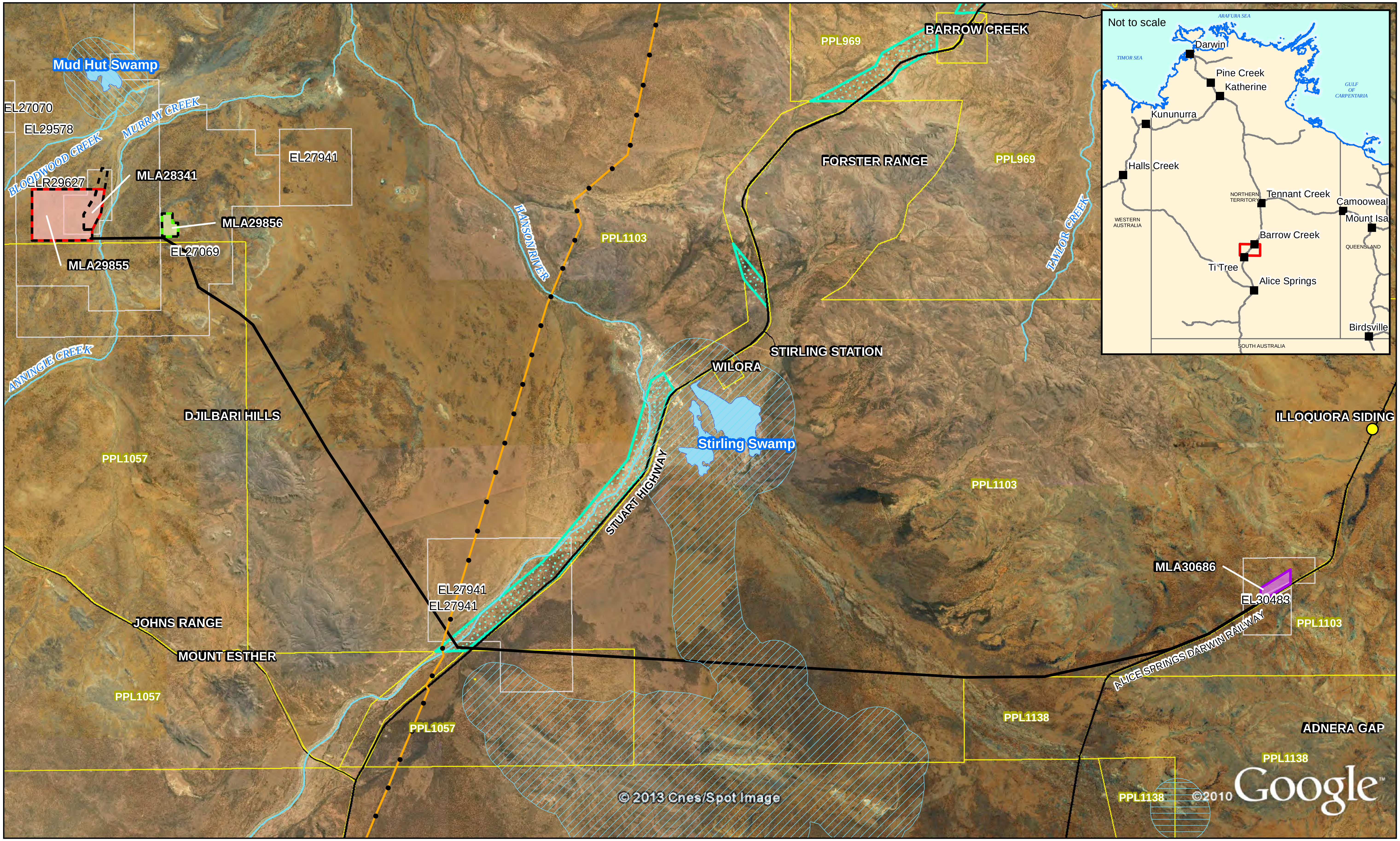
No EPBC Act-listed Ecological Communities occur within or near the Project area. Only one ecological community is listed in the NT as threatened under the EPBC Act (Arnhem Plateau Sandstone Shrubland Complex), and this does not occur within or near the Project area.

There is currently no mechanism for listing Threatened Ecological Communities under NT legislation.

4.1.5 Sites of Conservation Significance

Scientists from the Northern Territory Department of Land Resource Management (DLRM) have identified places that are recognised as areas of national or international significance for biodiversity conservation. There are 67 sites of conservation significance (SOCS) across the NT, and there is broad community recognition of the importance of long term protection of conservation values within these sites. Three SOCS are located within, or close to, the Study area.

The Anmatyerr North site includes Stirling Swamp, a large wetland complex comprised of claypans, lignum swamp, semi-saline samphire and temporary open water as well as parts of the adjacent Hanson River (NRETAS 2009b). The Anmatyerr North site is located across Stirling, Anningie and Ahakeye Stations and extends to the low rocky ranges about 20 km south of Stirling Swamp to encompass the known extent of the near threatended Giant Sweet Potato (*Ipomoea polpha* subsp. *latzii*) as well as a population of the threatened Dwarf Desert Spike Rush (*Eleocharis papillosa*). Stirling Swamp is noted to form occasionally at the northern edge of the Ti Tree Basin, storing flood waters discharged from the Hanson River and the ridges to the east of Wilora. This area is believed to act as an evaporation area for the basin (NRETAS 2009b).



1:250,000 @ A3

0 2.5 5 7.5 10

Kilometres

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

N

LEGEND

- Illoquora Siding
- Amadeus Gas Pipeline
- Principal Road
- Minor Road
- Major Watercourses
- Railway
- Mount Peake Mineral Leases
- Anmatyerr North Site of Conservation Significance
- Mud Hut Swamp Site of Conservation Significance
- Wood Duck Swamp Site of Conservation Significance
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Access Road
- Crown Land
- Cadastral Boundaries
- Mount Peake Granted Tenements

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Sites of Conservation Significance

Figure 4-2

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GHD House, 239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com W www.ghd.com

Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Rail Siding Loading Facility, Mount Peake Granted Tenements, Mount Peake Mineral Leases (2013). Geoscience Australia - Waterways, Roads, Place Names, Site of Conservation Significance, States, Oceans, Amadeus Basin to Darwin Gas Pipeline (2008). DLPE - Cadastral Boundaries (2013). Google Earth Pro - Imagery (Date extracted: 16/04/2013). GHD - Illoquora Siding (2013). Created by: CM

Mud Hut Swamp is located approximately 7.7 km to the north of the proposed mine pit (Figure 4-2). Mud Hut Swamp is a large, isolated, gum-barked coolabah (*Eucalyptus vitrix*) swamp that is fed by Bloodwood and Murray Creeks in the south-east and runoff from low hills and rises to the north and west (NRETAS 2009a). This is the largest swamp in the Burt Plain bioregion and remains inundated for a relatively long time after flooding, possibly retaining water for several months (NRETAS 2009a). The swamp is likely to support a range of wetland birds, fish and plants. Mud Hut Swamp is listed in the "*Inventory of sites of international and national significance for biodiversity values in the Northern Territory".*

Wood Duck Swamp is an ephemeral swamp that may hold water for many months in an otherwise dry landscape. It fills periodically after heavy rain. Wood Duck Swamp is dominated by smooth-barked coolabah *Eucalyptus victrix*. It is one of the largest such swamps in the Burt Plains bioregion (NRETAS 2009c). Wood Duck Swamp is entirely pastoral leasehold land within one pastoral lease (Mount Skinner). The main land use within the site and broader catchment is cattle grazing on native pastures. Wood Duck Swamp is located approximately 10 km south of the access road, outside of the Study Area.

4.2 Survey Results

4.2.1 Flora Species

A total of 238 species of flora were recorded within the Study area, comprising 233 native species and five exotic species. A further three collections could not be identified beyond genus level due to the lack of flowering parts or fruiting bodies or because they were only found in juvenile form. This represents approximately 22% of all flora species know to occur in the Burt Plain bioregion.

The Poaceae (grass family, 47 species, 45 native, 2 exotic), Fabaceae (pea family, 47 species, 46 native, one exotic), Malvaceae (19 native species) and Amaranthaceae (20 native species) were the most species-rich families recorded.

Flora species recorded within the Study area and their associated vegetation communities are relatively common in the region with the exception of a few species. No threatened plants were recorded within the Study area, nor were any plants endemic to the NT recorded. One species (*Euphorbia ferdinandii*) recorded within the Study area is listed as data deficient under the TPWC Act. An additional four species are noted to have bioregional significance within the Burt Plain bioregion.

Seventy-seven species recorded during the survey had not previously been recorded on the DLRM database for the locality. These new records combined with the existing NT Government flora records takes the total flora records for the locality to 571 species.

The full list of plant species recorded within the Study area is presented in Appendix B. Dominant species recorded within each of the vegetation types occurring within the Project area are in the following sections.

4.2.2 Vegetation Types

Based on the fine-scale vegetation mapping and flora sampling performed by GHD, a total of eight broad vegetation communities were identified as occurring within the Project area. These vegetation communities each display a degree of variation which is to be expected given the influence of differing fire regimes, grazing pressures, soils, hydrology and geology. Despite these variations these communities have been defined based on similarities in landscape position, floristics, vegetation structure and patterns.

Vegetation communities within the Study area have been described in accordance with the NVIS framework to hierarchical Level V: (Association).

The dominant vegetation types within the Study area are Mulga shrublands, which occur on alluvial fans and plains containing clayey red earths and Triodia hummock grasslands which grow on sandy plains and undulating hills. Vegetation across the Study area is generally in good condition with little anthropologic disturbance and high species richness. In more fertile riparian areas and associated floodplains there is clear evidence of impacts associated with cattle grazing including weed invasion, reduction in ground cover species and soil erosion. In particular there is a high abundance of the invasive grass *Cenchrus ciliaris* (Buffel Grass).

Vegetation types identified and mapped within the Study area are summarised in Table 4-2 and their distributions shown in Figure 4-3.

Detailed descriptions of each vegetation type are provided in Section 4.2.3.

Table 4-2 Vegetation Types within Study area

Veg. Code	Vegetation Type	NVIS Description (Level III Broad Floristic Formation)	NVIS Description (Level V Association)	Area (ha)
VT 1	Low open Eucalyptus woodland on limestone	Triodia hummock grassland	U^ *Eucalyptus socialis* subsp. *eucentrica, Eucalyptus pachyphylla, Corymbia opaca* /^tree mallee, tree/6/r M^ *Acacia ligulata*, *Senna artemisioides* subsp. *artemisioides, Senna artemisioides* subsp. *filifolia* /^Shrub/3/r *G+^ Triodia longiceps, Scaevola glabrata, Ptilotus obovatus* /^hummock grass, forb/3/c	775
VT 2	Mulga shrubland on sandy red earths	Acacia shrubland	U+^ *Acacia aptaneura, Acacia kempeana, Acacia aneura* /^shrub/6/i M ^*Sida platycalyx, Eremophila latrobei* subsp. *glabra* /^shrub/3/r G^ *Aristida inaequiglumis, Eragrostis eriopoda, Aristida holathera* /^tussock grass/1/i	11,885
VT 3	Riparian woodland along watercourses and drainage channels	Eucalyptus open woodland	U+^ *Eucalyptus camaldulensis* var. *obtusa, Erythrina vespertilio, Atalaya hemiglauca*/^tree/7/r M^ *Acacia cuthbertsonii, Jasminum calcarium*, *Senecio magnificus* /^Shrub/3/r G^ *Eulalia aurea Themeda avenacea, Cyperus centralis /*^tussock grass, sedge /2/i	554
VT 4	Low Corymbia woodland on loamy alluvial plains	Tussock grassland	U^ *Corymbia opaca, Atalaya hemiglauca, Hakea macrocarpa*/^tree/6/r M^ *Acacia kempeana, Acacia ligulata, Senna artemisioides* subsp. *helmsii* /-/^shrub/4/r G+^ *Eragrostis eriopoda, Aristida inaequiglumis, Triodia pungens* /^tussock grass, hummock grass /1/r	675
VT 5	Floodplains dominated by *Eucalyptus victrix*	Eucalyptus open woodland	U+^ *Eucalyptus victrix*, *Acacia estrophiolata* +/- *Eucalyptus camaldulensis* subsp. *obtusa* /^tree /7/i M^ *Eremophila latrobei* subsp *latrobei, Indigofera colutea /* shrub /3 /r G^ *Eragrostis cylindriflora, Fimbristylis dichotoma, Portulaca oleracea /* tussock grass, forb /1/r	609
VT 6	Triodia grassland on sandy plains	Triodia hummock grassland	U^ *Corymbia opaca, Atalaya hemiglauca* /^tree/6/bi M ^ *Acacia kempeana, Acacia aptaneura, Senna* spp. /^shrub/6/i +G^ *Triodia pungens, Eragrostis eriopoda, Aristida inaequiglumis*/^ hummock grassland, tussock grassland/1/c	8,115
VT 7	Low Acacia shrubland on rocky slopes	Triodia hummock grassland	U^ *Atalaya hemiglauca, Hakea macrocarpa* /^tree/6/bi M^ *Acacia spondonophylla*, *Grevillea wickhamii, Acacia adsurgens* /^shrub/3/i +G^ *Triodia basedowii, Eragrostis eriopoda, Aristida inaequiglumis*/^ hummock grassland, tussock grassland/1/c	441
VT 8	Tall Acacia shrubland on stony quartz	Acacia shrubland	U^ *Acacia georginae, Atalaya hemiglauca /^ tree* /6/bi M+^ *Acacia aneura, Senna spp. /*^ shrub G^ *Enneapogon clelandii, Themeda triandra, Sida filiformis /*^ tussock grass forb /1/i	223
TOTAL				**23,278**

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Kilometres

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

N

LEGEND

- 1 Flora Survey Locations
- 1 Check Sites
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Access Road Corridor
- Tracks (Unverified)
- Major Watercourses
- Principal Road
- Minor Road

Vegetation Communities

- 1 Low open Eucalyptus woodland on limestone ridges
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- 4 Low Corymbia open woodland on loamy alluvial plains
- 5 Floodplains dominated by *Eucalyptus victrix*
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- 8 Tall Acacia shrubland on stony quartz

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Figure 4-3

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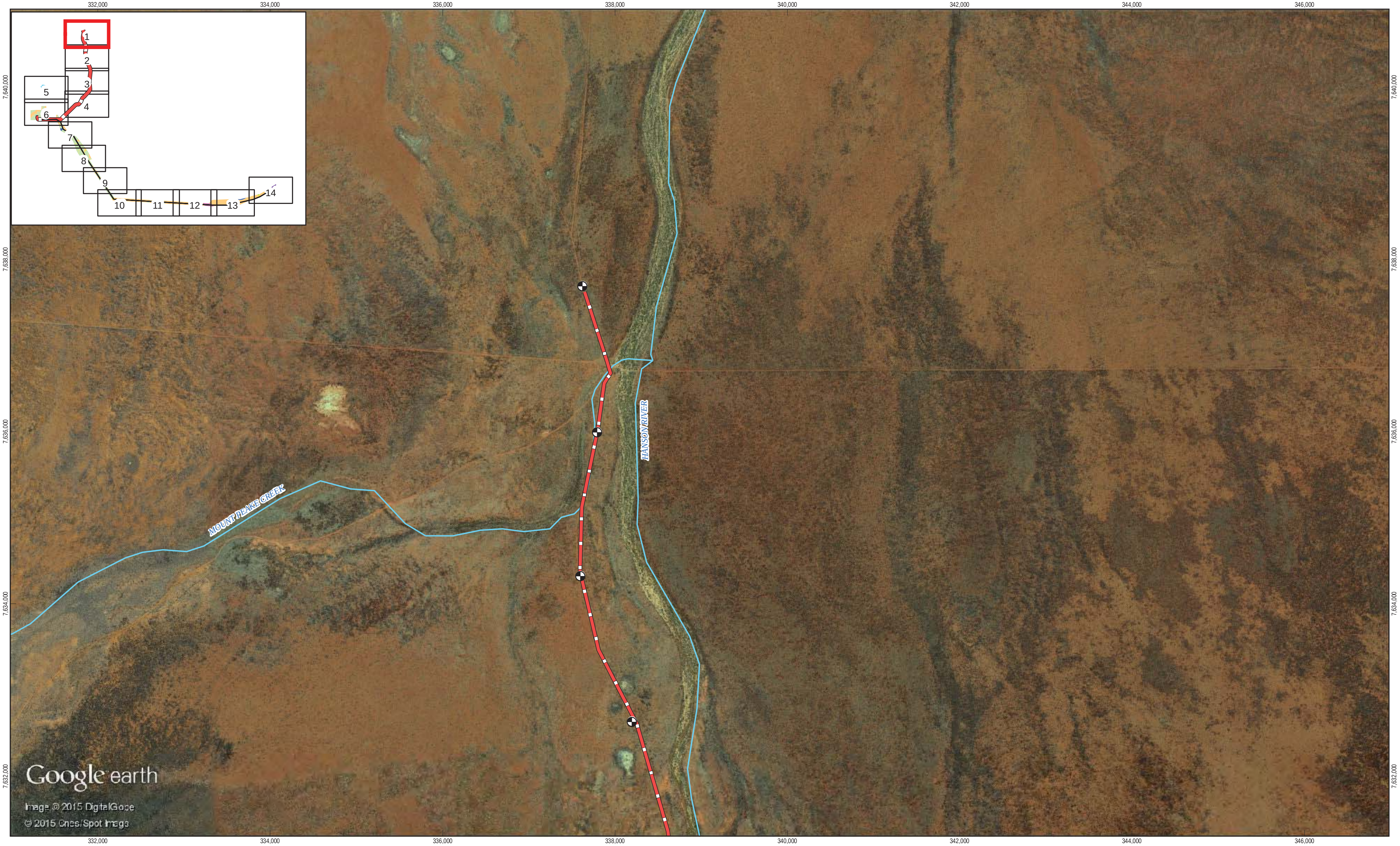

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Kilometres

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

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LEGEND

- Bore
- Flora Survey Locations
- Check Sites
- Borefield pipeline
- Major Watercourses
- Principal Road
- Minor Road
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Access Road Corridor
- Mine layout

Vegetation Communities

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Figure 4-3

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LEGEND

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- Flora Survey Locations
- Check Sites
- Borefield pipeline
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- Minor Road
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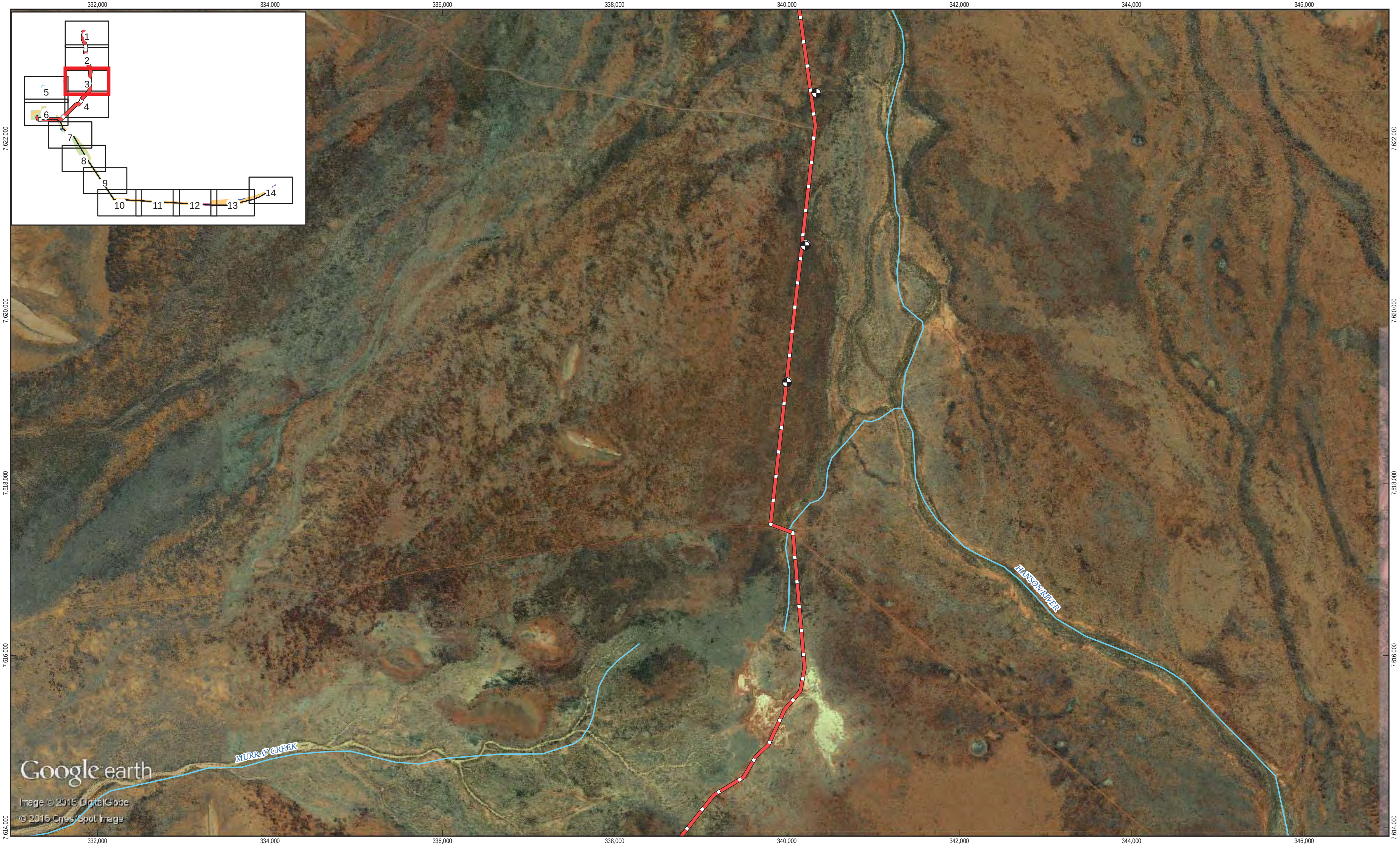

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LEGEND

- Bore
- Flora Survey Locations
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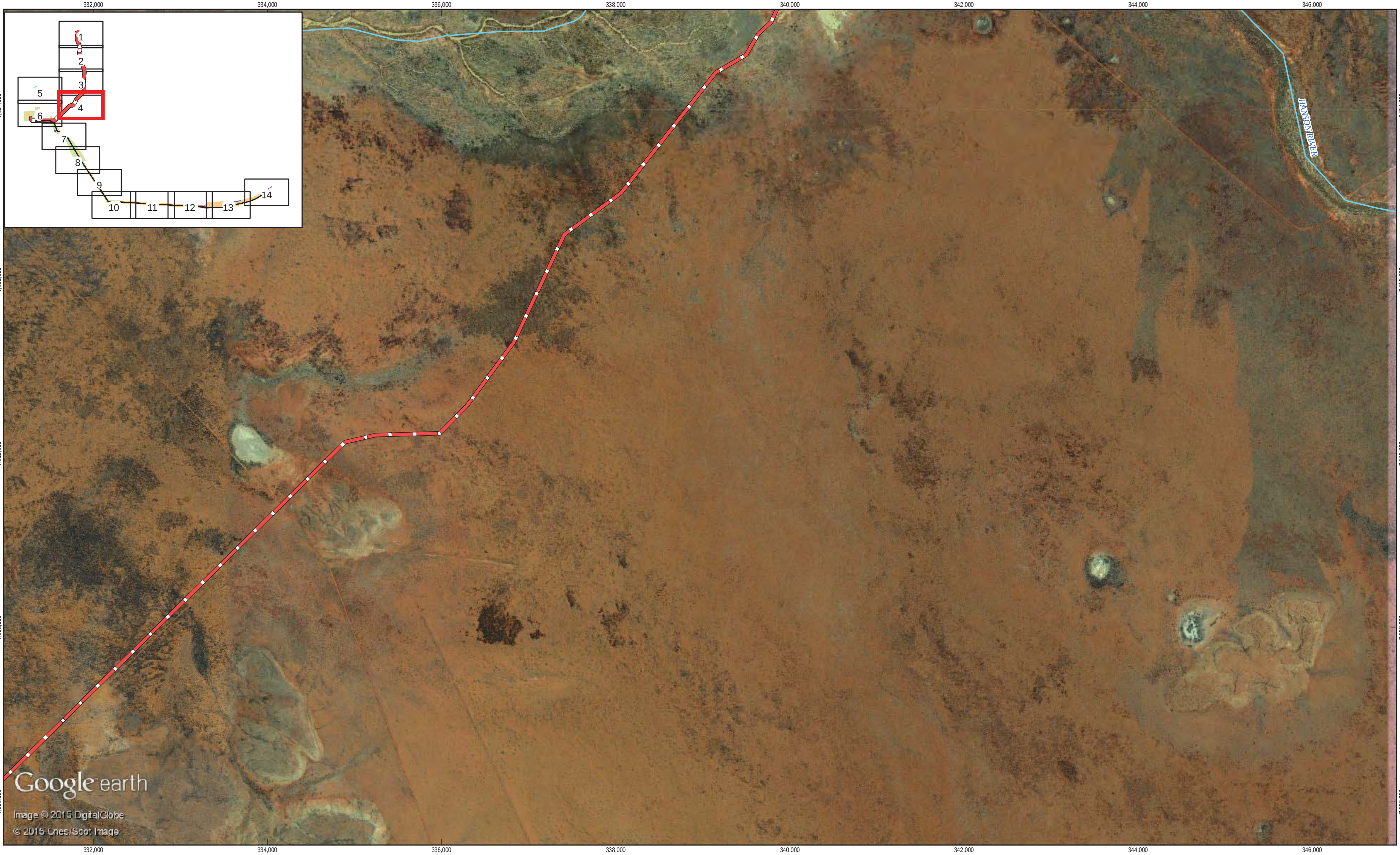

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LEGEND

- Bore
- Flora Survey Locations
- Check Sites
- Borefield pipeline
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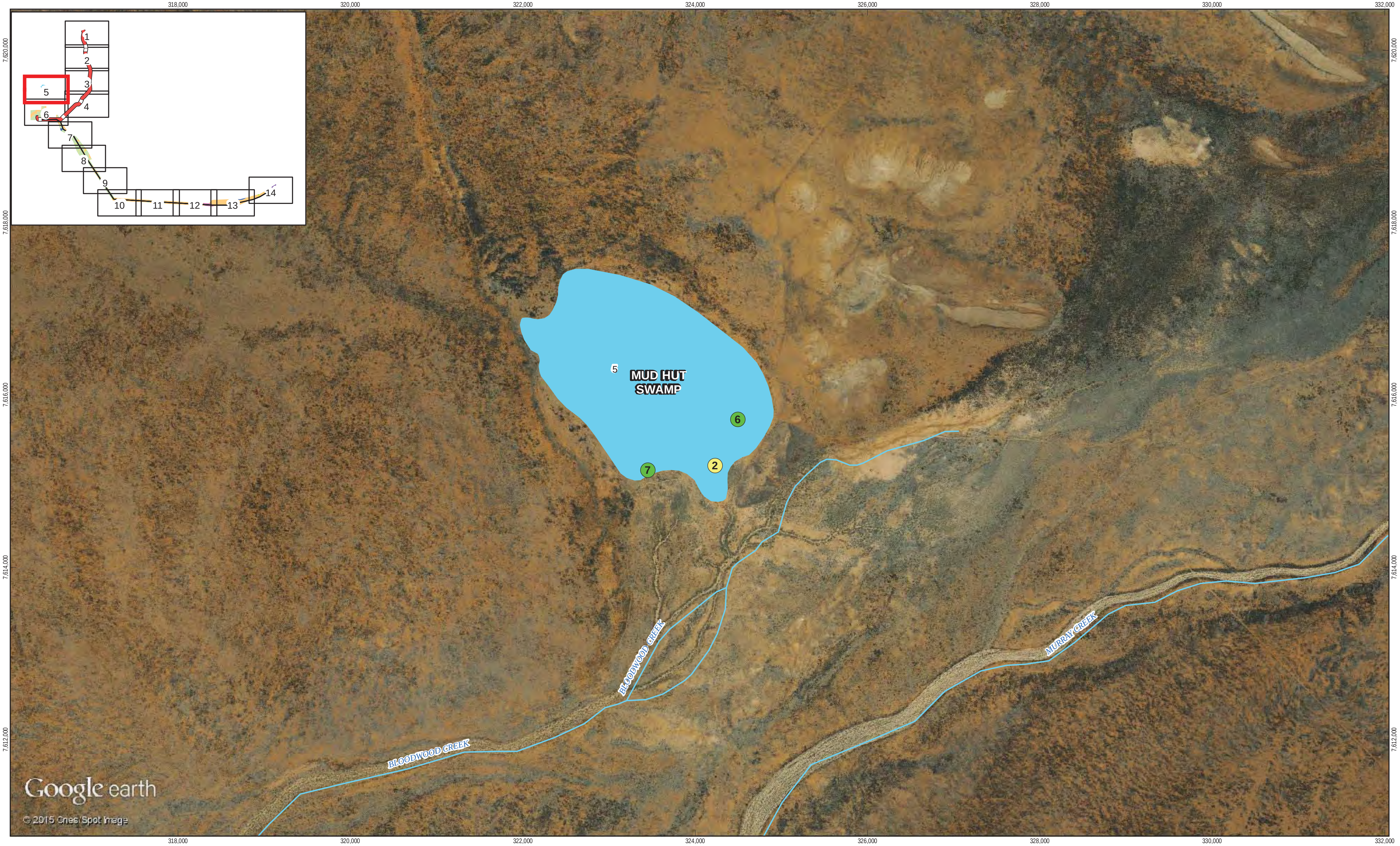

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- Bore
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- Check Sites
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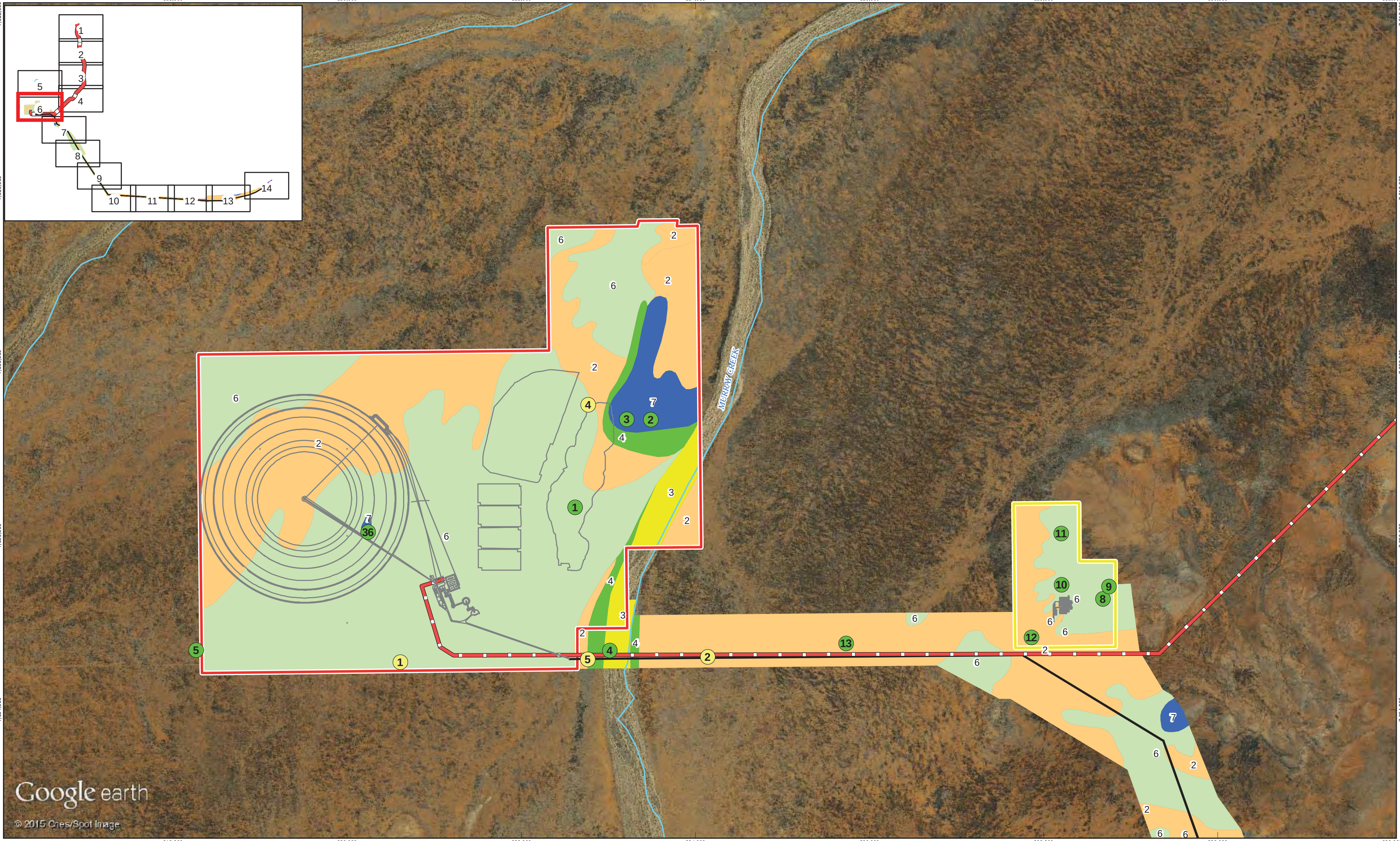

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LEGEND

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LEGEND

- Bore
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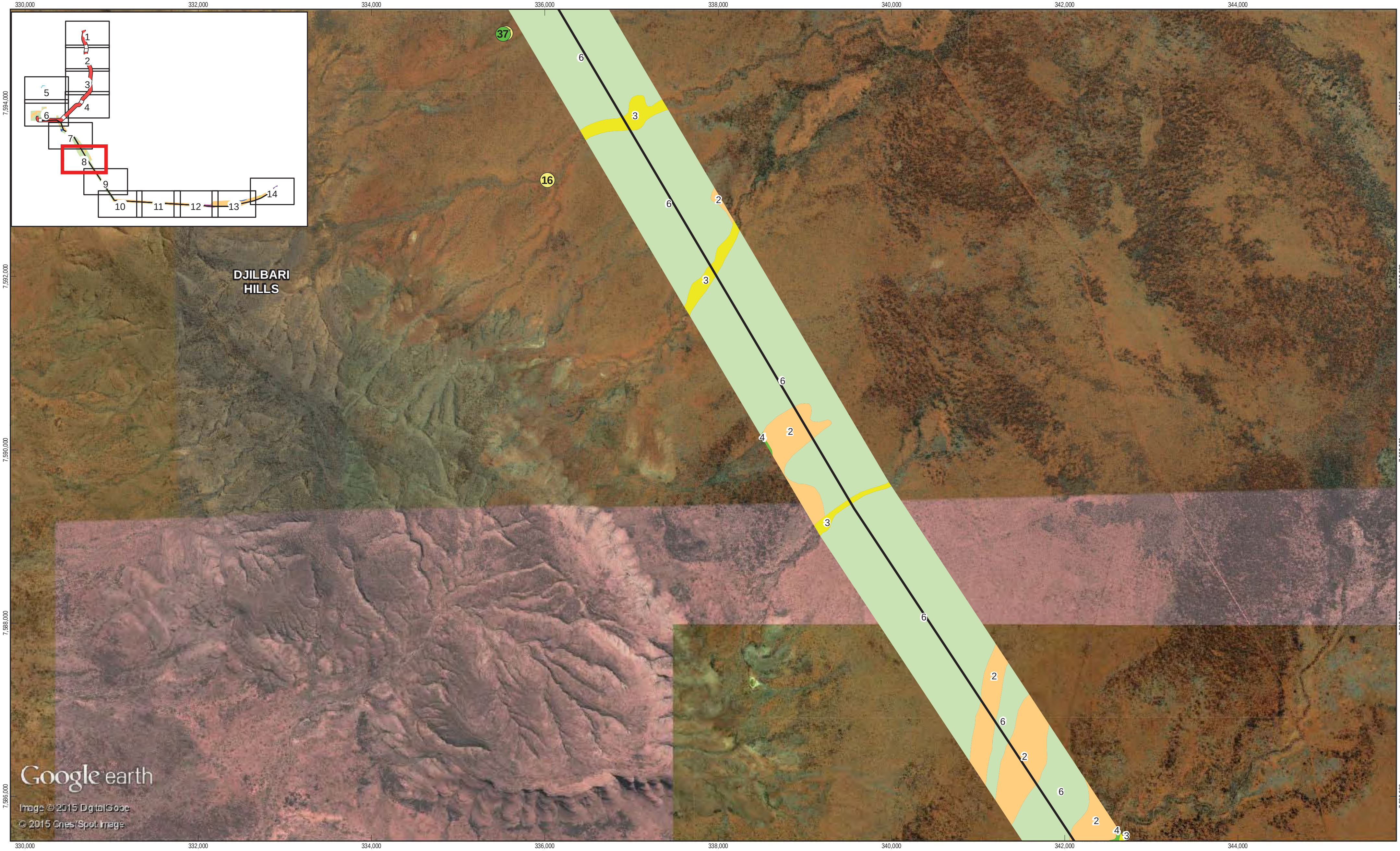

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Figure 4-3

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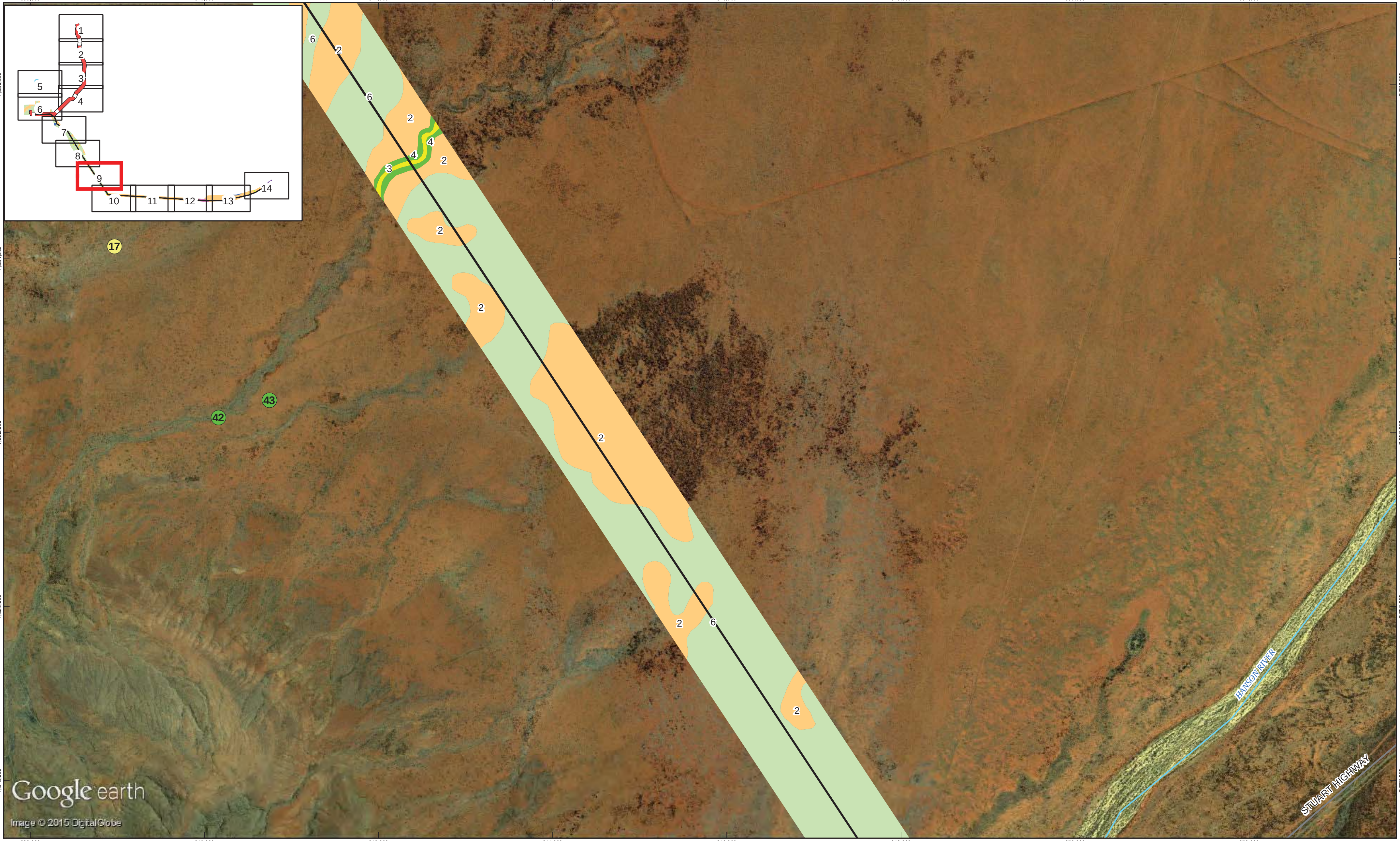

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Vegetation communities recorded within the study area

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Figure 4-3

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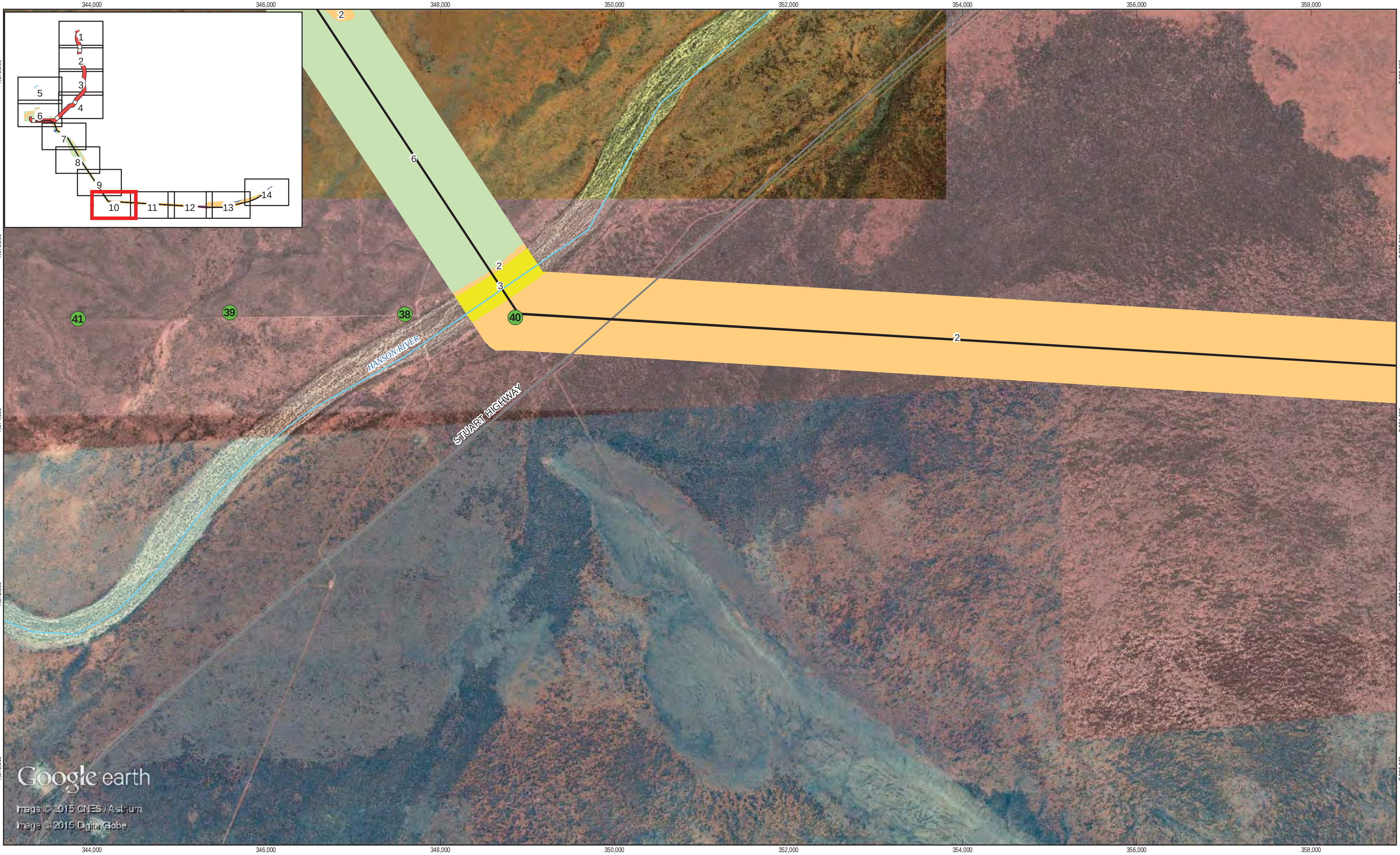

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LEGEND

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Vegetation communities
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Figure 4-3

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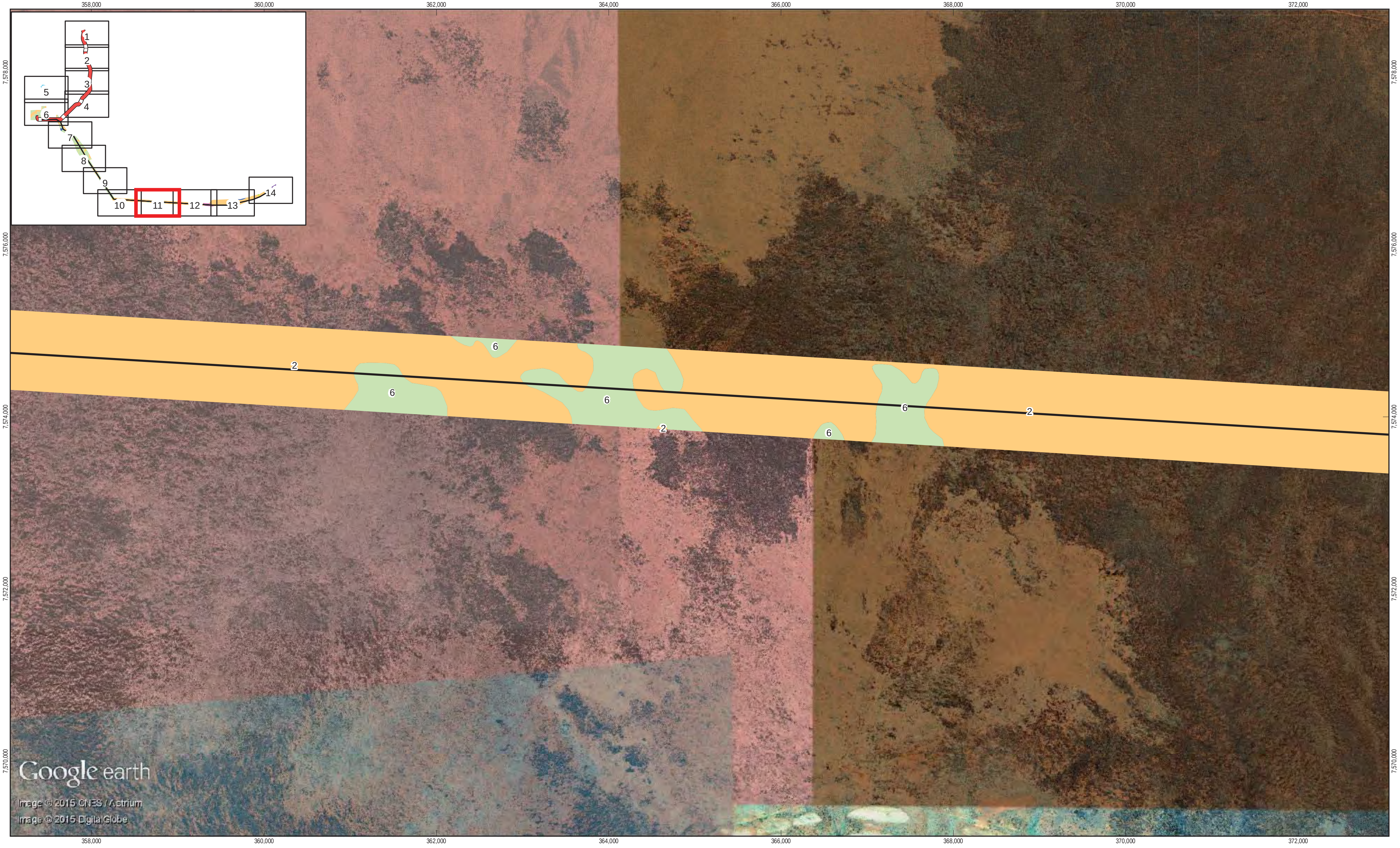

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LEGEND

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Vegetation communities recorded within the study area Figure 4-3

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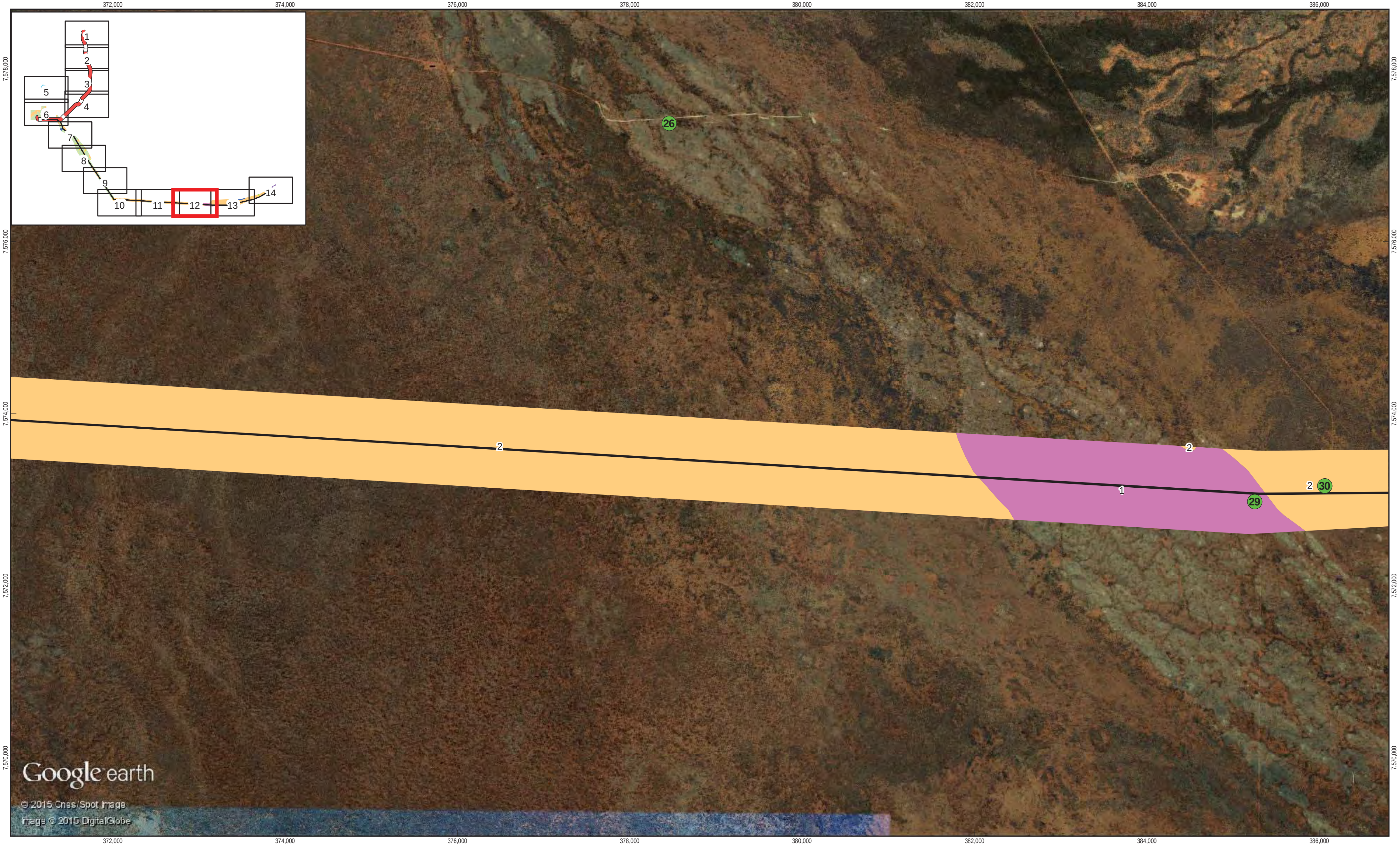
Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2013). Geoscience Australia - Waterways (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). GHD - Tracks, Flora Survey Sites, Vegetation Communities (2014). Created by: CM



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Kilometres

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

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LEGEND

- Bore
- Flora Survey Locations
- Check Sites
- Borefield pipeline
- Major Watercourses
- Principal Road
- Minor Road
- Rail Siding Loading Facility
- Mount Peake Mining Area
- Camp Facilities
- Access Road Corridor
- Mine layout

Vegetation Communities

- 1 Low open Eucalyptus woodland on limestone ridges
- 2 Mulga shrubland on sandy red earths
- 3 Riparian woodland along watercourses and drainage channels
- 4 Low Corymbia open woodland on loamy alluvial plains
- 5 Floodplains dominated by *Eucalyptus victrix*
- 6 Triodia grasslands and sandy plains
- 7 Low Acacia shrubland on rocky slopes
- 8 Tall Acacia shrubland on stony quartz

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Mount Peake EIS

Job Number	61-29057
Revision	A
Date	22 Oct 2015

Vegetation communities recorded within the study area

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Figure 4-3

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Data source: TNG - Gas / Slurry Pipeline Study Corridor, Camp Facilities, Transport Study Corridor, Mount Peake Mining Area, Mount Peake Granted Tenements (2013). Geoscience Australia - Waterways (2008). Google Earth Pro - Imagery (Date extracted: 13/02/2014). GHD - Tracks, Flora Survey Sites, Vegetation Communities (2014). Created by: CM

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Vegetation communities recorded within the study area

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Figure 4-3

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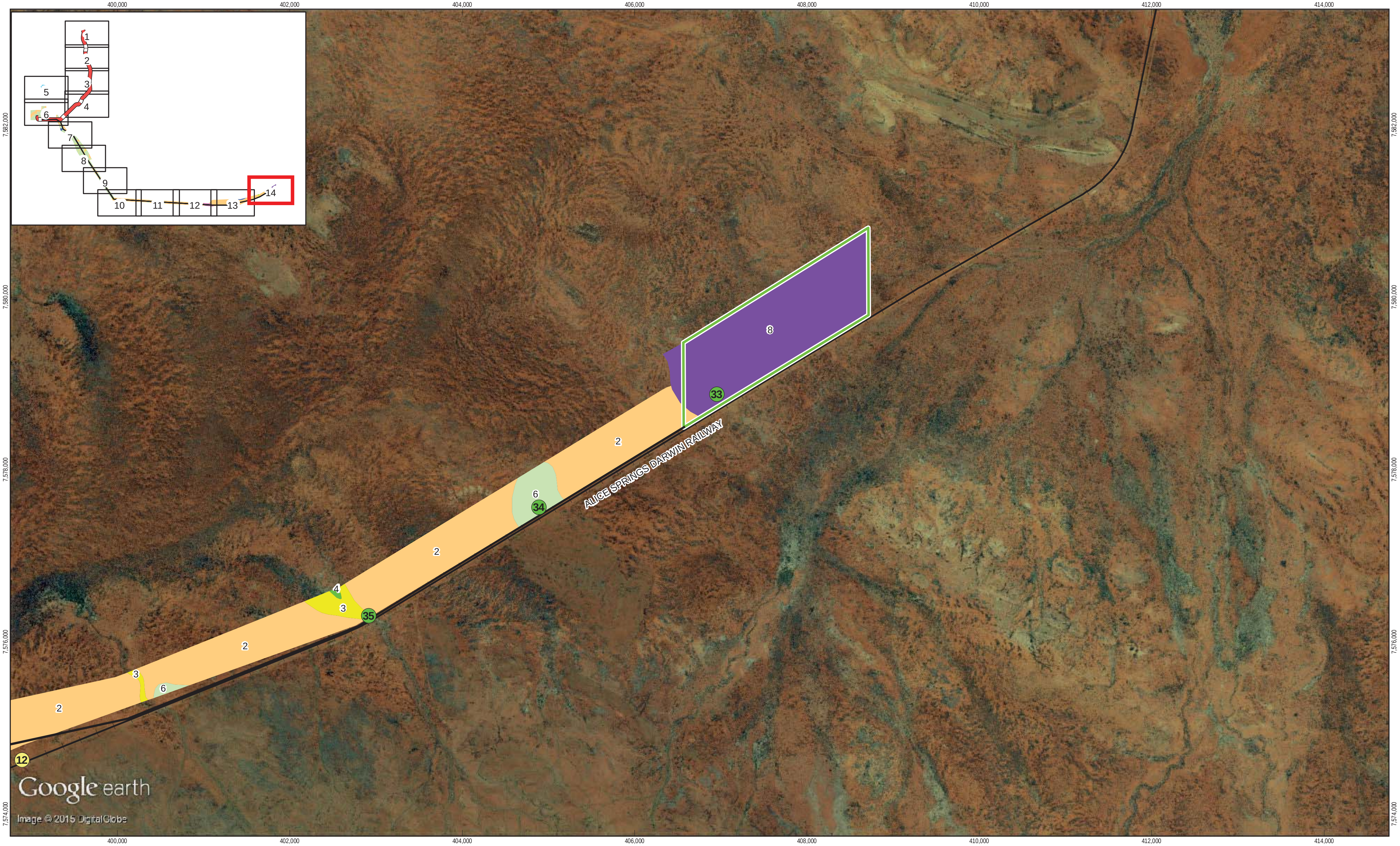

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Vegetation communities recorded within the study area Figure 4-3

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4.2.3 Vegetation Descriptions

***Low open Eucalyptus woodland on limestone ridges* (VT 1)**

This vegetation community occurs on an undulating limestone platform that runs in a northwest to south-easterly direction at the eastern end of the of the Study area. This landform is characterised by stony surfaces with limestone outcropping.

The overstorey of the community is characterised by low mallee Eucalyptus including *Eucalyptus socialis* subsp. *eucentrica* and *Eucalyptus pachyphylla*. Scattered individuals of *Corymbia opaca* and *Hakea lorea* are also present in low abundance in the canopy. In swales that hold water for longer periods *Corymbia aparrerinja* and *Eucalyptus victrix* dominant the canopy layer.

The sparse shrub layer is dominated by *Acacia ligulata*, *Eremophila longifolia*, *Senna artemisioides* subsp. *artemisioides* and *Senna artemisioides* subsp. *filifolia.*

The ground layer is dominated by *Triodia longiceps* hummocks. Other common grasses and forbs present within the ground layer of this vegetation community include *Ptilotus obovatus, Scaevola glabrata, Eriachne obtusa* and *Solanum centrale.*

Overstorey Layer: 6–12 m tall (0-5% cover) dominated by *Eucalyptus socialis* subsp. *eucentrica* and *Eucalyptus pachyphylla* on lower slopes and swales *Corymbia aparrerinja* and *Eucalyptus victrix* are common.

Shrub Layer: 1–4 m tall (5–10% cover) with several of the following species *Acacia ligulata*, *Eremophila longifolia*, *Senna artemisioides* subsp. *artemisioides, Senna artemisioides* subsp. *filifolia, Grevillea striata, Melhania oblongifolia* and *Acacia victoriae.*

Ground Layer: 0.3-1.5 m tall (20-70% cover) dominated by *Triodia longiceps* with several of the following grass and forb species present*: Ptilotus obovatus, Eriachne obtusa, Eragrostis eriopoda, Paraneurachne muelleri, Tripogon loliiformis, Indigofera linnaei, Euphorbia ferdinandii, Euphorbia australis, Anemocarpa saxatilis, Minuria leptophylla, Sclerolaena calcarata* and *Cassytha capillaris*.

NVIS Level V – U^ *Eucalyptus socialis* subsp. *eucentrica, Eucalyptus pachyphylla, Corymbia opaca* /^tree mallee, tree/6/r M^ *Acacia ligulata*, *Senna artemisioides* subsp. *artemisioides, Senna artemisioides* subsp. *filifolia /^Shrub/3/r G+^ Triodia longiceps, Scaevola glabrata, Ptilotus obovatus /*^hummock grass, forb/3/c.

Characteristic species: *Eucalyptus socialis* subsp. *eucentrica*, *Eucalyptus pachyphylla, Ptilotus obovatus* and *Scaevola glabrata.*

Introduced/exotic taxa: No exotic taxa were recorded within this vegetation community.

Total Area: 775.2 hectares

Number of quadrats: 3

Quadrat numbers: 25, 26, 29

Landforms and substrate: Occurs on limestone platform with exposed areas of calcrete on shallow calcareous soils.

Plate 1 Low open Eucalyptus woodland on limestone ridge in east of Study area

Mulga shrubland on sandy red earths (VT 2)

Vegetation structure and floristics

This vegetation community is a tall acacia shrubland to 4 m characterised by *Acacia aneura* and *Acacia aptaneura* with scattered *Corymbia opaca* and *Hakea macrocarpa* over a shrub layer dominated by *Acacia kempeana*, *Eremophila latrobei* subsp. *glabra* and *Eremophila latrobei* var. *latrobei*. The ground layer is dominated by tussock grasses including *Aristida inaequiglumis, Eragrostis eriopoda, Aristida holathera* and *Enneapogon avenaceus*. Throughout the Study area this community has considerable spatial variation with some areas dominated by dense thickets of tall mulga while other areas are characterised by a low sparse shrubland. This heterogeneity is likely to be a reflection of differences in soil type and landscape position as well as differing fire regimes across the Project area.

This community grows on red earths with intermediate fertility that occur between sand plains dominated by hummock grasses (VT 4) and the more fertile Corymbia woodlands that occur along the floodplains of major rivers and drainage lines (VT 4).

Mulga shrubland within the Project area form obvious thickets of alternating groves and intergroves. This growth pattern is evident as a distinct banding pattern on the aerial photography.

Mulga banding patterns tend to occur in areas of subdued topography where leaf litter within groves is concentrated and water and nutrients from surface flows are trapped (Tongway and Ludwig 1990). These layers of litter provide for effective recycling of nutrients and also as a fertile bed for seedling establishment.

Throughout the Study area this community is the dominant vegetation and is in good to excellent condition with high species diversity and very few weeds.

Overstorey Layer: 3–8 m tall (30–60 % cover) dominated by *Acacia aptaneura* and/or *Acacia aneura* and scattered *Corymbia opaca* and *Hakea macrocarpa.*

Shrub Layer: 1–3 m tall (0-10 % cover) often with one or more of the following species: *Acacia kempeana, Senna artemisioides* subsp*. petiolaris, Senna artemisioides* subsp. *filifolia, Senna artemisioides* subsp*. oligophylla, Senna artemisiodes* subsp. *artemisioides, Eremophila latrobei* subsp. *glabra and Enchylaena tomentosa* subsp*. tomentose.*

Ground Layer: < 0.6 m tall (10-35% cover) with several of the following species*: Enneapogon avenaceus, Eragrostis eriopoda, Eragrostis setifolia, Triodia pungens, Psydrax latifolia, Pterocaulon serrulatum* var. *serrulatum, Commelina ensifolia, Evolvulus alsinoides, Cheilanthes sieberi* subsp. *sieberi Sida fibulifera* and *Sida platycalyx*.

NVIS Level V – U+^ *Acacia aptaneura, Acacia kempeana, Acacia aneura* /^shrub/6/i, M ^*Sida platycalyx, Eremophila latrobei* subsp. *glabra* /^shrub/3/r G^ *Aristida inaequiglumis, Eragrostis eriopoda, Aristida holathera* /^tussock grass/1/i.

Characteristic species: *Acacia aneura, Acacia aptaneura.*

Introduced/exotic taxa: Small isolated occurrences of the exotic grass *Cenchrus ciliaris* (Buffel Grass) was recorded within this community.

Total Area: 11884.9 hectares

Number of quadrats: 13

Quadrat numbers: 5, 12, 15, 16, 27, 28, 31, 40, 44

Geology: Quaternary Soil

Landforms and substrate: Occurs on depositional surfaces such as alluvial plains containing clayey red earths. This vegetation type is aligned with the Bushy Park (Bu [67]), Alcoota (Ac [18]) and Boen (Bo [6]) land systems.

Plate 2 Mulga Shrubland

Riparian woodland along watercourses and drainage channels (VT 3)

This vegetation community is dominated by *Eucalyptus camaldulensis* var. *obtusa* and *Erythrina vespertilio* and *Atalaya hemiglauca* with *Corymbia aparrerinja* also present along smaller drainage channels. The shrub layer is typically sparse with *Acacia cuthbertsonii, Jasminum calcarium, Melhania oblongifolia, Senna artemisioides* subsp. *petiolaris* and *Senna artemisioides* subsp. *filifolia* common. The ground layer is dominated by a diverse array of tussock grasses and forbs including *Eulalia aurea*, *Themeda avenacea, Themeda triandra, Crotalaria eremaea, Bothriochloa ewartiana, Calotis latiuscula, Brachyscome ciliata, Cleome viscosa, Glycine canescens, Heliotropium tanythrix* and *Pterocaulon spathulatum*. Sedges may also be present including *Cyperus centralis* and *Cyperus concinnus.*

Overstorey Layer: 8-15 m tall (5–30% cover) with one or more of the following species present; *Eucalyptus camaldulensis* var. *obtusa, Erythrina vespertilio, Acacia estrophiolata, Corymbia aparrerinja* and/or *Atalaya hemiglauca.*

Shrub Layer: 0.5–4 m tall (5–15% cover) with one or more of the following species; *Eremophila latrobei* subsp. *glabra, Senna artemisioides* subsp. *filifolia, Senna artemisioides* subsp. *petiolaris, Melaleuca glomerata, Melhania oblongifolia, Jasminum calcareum.*

Ground Layer: <0.7 m tall (40–80% cover) with several of the following species; *Themeda triandra, Themeda avenacea, Senecio magnificus, Bothriochloa ewartiana, Cymbopogon ambiguous, Enteropogon ramosus, Eragrostis setifolia, Eragrostis speciosa, Evolvulus alsinoides, Hybanthus aurantiacus, Cleome viscosa, Ipomoea muelleri, Heliotropium tanythrix, Mirbelia viminalis, Pluchea dentex, Sauropus trachyspermus, Tephrosia brachyodon, Waltheria indica* and *Pterocaulon spathulatum.*

NVIS Level V – U+^ *Eucalyptus camaldulensis* var. *obtusa, Erythrina vespertilio, Atalaya hemiglauca*/^tree/7/r M^ *Acacia cuthbertsonii, Jasminum calcarium*, *Senecio magnificus* /^Shrub/3/r G^ *Eulalia aurea Themeda avenacea, Cyperus centralis* /^tussock grass, sedge /2/i.

Characteristic species: *Eucalyptus camaldulensis* var. *obtusa, Corymbia aparrerinja, Erythrina vespertilio, Themeda avenacea, Cymbopogon ambiguous, Senecio magnificus* and *Eragrostis setifolia.*

Introduced/exotic taxa: *Cenchrus ciliaris* is present in low (1-5%) to moderate (5-25%) abundance along most major drainage lines.

Other exotic species present included *Citrullus lanatus*, *Tribulus terrestris, Eragrostis tenuifolia* and *Vachellii farnesiana*.

Total Area: 554.5 hectares

Number of quadrats: 5

Quadrat numbers: 4, 8, 20, 24, 35, 42,

Landforms and substrate: Occurs on stream banks of the Hanson River as well as other smaller creeks and drainage channels; with a substrate of unconsolidated sands and gravel.

Plate 3 Riparian woodland along the Hanson River

Plate 4 Riparian woodland along the Hanson River flanked by Low Corymbia woodland (VT 4) on alluvial floodplain

Low Corymbia open woodland on plains with red earths (VT 4)

This open woodland occurs on fertile alluvial floodplains surrounding creek lines where moisture availability and fertility is greater and at the base of the ranges receiving water and nutrient runoff. Dominant canopy species include *Corymbia opaca* and *Hakea macrocarpa* with scattered *Acacia estrophiolata* and A*talaya hemiglauca,* which occur over a sparse shrub layer dominated by *Acacia kempeana, Acacia ligulata* and *Senna* spp*.* The ground layer is dominated by tussock grasses including *Eragrostis eriopoda, Aristida inaequiglumis, Aristida holathera* subsp*. holathera, Enneapogon avenaceus, Aristida contorta, Aristida holathera* subsp. *holathera, Enteropogon ramosus, Abutilon otocarpum, Gossypium australe* and *Evolvulus alsinoides*.

Overstorey Layer: 6–14 m tall (5-10% cover) dominated by *Corymbia opaca* and *Hakea macrocarpa* with scattered *Atalaya hemiglauca* and *Acacia estrophiolata.*

Shrub Layer: 1–3 m tall (10–15% cover) often with one or more of the following species: *Acacia Acacia estrophiolata*, *Acacia kempeana, Acacia ligulata, Acacia 31eolian3131a, Acacia victoriae, Hakea lorea, Senna artemisioides* subsp. *petiolaris* and *Senna artemisiodes* subsp. *artemisioides.*

Ground Layer: < 0.6 m tall (15-45% cover), with several of the following species: *Eragrostis eriopoda, Aristida inaequiglumis, Triodia pungens, Aristida holathera* subsp*. holathera, Enneapogon avenaceus, Aristida contorta, Abutilon otocarpum, Evolvulus alsinoides, Fimbristylis dichotoma, Indigofera linnaei, Gossypium australe, Paraneurachne muelleri, Triodia basedowii, Triodia pungens, Solanum quadriloculatum.*

NVIS Level V – U^ *Corymbia opaca, Atalaya hemiglauca, Hakea macrocarpa*/^tree/6/r M^ *Acacia kempeana, Acacia ligulata, Senna artemisioides* subsp*. helmsii* /- /^shrub/4/r G+^ *Eragrostis eriopoda, Aristida inaequiglumis, Triodia pungens* /^tussock grass, hummock grass /1/r.

Characteristic species: *Corymbia opaca, Eragrostis eriopoda.*

Introduced/exotic taxa: Minor isolated occurrences of the exotic grass *Cenchrus ciliaris* (buffel Grass) were recorded within this community.

Total Area: 674.7 hectares

Number of quadrats: 5

Quadrat numbers: 14, 21, 22, 23, and 45

Landforms and substrate: Occurs on alluvial floodplains and containing course to medium textured red earths.

Plate 5 Corymbia woodland on alluvial plains

Floodplains dominated by Eucalyptus victrix (VT 5)

This vegetation community occurs on flood out areas of Hanson River and Bloodwood Creek including Mud Hut Swamp. Soils are comprised of fine textures sands and clay hardpans.

The canopy layer is dominated by *Eucalyptus victrix* with *Acacia estrophiolata* and *Eucalyptus camaldulensis* subsp. *obtusa* also present in low abundance.

The shrub layer is characterised by a low sparse shrub layer including *Eremophila latrobei* subsp*. latrobei, Acacia aptaneura, Indigofera colutea* and *Carissa lanceolata.* The groundlayer is comprised predominantly of tussock grasses including *Eragrostis cylindriflora, Aristida inaequiglumis, Eragrostis elongata* and *Tripogon loliiformis.* The introduced grass *Cenchrus ciliaris* is also abundant throughout the ground layer.

Overstorey Layer: 7-15 m tall (5-20% cover) dominated by *Eucalyptus victrix* with *Acacia estrophiolata* and *Eucalyptus camaldulensis* subsp. *obtusa* also present as scattered individuals.

Shrub Layer: 0.5–1.5 m tall (0-3% cover). This layer includes a mixture of low growing shrubs including *Eremophila latrobei* subsp*. latrobei, Acacia aptaneura, Indigofera colutea*, *Carissa lanceolata, Acacia adsurgens, Senna artemisioides* subsp. *quadrifolia, Senna artemisioides* subsp. *filifolia* and *Tephrosia supine.*

Ground Layer: < 0.6 m tall (0-10% cover), dominated by *Eragrostis cylindriflora* with several of the following species also present*: Fimbristylis dichotoma, Portulaca oleracea, Centipeda minima* subsp*. minima, Evolvulus alsinoides, Goodenia hirsuta* subsp*. Run on areas, Melhania oblongifolia* and *Portulaca filifolia.*

NVIS Level V –U+^*Eucalyptus victrix*, *Acacia estrophiolata* +/- *Eucalyptus camaldulensis* subsp*. obtusa* /^tree /7/i M^ *Eremophila latrobei* subsp. *latrobei, Indigofera colutea /* shrub /3 /r G^ *Eragrostis cylindriflora, Fimbristylis dichotoma, Portulaca oleracea /* tussock grass, forb /1/r.

Characteristic species: *Eucalyptus victrix, Portulaca oleracea.*

Introduced/exotic taxa: *Cenchrus ciliaris* is present in moderate (5-25%) abundance within the ground layer.

Total Area: 609.4 hectares.

Number of quadrats: 4

Quadrat numbers: 6, 7, 19, 13

Landforms and substrate: Occurs on flood out areas of major creeks on fine textures soils and clay hardpans.

Plate 6 Floodplains dominated by *Eucalyptus victrix*

Triodia grassland on sand plains (VT 6)

The sparse overstorey of this vegetation community is dominated scattered *Corymbia opaca, Acacia estrophiolata* and *Atalaya hemiglauca* over a sparse shrub layer to 4 metres dominated by *Acacia kempeana* with *Acacia aptaneura, Senna* spp., *Eremophila longifolia*, *Eremophila latrobei* subsp*. glabra, Grevillea striata, Hakea lorea* and *Hakea macrocarpa* also common throughout*.* The ground layer is the dominant vegetation stratum and is characterised by *Triodia pungens* with *Triodia basedowii* also present in lower abundance. Tussock grasses such as *Eragrostis eriopoda, Aristida inaequiglumis, Aristida holathera* and *Aristida contorta* also occur frequently within this vegetation community.

Throughout the Study area this community occurs on sand plains on flat to gently undulating plains. There is considerable local variation within the community with some areas characterised by a dense ground covering of Triodia while others have a more open ground layer with a dense low mixed acacia shrub layer. This heterogeneity is likely to be a reflection of differences in grazing and fire regimes across the Study area.

In some areas this community forms a mosaic with mulga shrubland which occurs in small groves in areas of sheet flow.

Overstorey Layer: 6–10 m tall (0–3% cover) dominated by *Corymbia opaca, Atalaya hemiglauca* and scattered *Acacia estrophiolata*.

Shrub Layer: 2–8 m tall (5–40% cover) with several of the following species present: *Acacia kempeana, Acacia aptaneura, Acacia adsurgens, Senna* spp., *Eremophila longifolia*, *Eremophila latrobei* subsp*. glabra, Grevillea striata, Hakea lorea, Hakea macrocarpa.*

Ground Layer: 0.4-1.3 m tall (15-70% cover) dominated by *Triodia pungens* with several of the following species also present: *Eragrostis eriopoda, Aristida inaequiglumis, Solanum quadriloculatum, Aristida contorta, Aristida holathera* var. *holathera, Sida platycalyx, Gossypium australe, Scaevola parvifolia* subsp*. parvifolia, Evolvulus alsinoides, Sclerolaena cornishiana* and *Ptilotus obovatus.*

NVIS Level V – U^ *Corymbia opaca, Atalaya hemiglauca* /^tree/6/bi M ^ *Acacia kempeana, Acacia aptaneura, Senna spp.* /^shrub/6/i +G^ *Triodia pungens, Eragrostis eriopoda, Aristida inaequiglumis*/^ hummock grassland, tussock grassland/1/c

Characteristic species: *Acacia kempeana, Triodia pungens, Acacia adsurgens.*

Introduced/exotic taxa: Small isolated occurrences of the exotic grass *Cenchrus ciliaris* (Buffel Grass) were recorded within this community.

Total Area: 8115 hectares

Number of quadrats: 12

Quadrat numbers: 1, 9, 10, 11, 17, 18, 30,32, 34, 38, 39 and 43

Landforms and substrate: Occurs on gently undulating sandy plains.

Plate 7 Triodia hummock grassland on sandy plains

Low Acacia shrubland on rocky slopes (VT 7)

This vegetation community is characterised by low acacias growing on stony rises and low hills comprised of granite or quartzite with shallow soils with rocky surface fragments.

The canopy layer is extremely sparse and consists of occasional low growing *Eucalyptus trivalvis*, *Atalaya hemiglauca* and *Hakea macrocarpa.* Low growing *Acacia spondonophylla* to 0.5 m dominates the sparse shrub layer with other common species including *Grevillea wickhamii, Acacia adsurgens, Acacia aptaneura and Senna artemisioides* subsp. *alicia.* The groundlayer is comprised predominantly of low hummock grasses including *Triodia basedowii and Triodia pungens.*

Overstorey Layer: 1-3 m tall (0-1% cover) dominated by *Eucalyptus trivalvis, Atalaya hemiglauca* and *Hakea macrocarpa.*

Shrub Layer: 0.5–1.5 m tall (0-5% cover). This layer is dominated by the low growing *Acacia spondonopylla* with several of the following species also occurring in low abundance: *Acacia adsurgens, Acacia aptaneura, Grevillia wickhamii, Acacia ligulata, Acacia stipuligera, Acacia kempeana, Senna artemisioides* subsp. *alicia, Senna glutinosa* subsp. *pruinosa, Eremophila 35eolian35* subsp*. glabra, Mirbelia viminalis, Capparis mitchellii, Streptoglossa odora, Keraudrenia nephrosperma* and *Petalostylis cassioides*.

Ground Layer: < 0.6 m tall (15-70% cover), dominated by *Triodia basedowii* and *Triodia pungens* with several of the following species also present: *Solanum quadriloculatum, Eriachne mucronata, Aristida contorta, Aristida holathera, Sida filiformis, Heliotropium tanythrix, Ptilotus exaltatus, Cheilanthes sieberi* subsp. *sieberi, Enneapogon clelandii, Tripogon loliiformis, Solanum quadriloculatum, Hybanthus aurantiacus, Goodenia ramelii* and *Ptilotus obovatus.*

NVIS Level V – U^ *Atalaya hemiglauca, Hakea macrocarpa* /^tree/6/bi M^ *Acacia spondonophylla*, *Grevillea wickhamii, Acacia adsurgens* /^shrub/3/i +G^ *Triodia basedowii, Eragrostis eriopoda, Aristida inaequiglumis*/^ hummock grassland, tussock grassland/1/c.

Characteristic species: *Acacia spondonophylla, Grevillea wickhamii, Acacia adsurgens, Aristida inaequiglumis, Triodia basedowii*.

Introduced/exotic taxa: No exotic taxa were recorded within this vegetation community

Total Area*:* 441.2 hectares

Number of quadrats: 5

Quadrat numbers: 2, 3, 36, 37 and 41

Landforms and substrate: Occurs on low rocky slopes on sandy gravels.

Plate 8 Low Acacia Shrubland on Rocky Slopes

Tall Acacia shrubland on stony quartz plains (VT 8)

This vegetation community on flat run on areas at the base of low stony hills. Soils are comprised of red earths with quartz surface fragments.

The canopy layer is dominated by *Acacia georginae* with occasional *Atalaya hemiglauca* and *Hakea macrocarpa.* The midstorey consists of sparse *Acacia* and *Senna* spp. with a number of chenopod shrubs also present. Common species include *Acacia aneura, Acacia estrophiolata, Senna artemisioides* subsp. *oligophylla, Senna artemisioides* subsp. *helmsii, Senna artemisioides* subsp. *alicia*, *Sclerolaena cornishiana, Sclerolaena calcarata* and *Rhagodia eremaea.* The ground layer is comprised predominantly of low sparse tussock grasses including *Enneapogon clelandii, Themeda triandra, Enneapogon avenaceus* and *Aristida inaequiglumis.*

Overstorey Layer: 4-8 m tall (0-5% cover) dominated by *Acacia georginae* and *Atalaya hemiglauca.*

Shrub Layer: 0.5–1.5 m tall (0-15% cover). This layer is dominated by *Acacia aneura, Acacia estrophiolata* and *Senna* spp. with several of the following species also occurring in low abundance: *Sclerolaena cornishiana, Rhagodia eremaea, Ptilotus obovatus, Acacia aptaneura, Eremophila freelingii, Eremophila latrobei* subsp. *latrobei* and *Solanum quadriloculatum.*

Ground Layer: < 0.6 m tall (0-15% cover), dominated by *Enneapogon clelandii, Themeda triandra* and *Aristida inaequiglumis* with several of the following species also present in low abundance: *Enneapogon avenaceus, Solanum quadriloculatum, Fimbristylis dichotoma* and *Tripogon loliiformis.*

NVIS Level V – U^ *Acacia georginae Atalaya hemiglauca* /^ tree /6/bi M+^ *Acacia aneura, Senna* spp. /^ shrub G^ *Enneapogon clelandii, Themeda triandra, Sida filiformis* /^ tussock grass forb /1/i.

Characteristic species: *Acacia georginae, Themeda triandra.*

Introduced/exotic taxa: The exotic herb *Tribulus terrestris* was recorded in low abundance throughout this vegetation community.

Total Area: 222.5 hectares

Number of quadrats: 2

Quadrat numbers: 33 and 46

Landforms and substrate: Occurs at the base of stony hills on red earth soils with quartz surface fragments.

Plate 9 Tall Acacia shrubland on stony quartz plains

5. Conservation significance

5.1 Vegetation condition

Native vegetation within the Study area is generally in moderate to good condition. High to moderate level impacts from pastoral activities (trampling, grazing and weed invasion) are localised and generally confined to watering points, ephemeral watercourses, wetlands and stockyards. There are numerous cleared tracks, but little other evidence of vegetation clearing. Although low level grazing impacts are evident, vegetation is generally healthy with active seedling recruitment. Some modification to vegetation structure from fires is evident, particularly within Mulga shrublands and Triodia grassland vegetation types.

The presence of exotic flora species within the Study area is largely confined to drainage channels where low density infestations of *Cenchrus ciliaris (*Buffel Grass) and *Vachellia farnesiana* (Mimosa Bush) are common.

Species richness within the Study area is relatively high with highest diversity recorded in areas of rocky outcrops (43 ± 2) and mulga shrublands (38 ± 6) although plant species were well represented across the Study area with a mean species richness of 32 plant taxa per quadrat.

The Study area contains a high level of vegetation/habitat heterogeneity (diversity) including hummock grasslands, shrublands and riparian woodlands. This is largely due to the variety of landforms (watercourses, alluvial plains, eolian plains, alluvial foothill fans, rocky hills).

5.2 Threatened vegetation communities

5.2.1 Nationally and Regionally Significant Vegetation Communities

No nationally significant vegetation communities were recorded during this study.

Dominant vegetation communities within the Study area include mulga communities on red earths, woodlands on alluvial flats and hummock grasslands on sand plains. Most of the vegetation types present are well represented within the Burt Plain bioregion, however less than 1% of the Burt Plain bioregion is conserved within reserves; and thus vegetation communities within the Study area are poorly represented in conservation reserves, e.g. hummock grassland 0.01%, Acacia woodland 0.05%, Eucalyptus low woodland with tussock grass understorey 0.01% (NRETAS 2005).

A number of less common vegetation communities occur in small patches or along linear drainage lines throughout the Study area. These include Riparian Vegetation (VT 3) dominated by bean trees (*Erythrina vespertilio*) and Tall Acacia shrubland on stony quartz (VT 8).

The NT Land Clearing Guidelines identify a number of sensitive or significant vegetation types to avoid clearing including rainforests, monsoon vine thicket, riparian or closed forests. Vegetation types that correspond with the types include the Riparian woodland vegetation type that occurs along creeks and major drainage lines within the Project area.

Riparian vegetation is a key component of the catchment, providing a range of ecosystem services such as filtering contaminants and nutrients, providing habitat for flora and fauna and preventing soil erosion. The Riparian woodland vegetation community is a locally significant community. There is the potential for mining activities to impact the ecological values of riparian vegetation. Altering the flooding patterns may impact on the health of riparian vegetation due to changes in hydrological processes, e.g. the frequency, duration and/or extent of flooding.

Neave *et al.* (2006) provides an overview of important vegetation types within the Burt Plain bioregion. These include a number of wetlands and mesic areas, sites of botanical significance and flora and fauna hotspots. The Study area does not contain any of these identified sites however there are two swamps located near to the Study area that are listed SOCS and considered to contain important vegetation that should be protected during construction and operation of the proposal (Neave *et al* 2006).

Despite most of the vegetation types within the Study area being well represented in the bioregion, Neave *et al.* (2006) recognise that common vegetation types can be regarded as having conservation significance if they meet any of the following criteria:

- Habitat with high species richness that supports a high abundance of native species, and/or is structurally complex
- Habitat supporting species of high conservation values (e.g. threatened species, endemic species, poorly reserved species and/or rare species)
- Habitat that is of good quality (i.e. its compositional and structural integrity and ecological processes have not been undermined)
- Habitat that is poorly reserved.

A number of vegetation communities within the Study area would partially meet these criteria as they are known to support threatened species, including Brush-tailed Mulgara, Brush Tailed Rock Wallaby and Grey Falcon, which were detected during fauna surveys within or near the Project area (GHD 2015a). All of these habitat types however are well represented in the region and the Project area is not considered to provide unique habitat for any of these species.

5.3 Threatened flora

5.3.1 Nationally and state significant flora

No flora species listed as threatened under either the TPWC Act or EPBC Act were recorded within the Study area during the field assessment.

The EPBC PMST and NT herbarium database results indicate that one threatened flora species (*Eleocharis papillosa*, Dwarf Desert Spike Rush) listed as vulnerable under both the TPWC Act and EPBC Act has been recorded within the Project locality.

Dwarf Desert Spike-rush occurs within freshwater and semi-saline ephemeral wetlands, with above-ground plant material emerging from tubers in response to inundation or flooding. Associated species include Coolabah *Eucalyptus coolabah, Chenopod* spp. and *Eragrosti*s spp. (DSEWPaC 2010). There are several records of *Eleocharis papillosa* from Stirling Swamp which is located approximately 12 km to the north of the proposed access road. A review of the habitat requirements and ecology also indicates that there is habitat for this species within and surrounding Mud Hut Swamp which is situated approximately 7.7 km north of the proposed mine pit.

The above ground parts of this species grow in response to inundation, and for the rest of the time it exists as an underground tuber. Given the extremely dry conditions at the time of survey it is unlikely this species would have been detected if present within the Study area. If it proposed to disturb habitat potentially able to support this species it is recommended that targeted surveys for the species are undertaken following substantial rain within the region.

The survey identified one species listed as data deficient (*Euphorbia ferdinandii)* under the TPWC Act. *Euphorbia ferdinandii* is an upright, sparsely branching herb, up to 30 cm tall. Four records of *E. ferdinandii* were recorded within the Study area, all of which were located in Mulga shrubland and *Triodia* grassland communities along the proposed access road.

A summary of the assessment of the likelihood of occurrence for threatened flora species known or predicted to occur within the locality is provided in Table 5-1.

5.3.2 Near threatened flora

Flora classified as near threatened within the Northern Territory include those species that when evaluated against the International Union for the Conservation of Nature (IUCN) criteria for assessing conservation significance, do not qualify for critically endangered, endangered or vulnerable listing however are close to qualifying for, or are likely to qualify for, a threatened category in the future.

Although no flora species classified as near threatened were recorded within the Study area, six flora species listed as near threatened have been recorded within the Project locality.

Based on a review of habitat requirements and ecology for these species it is likely that one of these species (*Ipomoea polpha* subsp. *Latzii)* would occur. Furthermore based on the presence of suitable habitat, there is also a possibility that the following near threatened species may occur within the Project area:

- *Elatine macrocalyx*
- *Gymnanthera cunninghamii*
- *Digitaria hystrichoides*
- *Sclerolaena densiflora.*

A summary of the assessment of the likelihood of occurrence for near threatened flora species known or predicted to occur within the locality is provided in Table 5-1.

5.3.3 Endemic species

No flora species endemic to the Northern Territory were recorded within the Study area.

Table 5-1 Summary of the threatened and near threatened flora species known or predicted to occur with the locality

Key to Table:

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

TPWC *Territory Parks and Wildlife Conservation Act 2006*

DLRM The Department of Land Resource Management (DLRM) flora records database

PMST Information sourced from the EPBC Protected Matters Search Tool

V Vulnerable

NT Near Threatened

Likelihood of occurrence of rare/threatened flora is assessed on a 4-tier scale:

1 **Present** – observed during baseline survey

2 **Likely** – suitable habitat occurs within Project area and species previously recorded nearby.

3 **Possible** – suitable habitat occurs within the Project area

4 **Unlikely** – suitable habitat unlikely to occur within the Project area, or suitable habitat substantially modified, or suitable habitat present but species not recorded for over 50 years

5 **Highly unlikely** – no suitable habitat present within the Project area and individuals not recorded within Project area

Conservation status		Species name	Data source	DLRM records within and surrounding Project area	Habitat Requirements	Likelihood of occurrence within the Project area
TPWC Act	EPBC Act					
VU	VU	*Eleocharis papillosa*	DLRM / PMST	5	Dwarf Desert Spike-rush occurs in temporary wetlands, predominantly freshwater and semi-saline swamps. Within the NT this species is known from eight remote locations ranging from the northern Tanami Desert to the southern parts of the Finke bioregion and the edge of the Simpson Desert (DSEWPaC 2008). This species is known to flower and fruit throughout the year in response to seasonal rains (Woinarski *et al.* 2007).	Possible – There is suitable habitat for this species within Mud Hut Swamp and Stirling Swamp.
NT	NT	*Ipomoea polpha* subsp. *latzii*	DLRM	11	Grows in Acacia shrublands on red earth soils, and occasionally on adjacent sandplains with *Triodia basedowii*. All known populations are within a few kilometres of low rocky ranges that experience some degree of rainfall 'runon'. There are numerous records of this species at the base of the ranges immediately south of the proposed access road.	Likely – This species is likely to occur at the base of ranges that occur in the south of the Project area along the proposed access road.

Conservation status		Species name	Data source	DLRM records within and surrounding Project area	Habitat Requirements	Likelihood of occurrence within the Project area
TPWC Act	EPBC Act					
NT		*Bulbostylis pyriformis*	DLRM	1	Grows on edges of wetlands and swamps.	Possible – suitable habit present on the edges of Mud Hut and Stirling Swamps.
NT	NT	*Gymnanthera cunninghamii*	DLRM	10	This species is an erect shrub to 2 m high, occurring on sandy soils and frequently in drainage lines.	Possible – there is suitable habitat for this species within riparian woodland, mulga shrublands, Triodia grasslands and Low Corymbia woodland vegetation communities within the Project area.
NT	NT	*Osteocarpum salsuginosum*	DLRM	1	*Osteocarpum salsuginosum* is a herb to 0.15 m that grows on the margin on lakes.	Unlikely – suitable habitat for this species not present within the Study area.
NT	NT	*Sclerolaena densiflora*	DLRM	1	This erect to sprawling perennial herb is known to occur in clay, red sand or sandy clay, sandy loam, stony soils, hardpans, rocky hills and floodplains. There is record of this species approximately 20 km south west of Barrow Creek. In this area the species was found growing on gravelly soils on and around small rocky hills in *Triodia longiceps* grassland.	Possible – There is suitable habitat for this species on and surrounding low rocky hills.
NT	NT	*Elatine macrocalyx*	DLRM	1	Occurs on the temporarily moist margins of lakes and claypans on soils that are typically shallow sands over clay (Albrecht 2002). Known from records at the east side of Mud Hut Swamp.	Possible – suitable habit present on the edges of Mud Hut and Stirling Swamps.
NT	NT	*Digitaria hystrichoides*	DLRM	1	Occurs in NT, QLD and NSW where it is known to occur in woodlands and acacia shrublands. Within the Project locality this species has been recorded under *Acacia coreacea* with *Plectrachne schinzii.*	Moderate – within the Project area there is suitable habitat for this species within acacia shrublands and Corymbia woodlands,
NT		*Spartothamnella puberula*	DLRM	2	Grows in rocky loam, clay, sandy or skeletal soils on sandplains and hills	Possible – there is suitable habitat for this species within riparian woodland, mulga shrublands, Triodia grasslands and Low Corymbia woodland vegetation communities within the Project area.
NT		*Einadia nutans subsp. Nutans (Ruby Saltbush)*	DLRM	4	Grows in heavier soils in woodland.	Unlikely –Suitable habitat not present within Project Area.

5.3.4 Regionally Significant Flora

Four species listed as having bioregional conservation significance were recorded within the Study area. These species have conservation significance due to them being either at the limit of their range or being a disjunct population in the bioregion (DLRM 2015). These species and their regional conservation codes are listed in Table 5-2.

Within the Study area 228 species were recorded. This represents approximately 21% of species known to occur within the Burt Plain Bioregion.

The flora of the Burt Plain bioregion has many taxa in common with neighbouring bioregions, e.g. 79% of plant taxa found in the Burt Plain bioregion have been recorded in the MacDonnell Ranges bioregion (Neave *et al.* 2006). There is however a lack of systematic flora surveys across southern Northern Territory bioregions (excluding the MacDonnell Ranges and Finke Bioregions (Neave *et al.* 2004), limiting the value of a comparison of species richness between bioregions for determining regional significance for conservation planning.

Table 5-2 Species with bioregional significance recorded within the Study area

Species Name	Common Name	Regional Conservation Code DLRM 2015)
Acacia murrayana	Colony Wattle, Murrays Wattle	BRT (northern range limit)
Eucalyptus trivalvis	Victoria Spring Mallee	BRT (eastern range limit)
Sclerolaena calcarata	Red Copper Burr, Red Burr	BRT (disjunct), MAC (disjunct)
Spartothamnella teucriiflora	Mulga Stick-plant, Scented Stick-plant	BRT (northern range limit)

5.3.5 Groundwater dependant ecosystems

Serov *et al.* (2012) defines GDEs as 'ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater'. GDEs are known to occur in almost every environment across the landscape including terrestrial dry land, freshwater, marine and subterranean environments (Serov *et al*. 2012).

Wetland areas within the Project area have the potential to be maintained by groundwater. Stirling Swamp is located to the north of the access road. The swamp area is formed from a large network of claypans, lignum swamp, semi-saline samphire and temporary open water, and the adjacent Hanson River. The site also forms part of the Anmatyerr North Site of Conservation Significance (Duguid *et al.* 2005). Stirling Swamp is thought to be connected to groundwater through a topographical low forming a 'window' to the relatively shallow Ti Tree aquifer. This area is thus a discharge zone of the Ti Tree aquifer.

Mud Hut Swamp is located approximately 7.7 km to the north of the mine site. The swamp is formed from a flood-out of the Bloodwood Creek (Duguid *et al*. 2005). Based on its location as an outflow of the Bloodwood Creek, it is unlikely that the swamp is maintained by groundwater (GHD 2015b).

There are no known permanent or semi-permanent water holes along the Hanson River, with any pools formed through surface water flow. These are relatively short lived as they drain to the underlying aquifer and are subject to evaporation.

Eucalyptus trees can access water in deep soil layers and access groundwater by extending roots to the water table. Given the intermittent nature of creek and drainage lines within the Study area, Riparian woodlands are also likely to be at least partially dependant on groundwater.

5.3.6 Introduced Flora Species

Five exotic flora species were recorded within the Study area:

- *Cenchrus ciliaris* (Buffel Grass)
- *Citrullus lanatus* (Bitter Melon)
- *Eragrostis tenuifolia* (Elastic Grass)
- *Tribulus terrestris* (Caltrop)
- *Vachellia farnesiana* (Mimosa bush).

One of these species (*Tribulus terrestris*) is listed as a Class B (spread must be controlled) and Class C (not to be introduced to the NT) noxious weeds under the NT Weeds Management Act. *T. terrestris* is a spreading annual or bi-annual herb. Its fruit is a woody burr with sharp ridged spines. The species is known to cause photosensitisation and nitrate poisoning in livestock and its fruit can cause injury to the feet of cattle and horses (Smith 2002). *T. terrestris* is recognised a taxonomically complex species and it is thought to have both native and introduced elements (Baker 1998). This species was found in low abundance throughout all vegetation types within the Study area. It is likely that this species is spread by cattle and vehicle movement.

No weeds of national environmental significance (WONS) were recorded within the Study area.

Introduced flora species, including *Tribulus terrestris* occur in relatively low abundance across the Study area. The most abundant exotic species recorded was *Cenchrus ciliaris* (Buffel Grass) which occurs in moderate densities (5-25% cover abundance) along creeks and major drainage lines throughout the Study area as well as in low abundance (0-5% cover abundance) through the remaining vegetation communities within the Study area.

Buffel Grass is a deep rooted perennial grass native to northern Africa, the Middle East and India. It has been planted extensively in central Australia and elsewhere for cattle fodder and to help control erosion (Pitts and Albrecht 2000). *Cenchrus ciliaris* is recognised as a serious environmental weed, with the capability to alter species composition, structure and function of plant communities (Franks 2002) and increase the intensity and frequency of fires (Latz 1991). It is capable of forming dense swards and reducing the heterogeneity and floristic diversity of native plant communities (Franks 2002). It is also been associated with increased fire severity due to its ability to rapidly accumulate high amounts of combustible biomass compared to native understory species. It also has the ability to rapidly re-sprout after fire and can accumulate enough biomass to burn again in a short period of time compared with native species (Neave *et al.* 2006). Increased fire severity has been correlated with the mortality of overstorey tree species and a reduction in post-fire re-establishment of native species thus leading to altered plant community structure.

Buffel Grass generally requires lighter textures soils (sandy loams) and relatively high available phosphate levels which are generally associated with alluvial plains and calcareous landforms. Riparian vegetation communities are also particularly susceptible to invasion.

Areas of Riparian woodland along watercourses and drainage channels also commonly contain scattered individuals of the exotic species *Vachellia farnesiana* and *Citrullus lanatus.*

6. Legislation

TNG submitted a Notice of Intent (NOI) for the Mount Peak project to the NT EPA on 4 July 2013 for consideration under the NT *Environmental Assessment Act 1982* (EA Act). On 13 November 2013, the NT EPA decided that the Project required assessment under the Act at the level of an EIS. The Terms of Reference for the Project, finalised in March 2014, identify assessment requirements for both the NT EPA and Commonwealth DotE.

The Proponent also referred the project to the Commonwealth Department of the Environment (DotE) for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 13 November the project was determined to be a Controlled Action under the EPBC Act due to the potential for significant impacts to listed threatened species and communities (Sections 18 & 18A).

The project assessment as an EIS complies with the Bilateral Agreement provisions between the Commonwealth of Australia and the Northern Territory relating to environmental assessment, which allows the Commonwealth Minister for the Environment to rely on specified environmental impact assessment processes of the Northern Territory in assessing actions under the EPBC Act.

This flora and vegetation assessment has been prepared to accompany the Environmental Impact Statement (EIS) for the Project that has been prepared in accordance with the EA Act.

The following section summarises the legislation relevant to flora and vegetation that has been considered as part of this assessment.

6.1 Commonwealth Environmental Legislation

6.1.1 Environment Protection and Biodiversity Conservation Act 1999

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on Matters of National Environmental Significance (MNES) undergo an assessment and approval process. An action that ‘has, will have or is likely to have a significant impact on a MNES is deemed to be a ‘controlled action’ and may not be undertaken without prior approval from the Federal Minister for the Environment.

The EPBC Act identifies nine MNES these include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- Nuclear actions (including uranium mining)
- The Great Barrier Reef Marine Park
- A water resource, in relation to coal seam gas development and large coal mining development.

Potential impacts on any MNES must be subjected to an assessment of significance pursuant to the EPBC Act Significant Impact Guidelines (DotE 2013). If a significant impact is considered likely, a referral under the EPBC Act must be submitted to the Commonwealth Environment Minister.

This study assesses the likelihood of vegetation and flora listed under the EPBC Act to occur within the Project area and their potential to be impacted by the proposal. Assessments of the likelihood of occurrence for EPBC matters related to threatened flora and communities are discussed in Section 5 and summarised in Table 5-1.

6.2 Territory Environmental Legislation

6.2.1 Territory Parks and Wildlife Conservation Act 2006

The extended title of the TPWC Act is:

“An Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves, and the study, protection, conservation and sustainable utilisation of wildlife”.

The TPWC Act has provisions for parks and reserves, animals and plants (including wildlife and protected wildlife).

The TPWC Act defines wildlife as that being in a park, reserve, sanctuary, wilderness zone or area of essential habitat, or is a vertebrate that is indigenous to Australia (other than fish), or is specifically prescribed as being protected by the TPWC Regulations. Protected wildlife is protected wildlife whether or not the property with the wildlife is vested in the Territory.

The TPWC Act prohibits the intentional killing of any terrestrial or marine vertebrate (with the exception of fish).

All threatened species are classed as protected wildlife. The TPWC Act precludes the taking of and interference with protected species of wildlife. The Act includes “Principles of Management”. These require that a threatened species be managed in a manner that “maintains or increases their population or the extent of their distribution at or to a sustainable level”. Threatened species are defined under the Territory’s Wildlife regulations as being species that are ‘extinct”, “critically endangered”, “endangered” and “vulnerable”.

This study assesses the likelihood of vegetation and flora listed under the TPWC Act to occur within the Study area and their potential to be impacted by the proposal. Assessments of the likelihood of occurrence for flora species listed under the TPWC Act are discussed in Section 5 and summarised in Table 5-1.

6.2.2 Weeds Management Act 2001

The *Weeds Management Act 2001* (WM Act) is in place to prevent the spread of weeds and to ensure that the management of weeds is an integral component of land management. This is to be conducted in accordance with the Northern Territory Weeds Management Strategy 1996-2005 (NRETA, date unknown) or any other strategy adopted to control weeds in the Territory.

Noxious Weeds

Declared noxious weeds in the NT are plants proclaimed under the WM Act. The legislation requires that reasonable attempts be made to control or eradicate these species. Categories of noxious weeds include the following:

- Schedule Class A/C Weeds: These plants do not occur in the NT but pose a significant threat if they invade or if present, pose a serious threat. Reasonable effort must be made to eradicate these weeds
- Schedule Class B/C Weeds: These weeds often occur widely in the NT. They are capable of spreading further and should be prevented from doing so. Continuing control measures are required to prevent their spread. Reasonable attempts must be made to contain the growth and prevent the movement of these plants
- Schedule Class C Weeds: This category includes plants that pose an unacceptable risk of spreading in the Territory or to other parts of Australia if they were to be sold or traded in the NT and are a serious threat to another State or Territory of Australia. All schedule Class A and B weeds are considered to be Class C weeds.

The manager of the mine site has responsibilities to manage weeds in accordance with this act.

One noxious weed (*Tribulus terrestris*) was recorded within the Study area. This plant should be controlled in accordance with the WM Act.

6.3 Northern Territory Policies and Guidelines

6.3.1 Northern Territory Environment Protection Authority Survey Guidelines

In November 2013 the NT EPA released a series of draft guidelines related to implementation of the *Environmental Assessment Act 1982* and the *Waste Management and Pollution Control Act 2009*. Those draft guidelines relevant to this Assessment are:

- Guidelines on Environmental Offsets and Associated Approval Conditions
- Guidelines on Assessment of Impacts on Terrestrial Biodiversity.

This flora and vegetation assessment was prepared in accordance with these guidelines.

The Department of Land Resource Management (DLRM) has developed standardised methodologies for surveying terrestrial flora in the Northern Territory (*Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst *et al.* 2007)). These guidelines were complied with when undertaking this assessment.

7. Impact Assessment

The Project will include earthworks, vegetation clearing, construction of roads and access tracks, construction of infrastructure and mining operations.

New infrastructure requirements include:

- In the Mount Peake mine area – 125 m deep pit, process plant, waste rock dump, tailings storage facility, various stockpiles, gas-fired power station, water and waste-water treatment plants, explosives and detonator magazines, bulk fuels storage area, water dams, water storage tanks, administration building, workshops, laboratory and site roads
- Construction camp and accommodation village
- Rail load-out facility at Adnera.

The Project would also include the construction of an access road connecting the mine site with the Adnera Loadout Facility. This final road will be approximately 100 km long and constructed with two 5 m traffic lanes with two 0.5 m shoulders. Table drains will be constructed adjacent to the road. For assessment purposes a clearance corridor of 25 m has been allowed for to accommodate construction activities adjacent to the final formation. The access road will serve the dual purpose of providing general vehicle access from Stuart Highway to both the mine site and loadout facility, and as the haulage route for concentrate product. An underpass of the Stuart Highway will be constructed to remove road trains from the highway.

Floodways will be constructed across the Hanson River, Murray Creek and a number of minor watercourses that bisect the access road. These crossings will tolerate small river flows and wash out during significant flood events to eliminate the potential for backup of flood waters.

A new borefield will be established within the alluvial aquifer of the Hanson River. Six supply bores with two standby bores will provide water for the first four years of the project with an additional four bores installed from year 5. Bores will be spaced approximately 1,800 m apart and will pump at around 8.5 L/s each.

An above-ground water supply pipeline will be constructed between the borefield and the Raw Water Dam predominantly along existing tracks, a distance of approximately 49 km. The pipeline will have a diameter of up to 450 mm. Access to the borefield will be via a graded dirt road following the pipeline. The clearing width will be approximately 10 m.

The proposal has the potential to impact on flora and vegetation, or exacerbate existing threatening processes through:

- Clearing of flora and vegetation and associated loss of habitat during construction
- Alteration of hydrological regimes associated with earthworks and construction activities and associated changes to land surface areas, and/or impediments to surface flows
- Groundwater drawdown and/or changes to groundwater flows impacting groundwater dependent ecosystems
- Contamination of surface and/or groundwater
- Introduction and/or spread of invasive exotic flora species
- Changes to fire regimes
- Dust emissions from construction, mining and processing activities
- Erosion and sedimentation resulting from vegetation clearing during construction.

These potential impacts are discussed in further detail below.

7.1 Clearing of flora and vegetation

Earthworks associated with the Project will involve clearing, grubbing, cut and fill, preparation of unsealed roads and hardstands and basic drainage works. Areas will be levelled and compacted prior to construction of infrastructure.

Toward the end of the construction program a second phase of earthworks will be initiated. This work will involve trimming to final level, constructing final drainage profiles, installing culverts and sealing sections of road requiring a bitumen seal.

Clearing of approximately 1058 ha would be required for construction of the pit, waste rock dump, tailings storage facility, accommodation village, access roads, mine infrastructure, stockpile sites and the Adnera loadout facility (Table 7-1).

The location and area of borrow pits still needs to be determined.

Areas to be cleared for construction will be grubbed of trees and larger vegetation with material collected and stored for reuse in rehabilitation. Topsoil, where present, will be removed and stored for future use in rehabilitation. Where necessary stockpiles will be protected with erosion and sediment control structures and stabilised to prevent excessive wind erosion.

Vegetation clearing and topsoil removal will be carried out shortly before the area is required for construction.

Table 7-1 Areas of impact

Item	Disturbance Area (ha)
Pit	76.61
Waste Rock Dump	89.97
Long-term stockpiles	46.60
Mine facilities including ROM pad, process plant and associated stockpiles and ponds, mine offices and workshops, fuel storage facility, water treatment plant, power station and site roads	70.84
Tailings Storage Facility	474.98
Accommodation village	5.45
Access road	233.75
Adnera Loadout Facility	10
Borefield, delivery line and access road (approximate)	50
Access road borrow areas	To be determined
Total	**1058.2**

The areas of each vegetation community to be impacted by the Project are provided in Table 7-2. Vegetation clearing in these communities will involve removal of a moderately diverse range of non-threatened native plants, including mature trees.

Table 7-2 Vegetation communities impacted by the Project

Vegetation code	Vegetation community	Area to be impacted[1]	% of Project Area
VT 1	Low open Eucalyptus woodland on limestone	8.35	0.83
VT 2	Mulga shrubland on sandy red earths	420.25	41.68
VT 3	Riparian woodland along watercourses and drainage channels	2.90	0.29
VT 4	Low Corymbia woodland on loamy alluvial plains	4.61	0.46
VT 5	Floodplains dominated by *Eucalyptus victrix*	0	0
VT 6	Triodia grassland on sandy plains	558.58	55.40
VT 7	Low Acacia shrubland on rocky slopes	3.50	0.35
VT 8	Tall Acacia shrubland on stony quartz	10.00	0.99
TOTAL		**1008.19**	

[1] these impact areas do not include vegetation disturbance associated with the borefield and associated pipeline

In addition to the clearing areas included in Table 7-2 the proposal would result in approximately 50 ha of disturbance within the borefield area and associated pipeline. Within this area approximately 20 ha has already been cleared for existing access tracks. The proposal would therefore result in the clearing of an additional 30 ha of native vegetation. The borefied itself will disturb around 1 ha adjacent to Hanson River with an additional pipeline disturbance of around 11 ha adjacent to the river. Although this area was not assessed during the field survey a review of geological and topographic information as well as aerial imagery suggests that vegetation within this area would be comprised primarily of Triodia Grassland on sandy plains (VT 6), Low Corymbia woodland on loamy alluvial plains (VT 4) as well as a small amount of Riparian Woodland along water courses (VT 3). There may also be other vegetation types present within the borefield area and along the associated water pipeline that were not mapped during this assessment. A preclearance survey would be undertaken prior to any clearing works in the area to assist in the final location of infrastructure and ensure that no significant or sensitive vegetation communities would be impacted by clearing.

The remaining 18 ha to be cleared is for the pipeline that runs between the borefield and the Raw Water Dam (30 km x 6 m of vegetation clearing). The majority of this vegetation is likely to include Triodia grassland on sandy plains (VT 6) and Mulga shrubland on sandy red earths (VT 2). There may also be small areas of Riparian woodland along watercourses and drainage channels (VT 3).

None of the vegetation communities to be cleared as a result of the Project are listed as threatened under the EPBC or TPWC Act.

The average species richness within vegetation communities present within the Project area varies from 17 within Mulga Shrublands (VT 2) to 31 within Riparian woodlands (VT 3). None of the vegetation communities within the Project area are considered to have high species richness or structural complexity. Vegetation communities present within the Project area are well represented in the Burt Plain bioregion.

The two most common vegetation communities within the Project area are Triodia grassland on sandy plains (VT 6) and Mulga shrublands on sandy red earths (VT 2). Together these vegetation communities comprise 97 % of the vegetation proposed to be impacted within the Project area.

Fifty-five percent of the Project area is comprised of Triodia grassland on sandy plains. This vegetation type best corresponds to Wilsons vegetation Map Unit 76 – *Triodia pungens* (Soft Spinifex), *Plectrachne schinzii* (Curly Spinifex) hummock grassland with Acacia tall sparse-shrubland overstorey, which covers an area of 1,098,704 ha or 23.17% of the Burt Plain bioregion (Wilson *et al.* 1990, Pert 2006). The removal of 558 ha of this community would represent less than 0.05% of this vegetation type within the Burt Plain Bioregion.

Forty-one percent of the Project area is comprised of mulga shrublands on sandy red earths. This vegetation type corresponds to the Wilson Map Unit 65 – *Acacia aneura* (Mulga) tall open – shrubland with *Eragrostis eriopoda* (Woollybutt) open grassland understorey. There is approximately 2,771,054 ha of this vegetation type mapped within the Burt Plain Bioregion (Wilson *et al.* 1990, Pert 2006). The Project would therefore result in the disturbance of approximately 0.01% of this vegetation community within the bioregion.

There are a number of less common vegetation communities that occur in small patches or along linear drainage lines throughout the Study area. These include Riparian Vegetation (VT 3) dominated by bean trees (*Erythrina vespertilio*) and Tall Acacias shrubland on stony quartz (VT 8). These communities are not considered to be rare or threatened at the national or region scale.

Mitigation measures to ameliorate impacts associated with vegetation removal would include:

- Develop and implementation of a Vegetation Clearing Sub plan
- Minimise vegetation clearing where practical
- Conduct a preclearance survey of the borefield, pipeline route and borrow pit areas prior to any clearing works in the area to assist in the final location of infrastructure and ensure that no significant or sensitive vegetation communities would be impacted by clearing
- Use of already-disturbed areas (rather than undisturbed areas) wherever possible (e.g. laydown areas for construction)
- Delineation and protection of exclusion zones around native vegetation to be retained to prevent construction activities from encroaching on adjoining native vegetation
- Weed removal prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site.

7.2 Alteration of hydrological regimes

7.2.1 Alteration to surface water flows

Vegetation in riparian zones and floodplain areas are likely to be at least partially dependent on surface water flows. The construction of linear infrastructure such as access roads and pipelines has the potential to interfere with natural surface water flows by blocking or disrupting the movement of water across the landscape. These potential impacts are likely to be most significant where the proposed access road crosses the Hanson River and in areas within the borefield area adjacent to the Hanson River.

Additionally the proposed mining operations may impact surface water flows through changes to areas of inundation, concentration of flows and/or disruption to sheet flow regimes. Changes to flow pathways may result in changes to the flow regime experienced by downstream receptors. Flow pathways include drainage channels, distributed channels and sheet flow areas. The key receptors that are vulnerable to changes in environmental flows are vegetation communities that are at least partially dependent on surface water flows including sheet flow (i.e. Mulga shrubland) and the riparian vegetation within drainage channels and Mud Hut Swamp.

Approximately 37% of the Project area is comprised of floodplains and plains that would be subject to seasonal inundation or surface water flows. A reduction in surface water flows has the potential to result in the death of understorey species and also overstorey mulga shrubs during low rainfall periods and may in the long term lead to alterations to community composition (Anderson and Hodgkinson 1997).

Engineering controls that assist in maintaining surface water flows have been incorporated into road designs to ameliorate any potential risks to vegetation and flora due to changes in flows. Given the relatively small variation in relief across the Project area, these practices would also provide other benefits such as erosion control. Design features that recognise the need to maintain existing surface water flows include the installation of at-grade flood ways where the access road crosses a water course and culverts to maintain flows under the access road where the drainage line is well defined.

To control surface runoff and avoid erosion of the perimeter embankment of the TSF, surface runoff collector drains will be constructed along the downstream toe of the embankment. These drains will collect clean surface runoff and direct the flow away from the TSF.

Further mitigation measures to ameliorate impacts potential impacts of alterations to surface water flows are provided in Section 8.

7.2.2 Lowering of the water table

A new borefield will be established within the alluvial aquifer of the Hanson River. Six supply bores with two standby bores will provide water for the first four years of the project with an additional four bores installed from year 5. Bores will be spaced approximately 1,800 m apart and will pump at around 8.5 L/s each.

The Project will result in progressive water table drawdown from groundwater extraction.

The key groundwater receptors that are vulnerable are the recharge zones and floodout zones located downstream of the Project area. Groundwater dependent vegetation would also be susceptible to changes in groundwater levels, in particular riparian woodlands within the Project area which are likely to be at least partially dependant on groundwater. Lowering the groundwater table may result in the die back of riparian vegetation and/or changes to species composition within the community.

Changes to the water table can lead to changes in surface vegetation and habitat characteristics. Lowering of the water table has the potential to cause the following impacts on vegetation and flora:

- Decline in availability of water to ecosystems including riparian vegetation resulting in loss of habitat for species relying on riparian habitat; and
- Potential impacts to the threatened species *Eleocharis papillosa* which is known to occur in the nearby Stirling Swamp.

Water supply for the Project will be drawn from the Hanson River palaeovalley, approximately 25 km northeast of the mine site. Groundwater modelling was undertaken to predict the likely extent of groundwater drawdown from abstraction (GHD 2015b).

Maximum predicted drawdown contours for the borefield at the end of mining are shown in Figure 7-1. The maximum drawdown is modelled as being up to 12 m below current groundwater levels (which are 10 – 12 m below ground level) at the operating bores in the centre of the borefield. The 1 m drawdown contour extends to around 6 km south of the borefield.

A drawn down of 12 m below current groundwater levels is likely to result in impacts to groundwater dependent species that are drawing water from the water table. This would include *Eucalyptus camaldulensis* (River Red Gum) and *Corymbia aparreninja* (Ghost Gum) that line riparian areas within the Project area. A reduction in groundwater depth has the potential to starve these individuals of water and result in plant death and alterations in the structure of the riparian community.

A reduction in the water table may also result in impact to groundwater dependent vegetation within Stirling and Mud Hut Swamps. Groundwater modelling however indicates that groundwater levels in the area adjacent to Stirling Swamp and the outflow of the Ti -Tree basin would not be impacted by abstraction (GHD 2015b). Mud Hut Swamp will also not be impacted by drawdown associated with pit dewatering (GHD 2015b).

Measures to minimise risks associated with lowering the water table would include further predictive groundwater modelling to determine the likelihood of impact on sensitive vegetation.

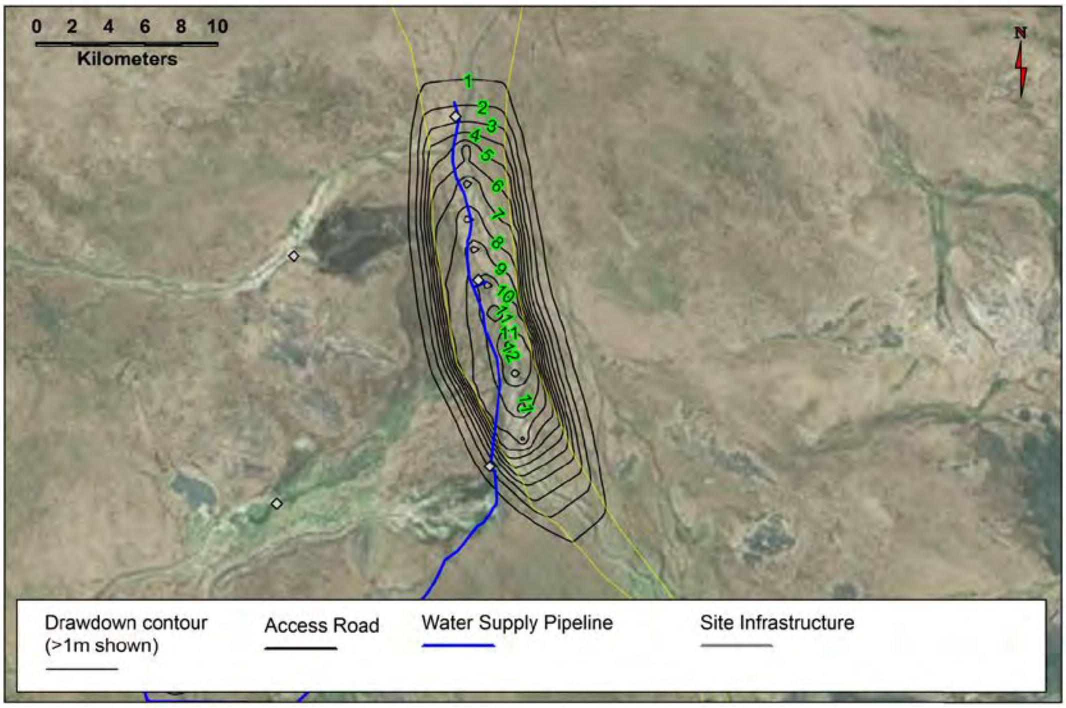

Figure 7-1 Simulated groundwater levels for the borefield at the end of mining (contours are depths below current water table levels)

7.3 Contamination of surface and groundwater

There are several risks associated with the construction and operation of the Project that could lead to contamination of surface and groundwater. These include contamination of waterways or the groundwater table caused by embankment failure or overtopping and subsequent uncontrolled release from storage ponds, the processing site and the TSF. Inappropriate storage and handling of hazardous substances may also result in uncontrolled release, spills or passive discharge into drainage lines.

Geochemical investigations by TNG have not identified the presence of material within the orebody with significant Acid Mine Drainage (AMD) potential.

Risks of contamination would be mitigated to reduce the risk of groundwater contamination. These would include erosion and sediment controls, appropriate storage and handling of hydrocarbons and chemicals, ongoing stabilisation and rehabilitation of disturbed areas, siting of stockpiles away from natural drainage lines, dust control, establishment of sediment basins and operation and maintenance procedures.

Other potential sources of contaminants to surface and groundwater include:

- Contamination from sediment runoff from areas stripped of vegetation
- Sediment runoff from soil stockpiles
- Runoff from hardstand areas, including roads, processing areas and site facilities
- Spills from storage facilities and runoff containing hazardous substances or elevated sediment concentrations
- Waste treatment areas (including the water treatment plant, wastewater treatment plant, and landfill facilities)
- Leakage or spillage of hydrocarbons from pipelines, vehicles, wash down areas and workshops
- Refuelling bays and fuel, oil and grease storages.

There are a number of sensitive riparian habitats close to the development footprint, including drainage lines, Bloodwood Creek, Murray Creek and the Hanson River. These areas are all sensitive receptors for any adverse impacts on water quality potentially arising from the Project. Vegetation and flora reliant on surface flows and groundwater uptake may also be impacted by surface water and groundwater contamination.

After closure, the mine void will act as a sink concentrating salts. Evaporation exceeds precipitation in the project area so any lake that forms will be confined to the bottom of the pit.

Project design has incorporated a number of control measures to minimise the potential for the release of contaminants to the environment. These include storage of diesel at the mine site in self bunded tanks.

Within the flood plain of the Hanson River elevated drill pads will be constructed to ensure the well casings, headworks, generators and fuel tanks remain above the 100-year ARI level. Generators and fuel tanks at the borefield will be located within lined and bunded structures constructed on top of the drill pad with bunded storage sufficient to accommodate simultaneously an appropriate ARI wet season rainfall event and failure of a full fuel tank

The site has also been designed so that there will be no process or contaminated water stream discharged to the environment. Clean water will be diverted around the site.

7.4 Introduction and/or spread of invasive species

Weeds compete with native species for space, nutrients and water, and have the potential to alter the structure and composition of vegetation communities. Weeds are commonly spread by wind, plant and machinery, surface runoff or animal movement. There is the potential for Project activities to introduce or increase the spread of weeds via the transportation of seeds on vehicle tyres and machinery, movement or stockpiling of soil and inappropriate waste management.

A number of weed species are known to be present within the Project area (Section 5.3.6). One of the exotic species (*Tribulus terrestris*), recorded during baseline surveys is listed as a declared weeds under the *Weeds Management Act 2001* and one species (*Cenchrus ciliaris,* Buffel Grass) has been identified as high threat environmental weeds in the Burt Plain Bioregion. Buffel Grass is a highly invasive species with potential to spread throughout the Project area. The proliferation of Buffel Grass throughout the Project area has the potential to increase fire severity due to its ability to accumulate higher amounts combustible biomass compared to native understory species. Increased fire severity has been correlated with the mortality of overstorey tree species, a reduction in post-fire re-establishment of native species and altered plant community structure.

The remainder of the introduced species recorded within the Project area are unlikely to have significant impacts on ecosystems as they are present in relatively low numbers and frequency and are not considered to be highly invasive.

A Weed Management Plan (WMP) will be developed for the Project to minimise the risks associated with the introduction of spread of weeds through the site. Further details of mitigation measures that would be included in the WMP are outlined in Section 8.

7.5 Changes to fire regime

Construction and operational activities, particularly hot works, are potential ignition sources, and could result in a bushfire. In addition, it may be necessary to conduct controlled burns to minimise fuel loads in the vicinity of the mine site. Without adequate fire management in place, there is potential for these activities to result in bushfires. Although wildfire has an influential role in arid zone ecology and is a necessary ecological process in some habitats, fire can have detrimental impacts on vegetation. For instance fires that are too frequent have the potential to impact vegetation composition and flora diversity, with many species unable to set seed if inadequate time elapses between consecutive fires and the setting of seed. Fires that occur at the wrong time of year (i.e. late dry season), or in habitats that don't respond well to fire, or those that generate excessive heat can also result in detrimental impacts to vegetation composition and flora diversity.

Measures to mitigate the impacts of unplanned wildfire will be included in the project CEMP as detailed in Section 8.

7.6 Dust emissions

The following activities are identified as potentially the main generators of dust for the Project:

- Vehicle movements over unsealed surfaces resulting in dust emissions
- Release of particulates from the handling and transport of materials and product
- Clearing of vegetation resulting in exposed soils that are more susceptible to wind erosion
- Wind erosion mobilising dust from exposed surfaces such as the pit, waste rock dump, tailings storage facility, laydown areas, stockpiles and roads.

Dust deposition on leaf surfaces may physically affect individual plants such as by blocking and damaging stomata, and abrasion of the leaf surface or cuticle which may in term impact on metabolic processes. Dust could also contribute to cumulative effects such as drought stress on already stressed individuals which may in turn lead to the loss of individual plants.

Dust is unlikely to result in the loss of any vegetation communities within the Project area but may result in impacts on individual plants. It is unlikely that these impacts would be significant in terms of the relative numbers of plants that could be impacted, particularly if management actions are implemented to minimise the impacts of dust (e.g. watering of unsealed roads). Any impacts to vegetation from dust are likely to be relatively minor and largely restricted to areas close to the Project (50 to 100 m).

A Dust Management Plan will be developed and implemented as part of the Project CEMP.

7.7 Soil degradation and erosion

Soils will be stripped in areas where new structures are to be constructed, with material stockpiled and used for rehabilitation. There is potential for the Project to result in the loss of soils in areas that have been stripped of vegetation. Soil erosion has the potential to impact Murray Creek and the downstream Mud Hut Swamp through the release of sediments from site during flow events.

Potential water quality impacts may be associated with sediment runoff from disturbed areas, including vegetation clearing areas, construction lay down areas and access roads if risks are not effectively managed and appropriate mitigation measures implemented. Concentrated and/or altered water movement within the construction footprint could increase the potential for sediment mobilisation and transport. Negative effects on aquatic habitats may include increases in stream sediment load, changes in channel form and changes in stream hydrology. Infrastructure impinging on a stream channel may also cause increases in sediment input and consequent declines in water quality and stream habitat integrity.

Soil protection measures and techniques would be implemented during construction and operation of the mine site. These would include:

- Preparation of an Erosion and Sediment Control Plan (ESCP). The ESCP would include a framework for managing the risk of erosion and release of sediment to receiving environment or the contamination of stormwater
- Implementation of progressive rehabilitation of disturbed areas
- Ongoing stabilisation and rehabilitation of waste landforms
- Regular inspection, management and maintenance of erosion and sediment control measures.

7.8 Impacts on vegetation and species of National Environmental Significance

No vegetation communities or flora species listed as threatened under the EPBC Act were recorded within the Project area.

One species (*Eleocharis papillosa* (Dwarf Desert Spike-rush) is known to occur within Stirling Swamp which is located approximately 12 km north of the proposed access road.

There is the potential that groundwater extraction could impact the hydrology of the Ti Tree Basin which could in turn result in impacts to Stirling Swamp and potentially the known population of *Eleocharis papillosa*. Groundwater modelling however indicates that groundwater levels in the area adjacent to Stirling Swamp and the outflow of the Ti Tree basin would not be impacted by abstraction from the borefield or drawn down from pit development (GHD 2015b).

There is also the potential that the Project could impact Stirling Swamp through contamination from hydrocarbon spills. The proposed site access road crosses the Hanson River upstream of Stirling Swamp.

7.9 Impacts on vegetation of regional significance

Neave *et al*. (2004) identifies a number of criteria for determining important habitats within the Burt Plain Bioregion. Vegetation of bioregional significance has been identified by Neave *et al.* (2004) as not only areas of rare habitat but also vegetation that is well represented elsewhere but is regarded as having conservation value as they meet any of the following criteria:

Habitat with high species richness that supports a high abundance of native species, and/or is structurally complex.

These attributes may relate to the:

- *Number of vegetation types and the degree of contrast between them*
- *Availability of shelter sites (e.g. nesting sites, ground litter and logs, rock crevices) and water and food resources (e.g. presence of nectar producing shrubs)*
- *Topographic/geological complexity creating a range of micro-habitats.*

The average species richness within vegetation communities present within the Project area varies from 17 within Mulga Shrubland (VT 2) to 31 within Riparian woodland (VT 3). None of the vegetation communities are considered to have high species richness or structural complexity and the communities present are well represented in the Burt Plain bioregion.

The two most common vegetation communities within the Project area are Triodia grassland on sandy plains and Mulga shrublands on sandy red earths. Together these vegetation communities comprise 97% of the vegetation within the Project area.

Fifty-five percent of the Project area is comprised of Triodia grassland on sandy plains. This vegetation type best corresponds to Wilsons vegetation Map Unit 76 – *Triodia pungens* (Soft Spinifex), *Plectrachne schinzii* (Curly Spinifex) hummock grassland with Acacia tall sparse-shrubland overstorey, which covers an area of 1,098,704 ha or 23.17% of the Burt Plain bioregion (Pert 2006). The removal of 558 ha of this community would represent less than 0.05% of this vegetation type within the Burt Plain Bioregion.

Forty-one percent of the Project area is comprised of mulga shrublands on sandy red earths. This vegetation type corresponds to the Wilson Map Unit 65 – *Acacia aneura* (Malga) tall open – shrubland with *Eragrostis eriopoda* (Woollybutt) open grassland understorey. There is approximately 2,771,054 of this vegetation type mapped within the Burt Plain Bioregion (Wilson *et al.* 1990, Pert 2006). The Project would therefore result in the disturbance of approximately 0.01% of this vegetation community within the bioregion.

There are a number of less common vegetation communities that occur in small patches or along linear drainage lines throughout the Study area. These include Riparian Vegetation (VT 3) dominated by bean trees (*Erythrina vespertilio*) and Tall Acacias shrubland on stony quartz (VT 8). These communities however are not considered to be rare or threatened at a regional scale.

None of the vegetation types within the Project area have a notable abundance of shelter or nesting sites for fauna or significant water or food resources. Nor do any of the vegetation types occur within areas that have topographic or geological complexity that would result in the creation of significant micro-habitats.

Habitat supporting species of high conservation value (e.g. threatened species, endemic species, poorly reserved species and/or rare species).

Vegetation within the Project area partially meets this criterion as is supports a number of threatened fauna species including Brush-tailed Mulgara (*Dasycercus blythi*), Black-footed Rock-wallaby (*Petrogale lateralis*) and Grey Falcon (*Falco hypoleucos*) which were recorded during the fauna survey completed at the site (GHD 2015a). A number of other threatened fauna species have also been predicted to occur at the site based on the presence of suitable habitat (GHD 2015a).

None of the vegetation communities present are considered to be rare in the region and all are well represented in the surrounding locality and elsewhere in the Burt Plain Bioregion. The fauna survey did not identify any fauna species of conservation significance that would solely rely on habitats within the Project area. It is therefore unlikely that any of the habitats within the Project area would be considered significant habitat for threatened species or be important for the persistence of any threatened species in the locality.

Stirling Swamp has been recognised as a site of botanical significance in the Burt Plain Bioregion (White *et al.* 2000). The site has been listed as a site of botanical significance as it supports a diversity of wetland habitats and a wide range of disjunct and rare threatened plant taxa including the EPBC listed vulnerable species *Eleocharis papillosa* (Dwarf Desert Spike-Rush) as well and a number of flora species of NT significance and bioregional significance. Groundwater modelling has concluded that Stirling Swamp would not be impacted by either abstraction from the borefield or draw down from the mine pit (GHD 2015b).

Habitat that is of good quality (i.e. its compositional and structural integrity and ecological processes have not been undermined). The level of habitat integrity is influenced by:

- *The presence / absence (or low cover abundance) of environmental weeds, especially Buffel Grass and Couch Grass, both of which are known to outcompete native plant taxa and alter habitat parameters for native fauna*
- *The presence / absence (or low abundance) of introduced animal species*
- *The presence / absence of an appropriate fire regime (inappropriate regimes are known to impact on species composition and canopy condition)*
- *Degree of isolation from infrastructure such as roads and water points (reduced risk of weed invasion and over-grazing)*
- *The state of the hydrological regime (altered regimes may lead to changes in site species composition).*

The Project area has a moderate cover abundance of environmental weeds including the invasive species *Cenchrus ciliaris* (Buffel Grass). Overall however the condition of vegetation in the Study area was good with weeds mostly confined to more fertile floodplain areas. There is evidence of recent widespread fires across the site however no information is available regarding the history of fires in the region.

The Project area is located near to the Stuart highway and has been subjected to cattle grazing for over 130 years. The area therefore is unlikely to have particularly good habitat such that it would be considered to have regional significance.

Habitat that is poorly reserved elsewhere.

Dominant vegetation communities within the Study area include mulga communities on red earths, woodlands on alluvial flats and hummock grasslands on sand plains. Most of the vegetation types present within the Project area are well represented within the Burt Plain bioregion, however less than 1% of the Burt Plain bioregion is conserved within reserves; and thus vegetation communities within the Study area are poorly represented in conservation reserves, e.g. hummock grassland 0.01%, Acacia woodland 0.05%, Eucalyptus low Woodland with Tussock Grass Understorey 0.01% (NRETAS 2005).

7.10 Impacts on Sites of Conservation Significance

The Anmatyerr North site includes Stirling Swamp, a large wetland complex comprised of claypans, lignum swamp, semi-saline samphire and temporary open water as well as parts of the adjacent Hanson River (NRETAS 2009b). The Anmatyerr North site is located across Stirling, Anningie and Ahakeye Stations and extends to the low rocky ranges about 20 km south of Stirling Swamp to encompass the known extent of the near threatended Giant Sweet Potato (*Ipomoea polpha* subsp. *latzii*) as well as a population of the threatened Dwarf Desert Spike Rush (*Eleocharis papillosa*). Stirling Swamp forms occasionally at the northern edge of the Ti Tree Basin, storing flood waters discharged from the Hanson River and the ridges to the east of Wilora. This area is believed to act as an evaporation area for the basin (NRETAS 2009b).

A section of the proposed access road crosses the Anmatyerr North SOCS. The construction this road would result in a direct impact to 21.07 ha of the Anmatyerr North SOCS. There is also potential for this site to be indirectly impacted through an increase in weed species brought into the area during construction of the road.

As discussed previously a Weed Management Plan would be developed and implemented to amilerorate impacts asociated with the introduction and/or spread of introduced species throughout the Project area.

Mud Hut Swamp is located approximately 7.7 km to the north of the proposed mine pit. Mud Hut Swamp is a large, isolated, gum-barked coolabah (*Eucalyptus vitrix*) swamp that is fed by Bloodwood and Murray Creeks in the south-east and runoff from low hills and rises to the north and west (NRETAS 2009a). This is the largest swamp in the Burt Plain bioregion and remains inundated for a relatively long time after flooding, possibly retaining water for several months (NRETAS 2009a). The swamp is likely to support a range of wetland birds, fish and plants. Mud Hut Swamp is listed in the "*Inventory of sites of international and national significance for biodiversity values in the Northern Territory".*

The Project may also have indirect imacts to Mud Hut Swamp SOCS though contamination of surface water which in turn could flow into Bloodwood Creek and on into Mud Hut Swamp. Any interruption or alteration of surface water drainage in the vicinity of the Project area has the potential to adversely affect the downstream ecosystem, including Mud Hut Swamp.

Groundwater modelling indicates that Stirling Swamp and Mud Hutt Swamp will not be impacted by groundwater drawdown resulting from groundwater abstraction from the borefield or from pit dewatering (GHD 2015b).

8. Mitigation Measures

The proposal would result in direct impacts on native vegetation and flora species within the development footprints as described in Section 7. There is also the potential for indirect impacts on retained vegetation and habitats adjacent to the Project area.

This section presents an overview of recommended mitigation measures to avoid or minimise the potential impacts of the Project on vegetation and native flora. Mitigation measures would be incorporated into the CEMP and OEMP for the Project.

The Project will result in unavoidable residual impacts to some elements of the natural environment. These residual impacts are not expected to impose a significant negative effect on local or regional occurrences of vegetation communities or flora species.

8.1 Avoidance of Impacts

It is recommended that detailed Project design should consider options for aligning infrastructure footprints to avoid or minimise clearing of vegetation. In particular the Project should aim to avoid where possible impacts to sensitive vegetation types such as riparian vegetation. Where possible the design should also incorporate options for avoiding modification to surface water flows to minimise the risk of vegetation stress and loss, or the proliferation of introduced flora species.

Engineering controls that assist in maintaining surface water flows should be incorporated into road designs to ameliorate any potential risks to vegetation and flora due to changes in flows. Given the relatively small variation in relief across the Project area, these practices would also provide other benefits such as erosion control. Design features that recognise the need to maintain existing surface water flows include the installation of at-grade flood ways where the access road crosses a water course and culverts to maintain flows under the access road where the drainage line is well defined.

To control surface runoff and avoid erosion of the perimeter embankment of the TSF, surface runoff collector drains will be constructed along the downstream toe of the perimeter embankment. These drains would collect clean surface runoff and direct the flow away from the TSF.

To limit impacts on riparian areas buffer widths recommended by the Northern Territory Land Clearing Guidelines should be adhered to where possible. If this is not possible structures that would capture sediment downstream of development would be installed.

8.2 Mitigation of Impacts

8.2.1 Project Construction

Where possible the amount of land disturbance and vegetation clearing should be minimised to as small an area as practicable to construct infrastructure. Construction personnel should be briefed during inductions regarding the conservation value of surrounding habitats and their responsibilities with regard to protecting these habitats during construction.

A preclearance survey of the borefield, pipeline route and borrow pit areas will be undertaken prior to any clearing works in the area to assist in the final location of infrastructure and ensure that no threatened species or significant or sensitive vegetation communities would be impacted by clearing.

8.2.2 Construction Environment Management Plan

A CEMP will be required for construction phases of the Project. The CEMP would include industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures including the procedures outlined below. The CEMP would be required to include the following mitigation measures as a minimum:

- Strategies to minimise vegetation clearance where possible
- Procedures for demarcating the limits of clearing and no-go areas
- Staged clearing of vegetation to minimise areas of bare ground and clear land only as required
- Strict vehicle hygiene protocols to prevent new weed incursion and spread, including a vehicle wash down facility on site
- Strict fire prevention management protocols to prevent wildfire during clearing activities
- Maintenance of fire breaks around high-risk areas/activities
- Use of already-disturbed areas (rather than undisturbed areas) wherever possible (e.g. lay down areas for construction)
- Development and implementation of a land stabilisation and revegetation strategy
- Progressive revegetation of cleared land as activities are completed
- An Erosion and Sediment Control Plan which would require:
  - Installation of erosion and sediment control measures prior to construction
  - Regular inspection of erosion and sediment control measures, particularly following rainfall events, to ensure their ongoing functionality
  - Runoff from disturbed and rehabilitated areas diverted into sediment ponds and not discharged into the natural system
  - Constructing adequate bunds around potential contamination sources, to contain contaminated water in the event of heavy rainfall.
- A Weed Management Plan including a description of:
  - Type and location of weeds of concern within the subject site
  - Sensitive receivers (such as native vegetation and waterways)
  - Measures to prevent the spread of weeds, including hygiene procedures for equipment, footwear and clothing
  - Mitigation measures to minimise the spread of weeds such as ensuring that any machinery entering the Project area is free of weed seed. This would typically be managed through the use of vehicle wash down stations
  - Keeping vehicles to established tracks and roads, and limiting the use of vehicles off-road
  - Proposed weed control methods and targeted areas
  - Weed disposal protocols
  - Annual weed monitoring and mapping.
- Application of industry dust control measures which would include:
  - Road wetting, covering of exposed loads where practicable and maintaining moisture levels in bulk loose construction materials
  - Minimising hauling and vehicle travel in conditions when wind strength results in spatially extensive and heavy dust deposition in surrounding habitats

- – Reduced vehicle speeds for high-use areas/roads
- – Progressive reinstatement of cleared land as activities are completed.

8.3 Operation

8.3.1 Groundwater Extraction

Measures to minimise risks associated with lowering of the water table during groundwater extraction from the borefield will include:

- Further predictive modelling to confirm the extent of groundwater drawdown
- Establishing a groundwater monitoring program to quantify drawdown during abstraction
- Monitoring vegetation potentially at risk of impact from a lowering of the water table
- If significant impacts are identified consider mitigation options. This could include modification of the pumping regime to manage groundwater levels.

8.3.2 Weed Management

During operation of the Project ongoing weed control measures should include:

- Regular monitoring of the Project area (including rehabilitated areas) and surrounding vegetation to identify new weed populations and monitor the effectiveness of weed control measures
- Vehicles and equipment to be inspected prior to entering the site if there is a risk of importation of soil, seed and plant material
- Vehicle access will be restricted to designated roads and access tracks
- Areas supporting existing weed infestations, or vulnerable to weed infestation, will be avoided where practicable
- Topsoil from weed affected areas will be stockpiled in a designated area with appropriate signage and bunding. Weed infested topsoil will be treated as required to eradicate weeds prior to re-spreading in rehabilitation areas
- All staff and contractors will be informed of weed hygiene measures and weed reporting requirements during the site induction
- Ongoing maintenance of erosion and sediment controls.

8.3.3 Fire

Fire management measures to be adopted include:

- Development of a Fire Management Plan
- All welding, cutting and grinding works undertaken will require approval via an internal hot works permit
- Maintenance of fire breaks around high-risk areas / activities
- All site personnel will be required to undertake fire control training, including the correct use of extinguishers
- All vehicles are required to carry a fire extinguisher and two-way radio
- Emergency procedures
- Active fire management and the use of cool-season control burns if needed.

8.4 Rehabilitation

Progressive rehabilitation undertaken over the Project area will be guided by the following principles:

- Areas not required for ongoing operations will be progressively rehabilitated with local provenance native species
- Locate and design landforms to be rehabilitated to optimise blending with the surrounding topography
- Topsoil will be stripped and stockpiled in a designated area, to prevent erosion or run-off
- Minimise soil erosion particularly on the batters of the waste rock dump
- Stockpile vegetative material and topsoil for later use
- Minimise length of stockpiling of vegetation and topsoil
- Seeds collected for the rehabilitation program will be sourced locally, within a 20 km radius of the Project area, wherever possible. Should insufficient quantities of seed be available within the area, seed of local provenance will be sourced where possible
- Annual monitoring of rehabilitation areas will be undertaken prior to, and following completion of rehabilitation
- If monitoring identifies that completion criteria are not being met, additional rehabilitation and monitoring will be completed until such criteria are met.

Rehabilitated areas will be monitored to ensure the success of the rehabilitation programme and impacts from mining activities. Monitoring of rehabilitated sites will be undertaken annually until completion criteria have been met. The monitoring will assess the species diversity, plant density and community structure against agreed completion criteria, which include:

- Species richness, species diversity and plant density of the restored community exceeds the median in the range of values established for baseline vegetation communities
- Dominant species in the restored community are also dominant in the baseline vegetation communities.

8.5 Closure

A Conceptual Mine Closure Plan has been developed and will be refined as a component of the Mine Management Plan. The plan outlines general and area specific decommissioning and closure measures, completion criteria and post closure monitoring requirements for the Project. The Conceptual Mine Closure Plan aims to ensure that:

- Mining is planned and carried out to ensure a sustainable mine closure outcome is achieved
- Self-sustaining native vegetation communities are returned after mining, which in species composition and ecological function are representative of naturally occurring analogue sites.

A post-closure monitoring programme will be initiated, with the aim of confirming that the rehabilitation and closure has been effective and the closure criteria satisfied. Post-closure monitoring will include assessments of public safety, geotechnical stability, physical stability, chemical stability and revegetation success.

9. Conclusion

The current survey identified 238 flora species (233 native and 5 introduced) within the Study area.

No threatened flora species were recorded during the survey, although there is potential habitat within the Study area for one threatened species (*Eleocharis papillosa* Dwarf Desert Spike-rush). This species is listed as vulnerable under both the TPWC Act and EPBC Act.

Eight vegetation communities were mapped within the Study area:

- Mulga shrubland on sandy red earths
- Riparian woodland along watercourses and drainage channels
- Triodia grassland on sandy plains
- Floodplains dominated by *Eucalyptus victrix*
- Open Corymbia woodland on loamy alluvial plains
- Low Acacia shrubland on rocky slopes
- Tall Acacia shrubland on stony quartz
- Low open Eucalyptus woodland on limestone.

All of these vegetation types are well represented at the local scale within the bioregion.

The proposal would result in the removal of approximately 1038 ha of native vegetation. None of the vegetation communities proposed to be removed has national or regional significance. The majority of the vegetation to be cleared for the project would be from two vegetation communities (Mulga shrubland on sandy red earths and Triodia grassland on sandy plains. Both of these communities are well represented at the local and regional scale.

The proposal has the potential to impact on flora and vegetation, or exacerbate existing threatening processes through:

- clearing of flora and vegetation and associated loss of habitat during construction;
- alteration of hydrological regimes associated with earthworks and construction activities and associated changes to land surface areas, and/or impediments to surface flows;
- groundwater drawdown and/or changes to groundwater flows impacting groundwater dependent ecosystems;
- contamination of surface and/or groundwater;
- introduction and/or spread of invasive exotic flora species;
- changes to fire regimes;
- dust emissions from construction, mining and processing activities; and
- erosion and sedimentation resulting from vegetation clearing during construction.

Mitigation measures would be implemented throughout the construction, operation and decommissioning phases of the Project to ameliorate potential impacts on vegetation and flora.

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Appendices

Appendix A EPBC Protected Matters Search

Australian Government
Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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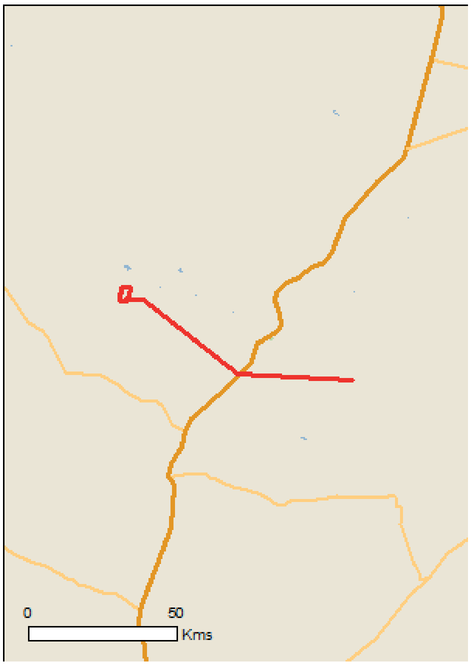

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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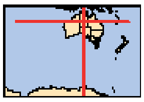

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	9
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes typhlops Itjaritjari, Southern Marsupial Mole, Yitjarritjarri [296]	Endangered	Species or species habitat likely to occur within area
Petrogale lateralis MacDonnell Ranges race Warru, Black-footed Rock-wallaby (MacDonnell Ranges race) [66649]	Vulnerable	Species or species habitat known to occur within area
Plants		
Eleocharis papillosa Dwarf Desert Spike-rush [2519]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		

Name	Threatened	Type of Presence
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Central Mount Stuart	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Bos taurus		
Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius		
Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.600237 133.275119,-21.599599 133.305331,-21.628325 133.301211,-21.639814 133.292285,-21.640452 133.270999,-21.599599 133.274432,-21.599599 133.303271,-21.625772 133.301211,-21.637899 133.290912,-21.637899 133.343097,-21.844547 133.626681,-21.863666 133.970691,-21.863666 133.970691

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix B List of flora species recorded within study area

Family	Species	Exotic
ADIANTACEAE	*Cheilanthes sieberi* subsp. *sieberi*	
AMARANTHACEAE	*Alternanthera angustifolia*	
AMARANTHACEAE	*Alternanthera nana*	
AMARANTHACEAE	*Enchylaena tomentosa* subsp. *tomentosa*	
AMARANTHACEAE	*Ptilotus exaltatus*	
AMARANTHACEAE	*Ptilotus obovatus* var. *obovatus*	
AMARANTHACEAE	*Ptilotus polystachyus*	
AMARANTHACEAE	*Rhagodia eremaea*	
AMARANTHACEAE	*Rhagodia spinescens*	
AMARANTHACEAE	*Salsola tragus* subsp. *tragus*	
AMARANTHACEAE	*Sclerolaena calcarata*	
AMARANTHACEAE	*Sclerolaena cornishiana*	
AMARANTHACEAE	*Einadia nutans* subsp. *eremaea*	
AMARANTHACEAE	*Ptilotus fusiformis*	
APIACEAE	*Trachymene glaucifolia*	
APOCYNACEAE	*Carissa lanceolata*	
ASTERACEAE	*Anemocarpa saxatilis*	
ASTERACEAE	*Centipeda minima* subsp. *minima*	
ASTERACEAE	*Chrysocephalum pterochaetum*	
ASTERACEAE	*Haloragis aspera*	
ASTERACEAE	*Minuria leptophylla*	
ASTERACEAE	*Pluchea dentex*	
ASTERACEAE	*Pluchea ferdinandi-muelleri*	
ASTERACEAE	*Pterocaulon serrulatum* var. *serrulatum*	
ASTERACEAE	*Pterocaulon sphacelatum*	
ASTERACEAE	*Senecio magnificus*	
ASTERACEAE	*Streptoglossa adscendens*	
ASTERACEAE	*Streptoglossa odora*	
BORAGINACEAE	*Heliotropium cunninghamii*	
BORAGINACEAE	*Heliotropium ovalifolium*	
BORAGINACEAE	*Heliotropium pachyphyllum*	
BORAGINACEAE	*Heliotropium tanythrix*	
BORAGINACEAE	*Heliotropium tenuifolium*	
BORAGINACEAE	*Trichodesma zeylanicum* var. *zeylanicum*	
CAPPARACEAE	*Capparis lasiantha*	
CAPPARACEAE	*Capparis mitchellii*	
CARYOPHYLLACEAE	*Polycarpaea arida*	
CHENOPODIACEAE	*Maireana villosa*	
CLEOMACEAE	*Cleome viscosa*	
CLEOMACEAE	*Cleome viscosa*	
COMMELINACEAE	*Commelina ensifolia*	
CONVOLVULACEAE	*Evolvulus alsinoides*	
CONVOLVULACEAE	*Ipomoea muelleri*	
CUCURBITACEAE	*Citrullus lanatus*	*
CUCURBITACEAE	*Cucumis maderaspatanus*	
CYPERACEAE	*Cyperus centralis*	
CYPERACEAE	*Cyperus concinnus*	
CYPERACEAE	*Fimbristylis dichotoma*	
ELATINACEAE	*Bergia occultipetala*	

Family	Species	Exotic
EUPHORBIACEAE	*Euphorbia australis*	
EUPHORBIACEAE	*Euphorbia coghlanii*	
EUPHORBIACEAE	*Euphorbia ferdinandii*	
EUPHORBIACEAE	*Euphorbia tannensis*	
EUPHORBIACEAE	*Microstachys chamaelea*	
FABACEAE	*Crotalaria eremaea*	
FABACEAE	*Erythrina vespertilio*	
FABACEAE	*Glycine canescens*	
FABACEAE	*Indigofera colutea*	
FABACEAE	*Indigofera linifolia*	
FABACEAE	*Indigofera linnaei*	
FABACEAE	*Indigofera georgei*	
FABACEAE	*Mirbelia viminalis*	
FABACEAE	*Muelleranthus stipularis*	
FABACEAE	*Petalostylis cassioides*	
FABACEAE	*Senna artemisioides* subsp. *alicia*	
FABACEAE	*Senna artemisioides* subsp. *filifolia*	
FABACEAE	*Senna artemisioides* subsp. *helmsii*	
FABACEAE	*Senna artemisioides* subsp. *oligophylla*	
FABACEAE	*Senna artemisioides* subsp. *petiolaris*	
FABACEAE	*Senna artemisioides* subsp. *quadrifolia*	
FABACEAE	*Senna artemisiodes* subsp. *artemisioides*	
FABACEAE	*Senna glutinosa* subsp. *glutinosa*	
FABACEAE	*Senna glutinosa* subsp. *pruinosa*	
FABACEAE	*Senna notabilis*	
FABACEAE	*Tephrosia brachyodon*	
FABACEAE	*Tephrosia sphaerospora*	
FABACEAE	*Tephrosia supina*	
FABACEAE	*Vigna lanceolata* subsp *latifolia*	
FABACEAE	*Zornia albiflora*	
FABACEAE (MIMOSOIDEAE)	*Vachellia farnesiana*	*
FABACEAE (MIMOSOIDEAE)	*Acacia ancistrocarpa*	
FABACEAE (MIMOSOIDEAE)	*Acacia georginae*	
FABACEAE (MIMOSOIDEAE)	*Acacia tetragonophylla*	
FABACEAE (MIMOSOIDEAE)	*Acacia adsurgens*	
FABACEAE (MIMOSOIDEAE)	*Acacia aneura*	
FABACEAE (MIMOSOIDEAE)	*Acacia aptaneura*	
FABACEAE (MIMOSOIDEAE)	*Acacia cowleana*	
FABACEAE (MIMOSOIDEAE)	*Acacia cuthbertsonii*	
FABACEAE (MIMOSOIDEAE)	*Acacia estrophiolata*	
FABACEAE	*Acacia holosericea*	

Family	Species	Exotic
(MIMOSOIDEAE)		
FABACEAE (MIMOSOIDEAE)	*Acacia inaequilatera*	
FABACEAE (MIMOSOIDEAE)	*Acacia kempeana*	
FABACEAE (MIMOSOIDEAE)	*Acacia ligulata*	
FABACEAE (MIMOSOIDEAE)	*Acacia melleodora*	
FABACEAE (MIMOSOIDEAE)	*Acacia monticola*	
FABACEAE (MIMOSOIDEAE)	*Acacia murrayana*	
FABACEAE (MIMOSOIDEAE)	*Acacia pteraneaura*	
FABACEAE (MIMOSOIDEAE)	*Acacia spondylophylla*	
FABACEAE (MIMOSOIDEAE)	*Acacia stipuligera*	
FABACEAE (MIMOSOIDEAE)	*Acacia victoriae*	
FABACEAE (MIMOSOIDEAE)	*Acacia cambagei*	
GOODENIACEAE	*Goodenia armitiana*	
GOODENIACEAE	*Goodenia hirsuta* subsp *Run on areas*	
GOODENIACEAE	*Goodenia lunata*	
GOODENIACEAE	*Goodenia ramelii*	
GOODENIACEAE	*Scaevola glabrata*	
GOODENIACEAE	*Scaevola ovalifolia*	
GOODENIACEAE	*Scaevola parvifolia* subsp. *parvifolia*	
GYROSTEMONACEAE	*Codonocarpus cotinifolius*	
LAMIACEAE	*Spartothamnella teucriiflora*	
LAURACEAE	*Cassytha capillaris*	
LILIACEAE	*Crinum flaccidum*	
LOGANIACEAE	*Mitrasacme* sp	
LORANTHACEAE	*Amyema maidenii* subsp. *maidenii*	
MALVACEAE	*Abutilon leucopetalum*	
MALVACEAE	*Abutilon macrum*	
MALVACEAE	*Abutilon otocarpum*	
MALVACEAE	*Abutilon* sp	
MALVACEAE	*Gossypium australe*	
MALVACEAE	*Gossypium sturtianum var. sturtianum*	
MALVACEAE	*Hibiscus brachychlaenus*	
MALVACEAE	*Hibiscus burtonii*	
MALVACEAE	*Hibiscus stuartianum* var. *stuartianum*	
MALVACEAE	*Hibiscus sturtii* subsp *grandiflorus*	
MALVACEAE	*Hibiscus sturtii* var. *truncatus*	
MALVACEAE	*Keraudrenia nephrosperma*	
MALVACEAE	*Melhania oblongifolia*	
MALVACEAE	*Sida cunninghamii*	
MALVACEAE	*Sida fibulifera*	

Family	Species	Exotic
MALVACEAE	*Sida filiformis*	
MALVACEAE	*Sida platycalyx*	
MALVACEAE	*Sida rohlenae* subsp. *rohlenae*	
MALVACEAE	*Waltheria indica*	
MARSILEACEAE	*Marsilea hirsuta*	
MENISPERMACEAE	*Tinospora smilacina*	
MOLLUGINACEAE	*Glinus lotoides*	
MYRTACEAE	*Corymbia aparrerinja*	
MYRTACEAE	*Corymbia opaca*	
MYRTACEAE	*Eucalyptus gregoriensis*	
MYRTACEAE	*Eucalyptus victrix*	
MYRTACEAE	*Eucalyptus camaldulensis* subsp. *obtusa*	
MYRTACEAE	*Eucalyptus microtheca*	
MYRTACEAE	*Eucalyptus pachyphylla*	
MYRTACEAE	*Eucalyptus socialis* subsp. *eucentrica*	
MYRTACEAE	*Eucalyptus trivalvis*	
MYRTACEAE	*Melaleuca glomerata*	
MYRTACEAE	*Melaleuca lasiandra*	
NYCTAGINACEAE	*Boerhavia coccinea*	
OLEACEAE	*Jasminum calcareum*	
PHYLLANTHACEAE	*Phyllanthus* sp. *broad turberculata seeds*	
PHYLLANTHACEAE	*Sauropus trachyspermus*	
PITTOSPORACEAE	*Pittosporum angustifolium*	
PLANTAGINACEAE	*Stemodia viscosa*	
POACEAE	*Cenchrus ciliaris*	*
POACEAE	*Eragrostis tenuifolia*	*
POACEAE	*Aristida contorta*	
POACEAE	*Aristida holathera* var. *holathera*	
POACEAE	*Aristida inaequiglumis*	
POACEAE	*Aristida jerichoensis* var. *subspinulifera*	
POACEAE	*Aristida latifolia*	
POACEAE	*Bothriochloa ewartiana*	
POACEAE	*Chrysopogon fallax*	
POACEAE	*Cymbopogon ambiguus*	
POACEAE	*Digitaria brownii*	
POACEAE	*Enneapogon avenaceus*	
POACEAE	*Enneapogon clelandii*	
POACEAE	*Enneapogon cylindricus*	
POACEAE	*Enneapogon polyphyllus*	
POACEAE	*Enteropogon acicularis*	
POACEAE	*Enteropogon ramosus*	
POACEAE	*Eragrostis setifolia*	
POACEAE	*Eragrostis confertiflora*	
POACEAE	*Eragrostis cylindriflora*	
POACEAE	*Eragrostis elongata*	
POACEAE	*Eragrostis eriopoda*	
POACEAE	*Eragrostis mucronata*	
POACEAE	*Eragrostis setifolia*	

Family	Species	Exotic
POACEAE	*Eragrostis speciosa*	
POACEAE	*Eragrostis xerophila*	
POACEAE	*Eriachne armitii*	
POACEAE	*Eriachne mucronata*	
POACEAE	*Eriachne obtusa*	
POACEAE	*Eriachne obtusa* var *Tallbroad inflorescence*	
POACEAE	*Eulalia aurea*	
POACEAE	*Monachather paradoxa*	
POACEAE	*Panicum decompositum*	
POACEAE	*Panicum effusum*	
POACEAE	*Paraneurachne muelleri*	
POACEAE	*Paspalidium constrictum*	
POACEAE	*Sporobolus australasicus*	
POACEAE	*Sporobolus virginicus*	
POACEAE	*Themeda avenacea*	
POACEAE	*Themeda triandra*	
POACEAE	*Triodia basedowii*	
POACEAE	*Triodia longiceps*	
POACEAE	*Triodia pungens*	
POACEAE	*Triodia schinzii*	
POACEAE	*Triodia spicata*	
POACEAE	*Tripogon loliiformis*	
POLYGONACEAE	*Muehlenbeckia cunninghamii*	
POLYGONACEAE	*Muehlenbeckia florulenta*	
PORTULACACEAE	*Calandrinia eremaea*	
PORTULACACEAE	*Portulaca filifolia*	
PORTULACACEAE	*Portulaca oleracea*	
PROTEACEAE	*Grevillea striata*	
PROTEACEAE	*Grevillea wickhamii*	
PROTEACEAE	*Hakea lorea* subsp. *indeterminate*	
PROTEACEAE	*Hakea macrocarpa*	
RHAMNACEAE	*Ventilago viminalis*	
RUBIACEAE	*Oldenandia mitrasacmoides*	
RUBIACEAE	*Psydrax latifolia*	
RUBIACEAE	*Synaptantha tillaeacea*	
SANTALACEAE	*Anthobolus leptomerioides*	
SANTALACEAE	*Exocarpos sparteus*	
SANTALACEAE	*Santalum lanceolatum*	
SAPINDACEAE	*Atalaya hemiglauca*	
SAPINDACEAE	*Dodonea viscosa* subsp. *angustissima*	
SAPINDACEAE	*Dodonaea coriacea*	
SCROPHULARIACEAE	*Eremophila freelingii*	
SCROPHULARIACEAE	*Eremophila gilesii* subsp. *gilesii*	
SCROPHULARIACEAE	*Eremophila latrobei* subsp. *glabra*	
SCROPHULARIACEAE	*Eremophila latrobei* subsp. *latrobei*	
SCROPHULARIACEAE	*Eremophila longifolia*	
SOLANACEAE	*Solanum centrale*	
SOLANACEAE	*Solanum chippendalei*	

Family	Species	Exotic
SOLANACEAE	*Solanum ellipticum*	
SOLANACEAE	*Solanum quadriloculatum*	
SURIANACEAE	*Stylobasium spathulatum*	
VERBENACEAE	*Dicrastylis lewellinii*	
VIOLACEAE	*Hybanthus aurantiacus*	
ZYGOPHYLLACEAE	*Tribulus terrestris*	*
ZYGOPHYLLACEAE	*Tribulus angustifolium*	

Appendix C Risk Assessment

Risk Assessment

Risk is expressed and assessed in terms of a combination of the consequence of an event and the associated likelihood of occurrence.

A “real chance or probability” of a significant impact from a particular source is defined as there being an extreme or high risk of a population (or the fauna community) experiencing of a significant consequence as defined in the guidelines e.g. reduce the diversity or modify the composition of plant and animal species in a National Heritage place.

The initial levels of risk and determination of residual risk (after avoidance, mitigation and management actions have been applied) have been undertaken using standard qualitative risk assessment procedures consistent with AS/NZS ISO 31000:2009 ‘Risk Management – Principles and guidelines’, with the exception of economic risk which is not addressed in the guidelines.

Assessment of risk has been conducted through consideration of the circumstances around risks, identifying necessary controls to address potential impacts and assuming effective implementation of planned and committed mitigation of potential impacts. Avoidance, mitigation and management actions are proposed in an attempt to reduce residual risk (risk after actions) where possible to below “Extreme” or “High” risk outcomes to the extent reasonably practicable as part of reducing the overall project risk profile.

The depth of focus on risk controls is linked to the level of risk and opportunity for reduction to meet organisational commitments and goals linked to an environmentally and socially responsible operation, and those requirements are part of the regulatory obligations and impact assessment guidelines.

Table 1 provides a summary of the qualitative risk matrix adopted and the levels of risk for the various consequence and likelihood combinations

Table 1 Qualitative Risk Analysis Matrix

		Severity of Consequence				
Likelihood of Consequence	**Likelihood**	**Critical (5)**	**Major (4)**	**Significant (3)**	**Moderate (2)**	**Minor (1)**
	Almost Certain (5)	Extreme	Extreme	High	High	Medium
	Likely (4)	Extreme	High	High	Medium	Medium
	Possible (3)	Extreme	High	Medium	Medium	Low
	Unlikely (2)	High	Medium	Medium	Low	Very Low
	Rare (1)	Medium	Medium	Low	Low	Very Low

A brief description of each risk classification and the likely responses is provided below.

Extreme

Represent unacceptable risks primarily critical in nature in terms of consequences (e.g. extensive and long term environmental harm, permanent sacred site damage, fatality, massive economic impacts) that are considered a possibility through to almost certain to occur. Such risks significantly exceed the risk acceptance threshold and require comprehensive control measures, and additional urgent and immediate attention towards the identification and implementation of measures necessary to reduce the level of risk.

High

Typically relate to significant to critical consequences (e.g. a major amount of environmental or heritage damage, and considerable safety, social or economic impacts) that are inclined to cut across the possible to almost certain likelihood ratings. These are also likely to exceed the risk acceptance threshold and although proactive control measures have been planned or implemented, a very close monitoring regime and additional actions towards achieving further risk reduction is required.

Medium

As suggested by the classification, medium level risks span a group of risk combinations varying from relatively low consequence / high likelihood to mid-level consequence / mid-level likelihood, to relatively high consequence / low likelihood scenarios across environmental, social and economic areas. These risks are likely to require active monitoring as they are positioned on the risk acceptance threshold.

Low

These risks are below the risk acceptance threshold and although they may require additional monitoring in certain cases are not considered to require active management. In general such risks represent relatively low likelihood and low to mid-level consequence scenarios.

Very Low

Such risks are below the risk acceptance threshold and would at the most require additional monitoring and in many cases would not require active management. These risks can include unlikely to rare events with minor consequences and in essence relate to situations around very low probabilities of relatively minor impacts occurring.

Definitions of likelihood are provided in Table 2. Likelihoods are categorised around the probability of occurrence, within the context of reasonable timeframes and frequencies given the nature of the anticipated Project life. Table 3 describes the types of consequences that have been identified and assessed as part of the risk assessment process.

Table 4 summarises Project risks to flora and vegetation.

Table 2 Definition of level of likelihood

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances (The event is likely to occur in the next 12 months
Likely	The event will probably occur in most circumstances (The event is likely to occur in the next 1 – 2 years).
Possible	The event might occur at some time (The event is likely to occur in the next 2 – 5 years).
Unlikely	The event could occur at some time (The event is likely to occur in the next 5 – 10 years).
Rare	The event may occur only in exceptional circumstances (The event is not likely to in the next 10 years).

Table 3 Definitions of levels of consequence

Levels of Consequence	Definitions
Critical	Extensive long term environmental harm and/or harm that is extremely widespread. Impacts unlikely to be reversible within 10 years.
Major	Major or widespread, unplanned environmental impact on or off the site. Significant resources required to respond and rehabilitate.
Significant	Significant, unplanned environmental impact contained within the site or minor impact that is off the site.
Moderate	Moderate, unplanned localised environmental impact contained on-site or with negligible off-site impact.
Minor	Minor environmental impact. Any impacts are contained on-site and short term in nature.

Table 4 Project Risk – Flora and vegetation

Source of Impact	Consequence	Minimising, mitigation and management actions	Likelihood	Consequence	Residual Risk
Clearing of 1008 ha of native vegetation (mapped) comprising approximately: - 558 ha of Triodia grassland on sandy plains - 420 ha of Mulga shrubland on sandy red earths - 10 ha of Tall Acacia shrubland on stony quartz - 8 ha of Low open Eucalyptus woodland on limestone - 3 ha of Riparian woodland along watercourses and drainage channels - 5 ha of Low Corymbia woodland on loamy alluvial plains - 4 ha of Low Acacia shrubland on rocky slopes. Additional clearing of 30 ha (unmapped) associated with the borefield and pipelined.	Reduction of terrestrial flora and fauna habitat locally and/or regionally.	Minimise vegetation clearing where practical. Use already-disturbed areas (rather than undisturbed areas) wherever possible (e.g. lay down areas for construction). Staged clearing of vegetation to minimise areas of bare ground and clear land only as required and in accordance with ESCP. Avoid land clearing for construction during the Wet Season. Develop and implement Vegetation Clearing sub plans which include areas not to be cleared (no-go areas). Conduct a preclearance survey to assist in the location of infrastructure in areas that have not been previously surveyed (e.g. borefield, delivery pipeline and borrow pit areas). Weed removal prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site. Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines where possible, with regard to riparian vegetation in drainage lines.	1	3	L
	Adverse impact on habitat critical to the survival of a species or community.		1	4	M
	Fragment or damage habitat important for the conservation of biological diversity.		1	4	M
	Cause a long term reduction in rare, endemic or unique plant populations or species.		1	4	M
	Modification, destruction, removal or isolation of habitat availability or quality such that a threatened species or community is likely to decline.		1	4	M
	Increased likelihood of weed establishment in cleared areas.	Development and implementation of a Weed Management sub-plan as part of the Project CEMP. Weed removal prior to vegetation clearing so that vegetative material would be clean and able to be mulched and reused directly on site.	2	3	M

Source of Impact	Consequence	Minimising, mitigation and management actions	Likelihood	Consequence	Residual Risk
Transport of materials, vehicle movements and inappropriate waste management allows for introduction of new weeds and spread of existing weeds during construction and operation phases.	Modify or inhibit ecological processes.	Development and implementation of a Weed Management sub plan as part of the project CEMP. Environmental inductions for workforce. Minimise exposure of bare soils. Vehicle and equipment wash-down procedures on site.	1	3	L
	Reduce the diversity or modify the composition of plant species.		1	3	L
	Fragment or damage habitat important for the conservation of biological diversity.		1	3	L
	Cause a long term reduction in rare, endemic or unique plant populations or species.		1	3	L
	Fragment, isolate or substantially damage habitat for rare, endemic or unique plant species.		1	3	L
Wind erosion mobilising dust from exposed surfaces, such as from pits, waste dumps, tailings storage facility, laydown areas, stockpiles, roads and sites of vegetation clearing. Drilling, blasting, excavation and materials handling at the Mine Site during operations results in dispersion of particulates and dust from the Mine Site.	Dust deposition leading to disturbance / loss of general terrestrial flora species and vegetation communities.	Development and implementation of a Dust Management Sub-Plan as part of the Project CEMP. Use water carts on roads, wet ore before crushing, use hooded crushers and enclosed HPGR's. Use of dust suppression techniques (i.e. spray trucks). Minimise exposure of bare soils.	2	2	L
	Modify or inhibit ecological processes		2	2	L
	Reduce the diversity or modify the composition of plant species.		2	2	L
	Cause a long term reduction in rare, endemic or unique plant populations or species.		1	4	M
Removal of individuals or habitat for the threatened flora species *Eleocharis papillosa* (Dwarf Desert Spike Rush).	Decrease in the population size of a listed threatened species.	Conduct targeted threatened species searches in areas of suitable habitat. Modify Project elements to avoid impact.	1	4	M

Source of Impact	Consequence	Minimising, mitigation and management actions	Likelihood	Consequence	Residual Risk
Unplanned wildfire.	Modify or inhibit ecological processes.	All welding, cutting and grinding works undertaken require prior approval of an internal hot works permit. All site personnel will be required to undertake fire control training, including the correct use of extinguishers. All vehicles are required to carry a fire extinguisher and two-way radio.	2	2	L
	Reduce the species diversity or modify the composition of plant communities.		2	2	L
	Fragment or damage habitat important for the conservation of biological diversity.		2	2	L
	Cause a long term reduction in rare, endemic or unique plant populations or species.		1	4	M
Alteration to surface water flows caused by construction of roads and hard stands or embankments.	Modify or inhibit ecological processes.	Incorporate engineering controls into road that act to maintain surface water flows (e.g. floodways and culverts). To control surface runoff and avoid erosion of the perimeter embankment of the TSF, surface runoff collector drains will be constructed along the downstream toe of the perimeter embankment.	2	3	M
	Reduce the species diversity or modify the composition of plant communities.		2	3	M
	Fragment or damage habitat important for the conservation of biological diversity.		2	3	M
	Cause a long term reduction in rare, endemic or unique plant populations or species.		1	4	M
Lowering of water table caused by groundwater extraction.	Disturbance to significant vegetation and flora within Mud Hut or Stirling Swamp.	No specific mitigation	1	3	L
	Modify or inhibit ecological processes.		1	4	M
	Reduce the species diversity or modify the composition of plant communities (i.e. Riparian communities or Swamp Vegetation within Anmatyerr North SOCS).		1	3	L
	Fragment or damage habitat important for the conservation of biological diversity.		2	2	L
	Cause a reduction in the population of *Eleocharis papillosa* (Dwarf Spike Rush) at Stirling Swamp.		1	4	M
	Impact on phreatophytic vegetation in the area of borefield groundwater drawdown.	Flora survey to identify presence and distribution of phreatophytic vegetation. Monitor health of phreatophytic vegetation within the area of groundwater drawdown during operations. Consider modifying extraction (rate and distribution) if significant impacts to vegetation occur.	5	2	H

Source of Impact	Consequence	Minimising, mitigation and management actions	Likelihood	Consequence	Residual Risk
Contamination of surface and/or groundwater caused by erosion and sedimentation, hydrocarbon or chemical spills.	Disturbance to significant vegetation and flora within Anmatyerr North SOCS.	Preparation and implementation of an Erosion and Sediment Control Plan as part of the Project CEMP.	1	3	L
	Disturbance of vegetation along Hanson River.	Regular inspection of erosion and sediment control measures, particularly following rainfall events, to ensure their ongoing functionality. Siting of stockpiles away from natural drainage channels. Staged clearing of vegetation to minimise areas of bare ground and clear land only as required and in accordance with ESCP. Avoid land clearing for construction during the Wet Season. Minimise surface water infiltration, water runoff and groundwater seepage. Preparation of a Water Management Plan for construction and operational activities. Runoff from ROM pad, stockpiles and workshops directed to sediment basins. All mining equipment refuelled, serviced and repaired within designated areas outlined for such activity. Constructing adequate bunds around sources of potential contamination, to contain contaminated water in the event of heavy rainfall. Spill clean-up procedures developed and implemented. Personnel trained in the use of spill kits and emergency response procedures.	3	3	M
Failure of TSF.	Destruction of flora and vegetation.	Design according to ANCOLD guidelines including storm water drainage, erosion and sediment controls. Immediate reconstruction of affected area.	1	3	L

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