



Rustlers Roost and Quest 29 Open-Cut Mine Redevelopment

Draft Environmental Impact Statement (EIS)

Sections 5 and 6 - Existing Environment and Risk Assessment

Prepared pursuant to the Environment Protection Act 2019

October 2021

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Document History and Status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	05/09/2021	P.Davey, T.Mitchell	P.Davey	05/09/2021	Draft
B	24/09/2021	S.Ley; T.Mitchell	P.Davey	30/09/2021	Draft
0	22/10/2021	P.Davey	P.Davey	22/10/2021	Final

Distribution of Copies

Version	Date issued	Quantity	Electronic	Issued to
Draft, Rev A	05/09/2021	1	Word	Primary Gold Ltd
Rev B	30/09/2021	1	Word	Primary Gold Ltd
Rev 0	22/10/2021	1	PDF	Primary Gold Ltd

Last Saved:	25 October 2021
File Name:	1001087_Rustlers-Roost-Quest-29-Draft EIS_Final_Oct 2021
Author:	CDM Smith
Project Manager:	Paul Davey
Client:	Primary Gold Ltd (PGO)
Document Title:	Rustlers Roost and Quest 29 Open-Cut Mine Redevelopment: Draft Environmental Impacts Statement (EIS)
Document Version:	Rev 0
Project Number:	1001087

Key Project Terms

Term	Definition
Adaptive Management	Systematic process for incrementally improving management practices by learning from the outcomes of past and current practices.
Carbon in Leach	This process uses a dilute alkaline cyanide solution to leach (dissolve) gold from the ore material. Activated carbon removes gold out of dilute cyanide solution by adsorption (sticking). The leaching agent and activated carbon are added together in a slurry of ore and water.
Development Envelope	Defined as the maximum area within which the Project footprint could occur. The development envelope for the Project encompasses 790 ha, inclusive of Rustlers Roost, Quest 29, the accommodation camp and haul road.
Environmental Aspect	An element of the Primary Gold's activities, products or services that can interact with the environment.
Environmental Impact	Change to the environment whether adverse or beneficial, wholly or partially resulting from the Primary Gold's environmental aspects. Environmental impacts can be caused directly or indirectly from a Project activity or cumulatively with other non-Project related activities in a set area.
Environmental Factor	The NT EPA listed environmental objectives to identify environmental matters that have value to the Northern Territory and that need to be protected; and to state the objective to be achieved for each matter. The NT EPA has prepared these environmental objectives and organised these in structured divisions of the environment, called environmental factors.
Existing Disturbance Footprint	Defined as the direct disturbance area from known historical activities associated with the Rustlers Roost, Quest 29, accommodation camp and haul road areas. For Rustlers Roost and Quest 29 this is taken from the existing Mine Management Plans. The existing direct disturbance footprint encompasses 169.4ha within the development envelope.
Heap Leach Pad	Existing areas where historic mining placed ore for processing via a leaching solution to dissolve and capture the mineral. The pads contain the remaining material.
Maximum Vegetation Clearing Extent	The maximum extent of native vegetation clearing proposed for the Project based on mapped vegetation extent layers which account for historic anthropogenic disturbances to the development envelope (e.g. historic mining and pastoral activities). This area constitutes a total of 368.86 ha.
Project	The Project includes the expansion of existing pits, waste rock landforms, water storage dams and internal roads in both the Rustlers Roost and Quest 29 MLs. Two new pits will be constructed at Rustlers Roost and new infrastructure includes an onsite processing plant, a tailings storage facility, a landfill, laydown area, magazine, administration office, accommodation camp and groundwater bores for water supply. The Project is inclusive of an expanded connecting haul road between the non-contiguous extraction areas and an accommodation camp.
Project Area	The Project area is defined as wholly including ML1083 (Rustlers Roost), ML 29783 (Quest 29), ML 29814 (accommodation camp) and the connecting haul road. The entire Project area covers 1,143.25 ha.
Direct Disturbance Footprint	Defined as the direct disturbance area based on the current proposed infrastructure and material placement inclusive of Rustlers Roost, Quest 29, the accommodation camp and haul road. This area covers both historically disturbed and undisturbed areas. The disturbance footprint encompasses 532.84 ha within the Project area.
Significant Impact	A significant impact of an action is an impact of major consequence having regard to: (a) the context and intensity of the impact; and (b) the sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact.
Study Area	Refers to the area of survey or investigation for a specific study. This area may be beyond the Project area or development envelope.
Tailings Storage Facility	A specially engineered and constructed impoundment into which tailings (residue) from the ore processing plant is deposited for placement in perpetuity. The storage facility is constructed with confining embankments consisting of earthen material (e.g. rock and soil) and capped following closure.
Waste Rock Dump	An engineered and constructed impoundment into which overburden from the mining process is placed for safe storage in perpetuity.

Acronyms, Abbreviations and Units

Abbreviation, Acronym or Unit	Definition
\$m	Million dollars
%	Percentage
+ve	Assessment of positive
μS	Microsiemens
4WD	Four-wheel drive
AADT	Average Annual Daily Traffic
AAS	Atomic Absorption Spectrophotometer
AAPA	Aboriginal Areas Protection Authority
AARL	Anglo American Research Laboratory
ABS	Australian Bureau of Statistics
AE	Aquatic Ecosystems
AEP	Annual Exceedance Probability
AFANT	Amateur Fishermen's Association of the Northern Territory
AHD	Australian Height Datum
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practicable
AMD	Acid and Metalliferous Drainage
ANC	Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
ANFO	Ammonium Nitrate
ANZG	Australia and New Zealand Government
ARI	Average Recurrence Interval
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
ASRIS	Australian Soil Resource Information System
ASX	Australian Stock Exchange
AS/NZS	Australian/New Zealand Standards
AUSRIVAS	Australian River Assessment System
BESS	Battery Energy Storage System
BoM	Bureau of Meteorology
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
Bq	Becquerel
BUD	Beneficial Use Declaration
CAD	Computer-Aided Design
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CE	Community and Economy
CEO	Chief Operating Officer
CH ₄	Methane

Abbreviation, Acronym or Unit	Definition
CIL	Carbon in Leach
CO ₂	Carbon Dioxide
CO ₂ -e	Carbon Dioxide Equivalent
COPC	Contaminant of Potential Concern
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSL	Compact Soil Liner
CSM	Conceptual Site Model
C&D	Construction and Demolition
C&I	Commercial and Industrial
DAWE	Department of Agriculture, Water and Environment (Cth) (current)
DEPWS	Department of Environment, Parks and Water Security (NT) (current)
DGV	Default Guideline Value
DIDO	Drive-in Drive-out
DITT	Department of Industry, Tourism and Trade (NT) (current)
DIWA	Directory of Important Wetlands of Australia
DO	Dissolved Oxygen
DotE	Department of the Environment (Cth) (former)
DotEE	Department of the Environment and Energy (Cth) (former)
EC	Electrical Conductivity
EH&S	Environment, Health and Safety
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment Protection Licence
EP Act	<i>Environment Protection Act 2019</i>
ERA	Energy Resources of Australia
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically Sustainable Development
GDE	Groundwater Dependent Ecosystem
GGAP	Greenhouse Gas Abatement Plan
GHG	Greenhouse Gas
GJ	Gigajoule
GL	Gigalitre (1,000 Megalitres)
GPS	Global Positioning System
GRP	Gross Regional Product
GST	Goods and Services Tax
g/t	Grams Per Tonne
GV	Guideline Value
GWP	Global Warming Potential
ha	Hectare

Abbreviation, Acronym or Unit	Definition
HDPE	High Density Polyethylene
HEC-HMS	Hydrologic Modelling System
HFC	Hydrofluorocarbons
HP	Hydrological Processes
HSE	Health, Safety and Environment
IAP2	International Association for Public Participation
IBC	Intermediate Bulk Container
ID	Identification
IECA	International Erosion Control Association
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Provider
ISO	International Organisation for Standardisation
IWEQ	Inland Water Environmental Quality
JORC	Joint Ore Reserve Committee
kL	Kilolitre
km	Kilometre
km ²	Square Kilometre
kV	Kilovolt
L	Litre
L/s	Litre Per Second
LED	Light Emitting Diode
LiDAR	Light Detection and Ranging
LNG	Liquefied Natural Gas
LOM	Life-of-Mine
LPG	Liquefied Petroleum Gas
M	Million
m	Metre
m ²	Metre squared
m ³	Cubic metre
mAHD	Metres Australian Height Datum
mBGL	Metres Below Ground Level
MCP	Mine Closure Plan
MEDLI	Model for Effluent Disposal Using Land
mg	Milligram
ML	Mining Lease (Granted)
MLA	Mining Lease Application
mm	Millimetre
MMP	Mining Management Plan
MNES	Matter of National Environmental Significance
MP	Management Plan
mRL	Metres Reduced Level
Mt	Million Tonnes

Abbreviation, Acronym or Unit	Definition
Mtpa	Million Tonnes Per Annum
MW	Megawatt
N ₂ O	Nitrous Oxide
NAF	Non-Acid Forming
NAPP	Net Acid Producing Potential
N/A	Not Applicable
NGER Act	<i>National Greenhouse Energy Reporting Act 2007</i>
NLC	Northern Land Council
NMD	Neutral Mine Drainage
NORM	Naturally Occurring Radioactive Material
NOI	Notice of Intent
NO ₂	Nitrogen Dioxide
NSESD	National Strategy for Ecologically Sustainable Development
NT	Northern Territory
NTG	Northern Territory Government
NTU	Nephelometric Turbidity Unit
NT Act	<i>Native Title Act 1993</i>
NVIS	National Vegetation Information System
OPEX	Operational Expenditure
PAF	Potentially Acid Forming
PASS	Potential Acid Sulfate Soil
PER	Public Environmental Report
PET	Plecoptera, Ephemeroptera and Trichoptera
PFC	Perfluorocarbon
PGO	Primary Gold Limited, a wholly owned subsidiary of Hanking Australia Investment Pty Ltd
PMF	Probable Maximum Flood
PMLU	Post Mining Land Use
PMST	Protected Matter Search Tool
PPL	Perpetual Pastoral Lease
Q	Quarter
RL	Reduced Level
RMP	Risk Management Plan
RO	Reverse Osmosis
ROM	Run of Mine
RRMPL	Rustlers Roost Mining Pty Ltd
RSWL	Reduced Standing Water Level
SA	Statistical Area
SD	Saline Drainage
SDS	Safety Data Sheet
SEP	Stakeholder Engagement Plan
SEIFA	Socio-Economic Indexes for Areas
SF ₆	Sulfur Hexafluoride
SGV	Site-Specific Guideline Value

Abbreviation, Acronym or Unit	Definition
SIGNAL	Stream Invertebrate Grade Number – Average Level
SoBS	Site of Botanical Significance
SoCS	Site of Conservation Significance
SSAN	Security Sensitive Ammonium Nitrate
SSC	State Suburb Code
SSTV	Site-Specific Trigger Values
STP	Sewage Treatment Plant
SWGs	Stock Water Drinking Guidelines
SWL	Standing Water Level
t	Tonne
TAMS	Territory Asset Management Services
TARP	Trigger Action Response Plan
TBD	To Be Determined
TE	Terrestrial Ecosystems
TEC	Threatened Ecological Community
TEQ	Terrestrial Environmental Quality
Th	Thorium
TN	Total Nitrogen
ToR	Terms of Reference
TP	Total Phosphorus
TPWC Act	<i>Territory Parks and Wildlife Conservation Act 1976</i>
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
TSSC	Threatened Species Scientific Committee
U	Uranium
UC	Uncertain
V	Volt
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WCD	Water Control District
WDL	Waste Discharge Licence
WMP	Water Management Plan
WONS	Weed of National Significance
WRD	Waste Rock Dump
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Section 5 Existing Environment

This section provides an overview of the existing environmental values, important sites and features present within the Project area and surrounds. Where relevant, these are described in detail in subsequent sections for the particular environmental factors pertinent to this Draft EIS.

5.1 Natural Environment

5.1.1 Geology

The Project area is located within the Pine Creek Geosyncline, which consists of an extensive but poorly exposed sequence of low to medium metamorphic grade, early Proterozoic sediments (pellites and psammites) deposited in a shallow intra-cratonic geosyncline that overlies a late Archean granitic basement. The Pine Creek inlier can be divided into five sub-regions: Litchfield Province, Rum Jungle Region, Central Region, South Alligator Valley and Alligator River (Ahmed 1998). Pine Creek is a metamorphosed and deformed Palaeoproterozoic sequence of pellites and psammites (silty and sandy sediments), with minor carbonate sediments and volcanics (Figure 5-1). Dolerite sills intruded into the region (Zamu Dolerite and equivalents) before the metamorphism and deformation (Ahmed 1998).

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

The mineral deposits are predominantly found within the central region where the granitoids dominate the geology. The deposits contain most of the gold, base metal and tin bearing veins as well as stratabound gold and polymetallic deposits (Ahmed 1998). The Pine Creek Inlier gold deposits have been classified into three groups; gold-quartz vein, stratiform gold lenses in iron rich sediments and stratabound zinc-lead-copper-gold-silver lenses (Ahmed *et al.*, 1993). The deposit type sits within sediments of the Wildman Siltstone (sandstone) and locally within Burrell Creek Formation (refer to Figure 5-2) which are a series of Proterozoic turbidite marine sediments.

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

The Quest 29 Project area straddles a prominent anticline structure within Proterozoic meta-sediments which is oriented roughly north-south and plunges gently to the south. The majority of the Project area is covered by the Koolpin Formation (ferruginous siltstone, shale, dolomite), which is exposed along the hinge of the anticline. Regionally, the Koolpin Formation averages 100 m in thickness but ranges up to 200 m in fold hinges. The Koolpin formation is intruded in areas by the Zamu dolerite (massive quartz dolerite). Gold mineralisation is associated with the Koolpin Formation and the Zamu Dolerite.

On the limbs of the anticline along the south-eastern and western edges of the lease exposures of Gerowie Tuff occur, comprising silicified siltstone, argillite, crystal tuff and chert with an average thickness of 600 m. In the north of the lease, the anticline is truncated by the Mount Bundey Granite which outcrops in an extensive batholith. North-east of the Project area the contact between the meta-sediments and the granite is truncated with a major fault (Appendix H).

The Project area is situated over a thick turbidite sequence of the South Alligator Group. The geology is extensively folded, with fold axes aligned on a north-north-east orientation and plunging to the south at a dip of approximately 35 degrees. The Gerowie Tuff outcrops in the northern third of the lease. It comprises silicified siltstone, argillite, crystal

tuff and chert and has an average thickness of 600 m. The Mount Bonnie Formation overlies the Gerowie Tuff and outcrops over the central portion of the lease.

The Mt Bonnie Formation predominantly comprises shales, siltstones and mudstones with minor sandstone, tuff and chert bands. Regionally, it has an average thickness of 650 m. Gold mineralisation is hosted in quartz veins and chert bands within the Mt Bonnie Formation. The Burrell Creek Formation outcrops in the south of the site where it conformably overlies the Mt Bonnie Formation. The Burrell Creek formation consists of a thick sequence of interbedded shale, siltstone, phyllite and greywacke. While small scale faulting is observed in the existing pit walls, there is no evidence of major faulting at Rustlers Roost (Valdora 1994).

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

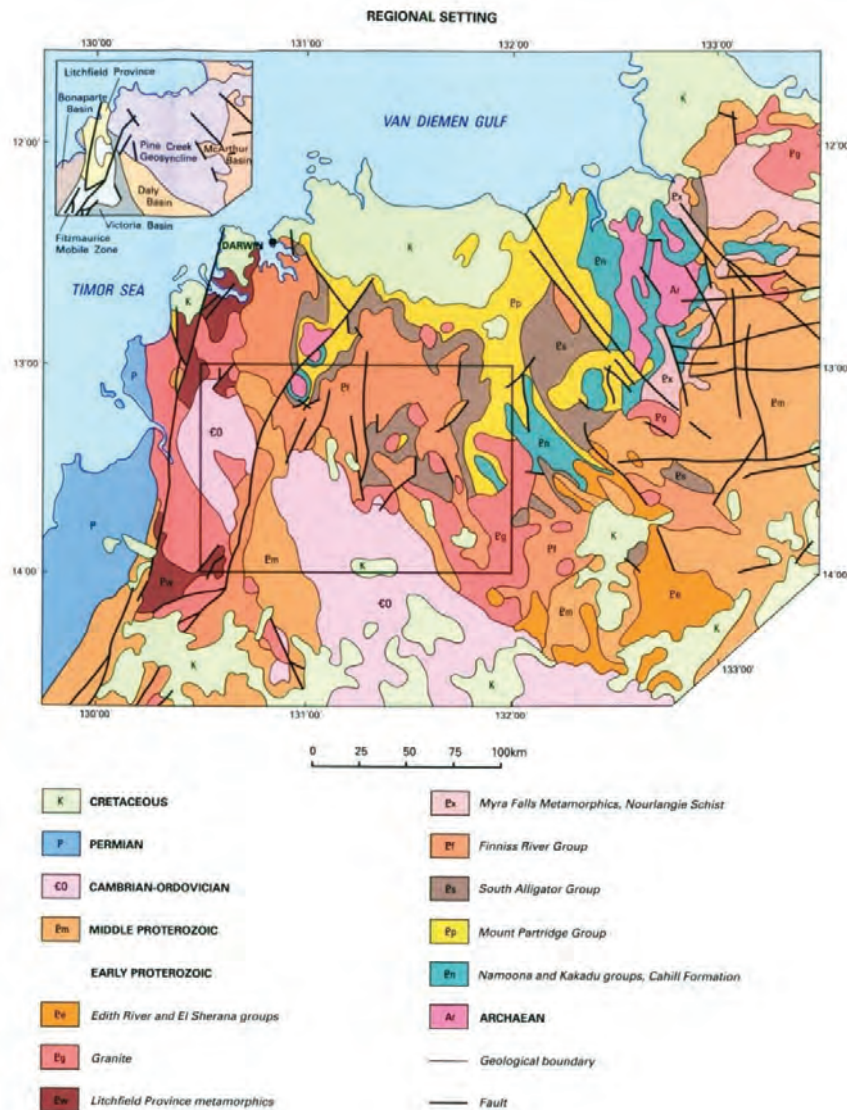


Figure 5-1 Geological Map of the Pine Creek Inlier

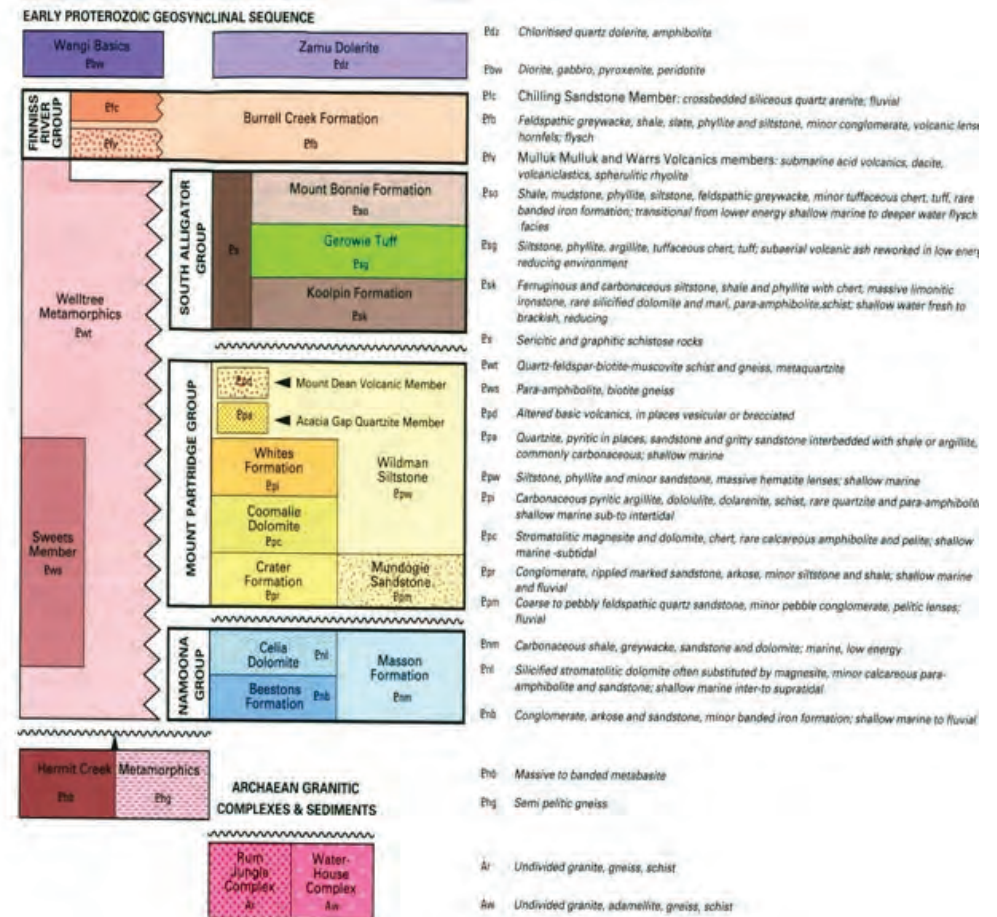
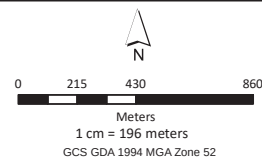


Figure 5-2 Archean to Early Proterozoic Stratigraphy and Lithological Descriptions

R	Details	Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.			
1	First Draft	29/07/21	DESIGNED	TK	CHECKED	TK
-	-	-	DRAWN	TK	CHECKED	TK
-	-	-	APPROVED	TK	DATE	29/07/21
-	-	-	Notes:			



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DATA SOURCE
NT Government Open Source Data

DESIGNER

CDM Smith

CLIENT

PRIMARY GOLD

FIGURE 5-1 and Figure 5-2

DRG Ref: 1001087-EIS-05-5.1+5.2

5.1.2 Landform and Soils

The current condition of the Project area is largely disturbed from past mining activities, with the surrounding area also subject to pastoral activities. Topsoil has been removed and the previously disturbed areas have not been rehabilitated. There is evidence of localised erosion, in particular inspections have recorded erosion around the Rustlers Roost heap leach pad.

The Project area consists of predominantly low hills to rises. The Rustlers Roost and Quest 29 Project area topography and soil type are provided in Figure 5-3. Detailed Project area soil type and land units including in the Rustlers Roost, Quest 29, accommodation camp and haul road are described in Table 5-1 and shown in Figure 7-3 and Figure 7-4 respectively. Mount Bunday, an area of outcropping granite, is a significant landform in the region located approximately 12 km north-east of Rustlers Roost and 7 km north of the Quest 29 ML. Existing vegetation and extensive stone surface outcrops provide land stability; however, land disturbed on slopes $>2\%$ may have increased surface water runoff velocities and consequently a higher erosion risk.

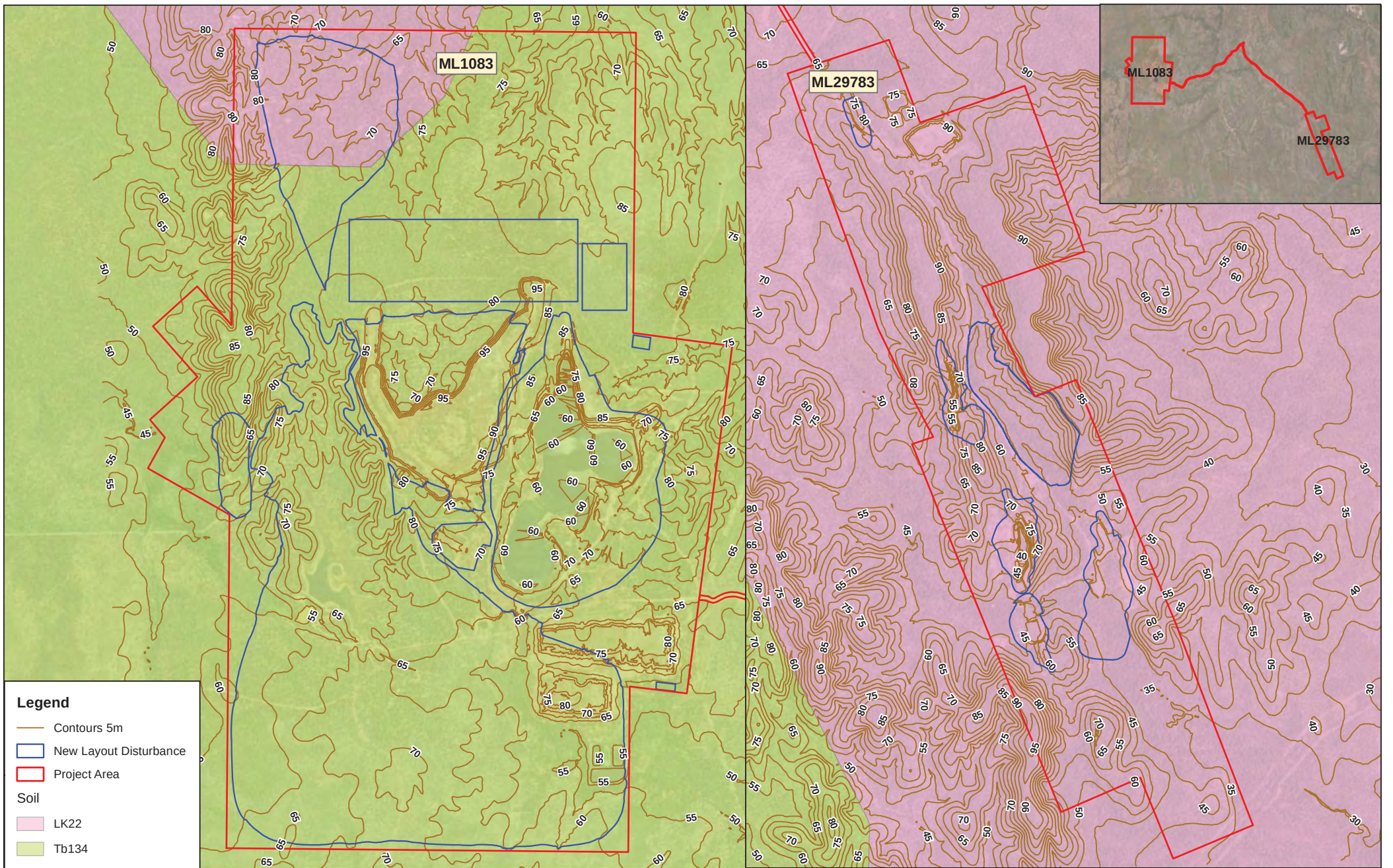
Table 5-1 Land Units of the Project Area

Project Area	Land Unit	Landform Class	Landform Description	Soil	Soil Description	Vegetation Description
Quest 29	2a	Low hills	Rugged terrain associated with siltstones and greywacke of Burrells Creek formation and Upper Proterozoic dolomites and sandstones; relief 10-80m; slopes >10%; surface stone and outcrop extensive.	LK22 - Rudosols	Very shallow stony lithosols.	<i>Corymbia polysciada</i> , <i>Eucalyptus miniata</i> , <i>Corymbia dichromophloia</i> and <i>Erythrophleum chlorostachys</i> woodland/low open woodland with a <i>Chrysopogon fallax</i> , <i>Triodia bitextura</i> , <i>Heteropogon triticeus</i> mixed spp. tussock grass understorey.
Rustlers Roost, Accommodation Camp, Haul Road	2b	Rises	Low hills; ridges same lithologies as 2a; relief between 5-20m; slope gradients between 6-15%; extensive surface stone outcrop.	LK22 and Tb134 - Kandosols	Shallow stony and gravelly lithosols.	<i>Corymbia polysciada</i> , <i>Eucalyptus miniata</i> , <i>Corymbia dichromophloia</i> and <i>Erythrophleum chlorostachys</i> woodland/low open woodland with a <i>Chrysopogon fallax</i> , <i>Triodia bitextura</i> , <i>Heteropogon triticeus</i> mixed spp. tussock grass understorey.
Haul Road	3a	Rises	Low erosional rises, rounded crests and upper slopes <5%; 1-15m relief; occasional outcrop; 30-100% surface gravel.	LK22 and Tb134 - Kandosols	Gravelly yellow brown and yellow lithosols (Burrell 1 & 2) up to 1m deep overlying friable weathered siltstone and greywacke.	<i>Corymbia clavigera</i> , <i>Erythrophleum chlorostachys</i> , <i>Corymbia foelscheana</i> and <i>Calytrix</i> spp. low woodland; minor <i>Eucalyptus tectifica</i> and <i>Corymbia bleeseri</i> woodland; mixed spp. tussock grass understorey.
RustlersRoost, Haul Road	3b	Low Rises	Erosional slopes, commonly below 3a, also below 2b and 2c; slopes <5%; 50-100% siltstone surface gravel.	Tb134 - Kandosols	Gravelly yellow brown and yellow lithosols (Burrell 1 & 2).	<i>Corymbia polysciada</i> , <i>Erythrophleum chlorostachys</i> , <i>Corymbia foelscheana</i> and <i>Calytrix</i> spp. low woodland. Minor <i>Eucalyptus miniata</i> , <i>Eucalyptus tectifica</i> and <i>Corymbia bleeseri</i> woodland.
Accommodation Camp	4a	Low Rises	Colluvial slopes below 3a and 3b; occasionally below 2b in southern areas; slopes <5%; up to 500m wide; relief 10m.	Wd13 - Kandosols	Shallow to moderately deep yellow earths (Battern 1); indistinct mottling in B horizon; scattered low termitaria.	<i>Erythrophleum chlorostachys</i> , <i>Eucalyptus miniata</i> mixed species woodland with <i>Sorghum plumosum</i> , <i>Themeda triandra</i> , <i>Chrysopogon fallax</i> and <i>Heteropogon triticeus</i> tussock grass understorey.
Quest 29	4b	Plains	Colluvial slopes below 3b and 4a above alluvial areas; slopes <2%; commonly 200m to 800m wide; relief <5m.	LK22 - Hydrosols	Moderately deep to deep yellow (Batten 1, Elliot 1 and 2); distinct mottling in sub-soil; minor debil; scattered large termitaria; waterlogged for short periods.	<i>Corymbia polycarpa</i> , <i>Corymbia grandifolia</i> , <i>Vitex glabrata</i> and <i>Lophostemon lactifluus</i> woodland with <i>Sorghum plumosum</i> , <i>Themeda triandra</i> , <i>Chrysopogon fallax</i> and <i>Eriachne burkittii</i> tussock grass understorey.

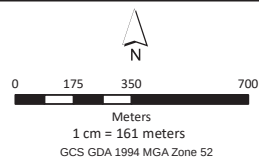
Section 5 Existing Environment

Project Area	Land Unit	Landform Class	Landform Description	Soil	Soil Description	Vegetation Description
Haul Road	5b	Alluvial Plains	Alluvial plains up to 3km wide; negligible slope.	Tb134 - Hydrosols	Mottled yellow duplex (solodic) soils (Bundey, Keppler 1); shallow, hardsetting and pulverulent A horizon over a dense, mottled B horizon; well developed debil debil.	<i>Corymbia polycarpa</i> , <i>Corymbia bella</i> and <i>Corymbia grandifolia</i> open woodland/woodland; minor <i>Melaleuca spp.</i> ; <i>Eriachne burkittii</i> , <i>Chrysopogon setifolius</i> , <i>Themeda triandra</i> mixed tussock grass understorey.
Accommodation Camp, Haul Road	5c	Alluvial Plains	Alluvial plains up to 3km wide; negligible slope.	Tb134 and Wd13 - Hydrosols	Mottled yellow duplex (solodic) soils (Bundey, Keppler 1); shallow, hardsetting and pulverulent A horizon over a dense, mottled B horizon; well developed debil debil; minor grey non-cracking clays on Mary River floodplain.	<i>Eriachne burkittii</i> , <i>Chrysopogon setifolius</i> mixed spp. tussock grassland with sedges.
Quest 29	6a	Creek channel	Rivers and major creeks with associated narrow levees; channels incised up to 6m.	LK22 - Hydrosols	Alluvial yellow and red earths on levees; deep, gradational-textured profiles.	<i>Corymbia bella</i> , <i>Corymbia polycarpa</i> , <i>Ficus racemosa</i> and occasional <i>Melaleuca leucadendra</i> , <i>Alstonia actinophylla</i> , <i>Barringtonia acutangula</i> and Banyan trees mid high woodland to open forest, over <i>Erythrophleum chlorostachys</i> , <i>Terminalia sp.</i> , and <i>Acacia auriculiformis</i> and occasional <i>Planchonia careya</i> open shrubland, over <i>Aristida sp.</i> , and <i>Hyptis</i> mid high open tussock grassland.
Quest 29, RustlersRoost, Accommodation Camp, Haul Road	6a1	Drainagelines	Drainage lines in rugged terrain; narrow (<200m); normally incised to <2m.	LK22, Tb134 and Wd13 - Hydrosols	Yellow earths (Tortilla 2); moderately deep and usually sandy in upper reaches; weakly developed solodics (Bundey 1) in lower reaches towards major alluvials.	<i>Corymbia polycarpa</i> , <i>Corymbia grandifolia</i> , <i>Corymbia bella</i> , <i>Eucalyptus bigalerita</i> and <i>Melaleuca spp.</i> woodland/open forest with <i>Arundinella nepalensis</i> , <i>Eriachne burkittii</i> , <i>Mnesithea sp.</i> mixed species tussock grass understorey.

Source: NTG NR Maps



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DATA SOURCE
NT Government Open Source Data



FIGURE 5-3
Map of Rustlers Roost and Quest 29 Topography and Soils
DRG Ref: 1001087-EIS-07-5.3

5.1.3 Flora and Fauna

5.1.3.1 Flora

The surrounding vegetation within the region of the Project is classified as Eucalyptus woodland under the National Vegetation Information System (NVIS) and as mapped by NR Maps.

Mapped remnant native vegetation makes up 68.78% of the Project area. Ecological surveys undertaken by Low Ecological Services (LES) in 2016 and 2017 mapped the vegetation in the lease areas at a scale of 1:100,000 and found that there are two vegetation types as described by Wilson *et al.* (1990) over the Project area for Rustlers Roost and Quest 29. These vegetation types are described as “Woodlands”, and ‘Low Woodlands’. The vegetation at Rustlers Roost consists entirely of “Woodlands” vegetation dominated by *Eucalyptus tectifica*, *Eucalyptus latifolia* woodland with *Sorghum* grassland understorey which is common in the broader region (LES 2017). The majority of the vegetation type at Quest 29 consists of “Low Woodlands” which is comprised of *Eucalyptus tintinnans* low woodland with *Sorghum* grassland understorey, with a minor portion of the area mapped as “Woodlands”, similar to the Rustlers Roost site (refer to Table 5-2).

Table 5-2 Description of Vegetation Types for Rustlers Roost and Quest 29 Project Areas

Vegetation Unit	Sites	Broad Classification	Structural formation	Fine vegetation Description
15	Rustlers Roost	Eucalyptus with grass understorey	Woodlands	<i>Eucalyptus tectifica</i> , <i>Eucalyptus latifolia</i> woodland with <i>Sorghum</i> grassland understorey
15	Quest 29	Eucalyptus with grass understorey	Woodlands	<i>Eucalyptus tectifica</i> , <i>Eucalyptus latifolia</i> woodland with <i>Sorghum</i> grassland understorey
21	Quest 29	Eucalyptus with grass understorey	Low Woodlands	<i>Eucalyptus tintinnans</i> low woodland with <i>Sorghum</i>

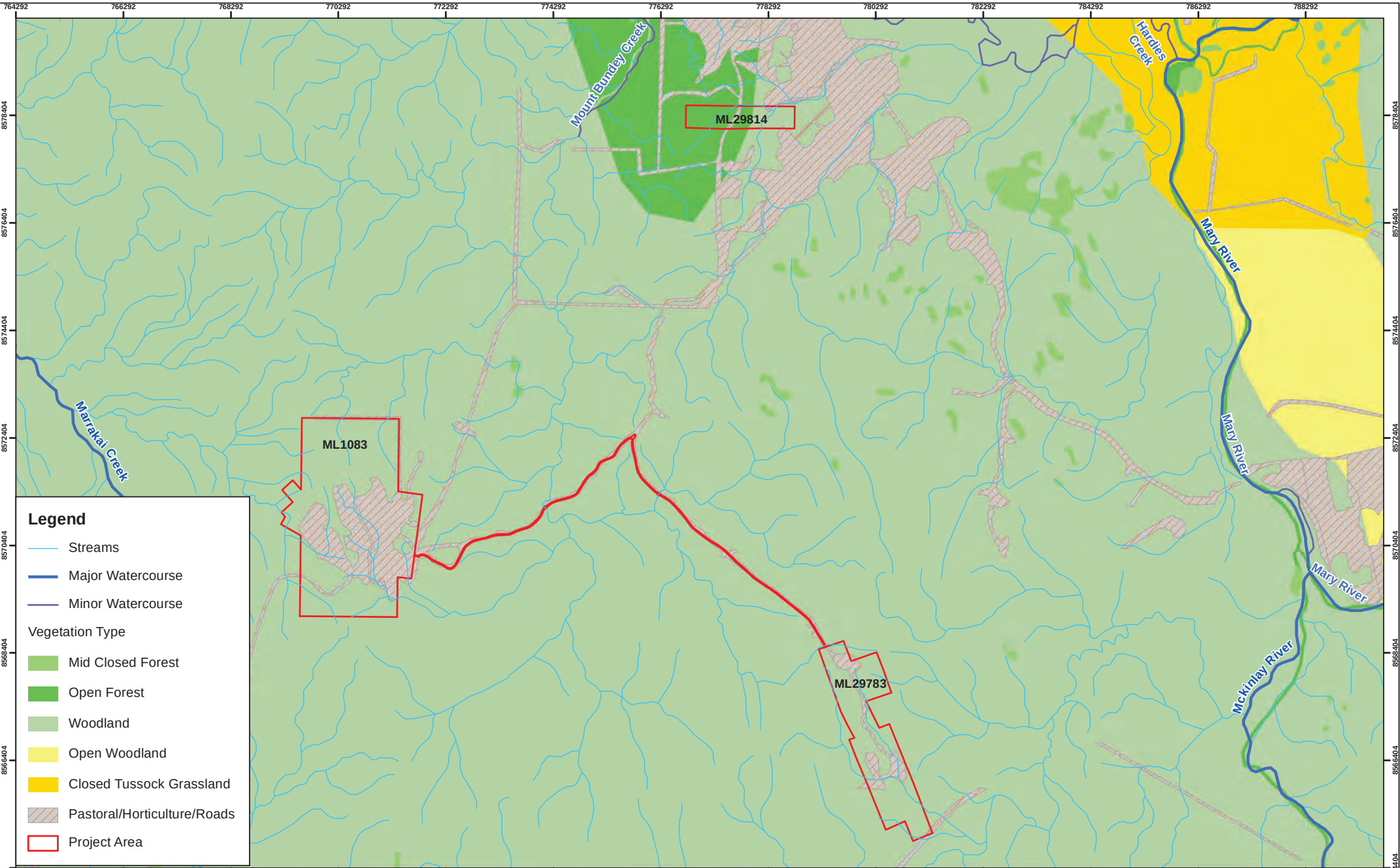
Source: LES (2017)

Surveys undertaken by EcOz Environmental Consultants (EcOz) (2020a) identified riparian habitat present within the Project area. Much of the riparian areas within, and to the east of Rustlers Roost have been disturbed due to previous mining activities, however, during the survey, these areas were found to contain some monsoonal species. Riparian areas to the west of Rustlers Roost were largely intact and weed free (EcOz 2020a). Areas within the Quest 29 Project area were classified as the riparian land unit 6a and comprised of riparian and contained monsoon vine species. Much of these riparian areas have been disturbed by previous clearing and stockpiling of fill material; weeds and feral animals were observed in these areas (EcOz 2020a). Riparian vegetation is common in the region with riparian habitat present downstream of the Project area in Mount Bunday Creek (GHD 2018). The riparian habitat was largely intact along Mount Bunday Creek (GHD 2018).

From interpretation of the NR Maps, four additional riparian vegetation communities were identified as possibly being present at drainage lines that intersect the haul road between Rustlers Roost and Quest 29. These sites were subject of further site survey on 20 August 2021 with one site containing riparian/rainforest species (RP01) with the other sites containing species consistent with open drainage lines (refer to Appendix M).

Habitat modelling indicates that two threatened species, *Helicteres macrothrix* and *Stylidium ensatum* could occur in the Project Area (refer to Figure 7-10). *H. macrothrix* and *S. ensatum* are listed as Endangered under the EPBC Act and the TPWC Act (DoE 2021). Additional targeted surveys for both *H. macrothrix* and *S. ensatum* were completed in 2020 and 2021, for portions of the Project area intersecting modelled potential habitat. Neither were detected and no other threatened flora species were identified as part of these surveys, described further in Section 7.2.

The vegetation survey undertaken by EcOz (2020a) also identified two areas of ‘closed forest’. Closed Forests are considered to be sensitive and significant vegetation types in the NT, as they can be easily impacted by adjacent land-uses or management; or that they are spatially restricted habitat types that play an important role to wildlife (DENR 2020). Vegetation types and riparian areas intersecting and surrounding the Project area are shown in Figure 5-4, and further detail on flora is provided in Section 7.2.



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R	Details	Date		©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.										DISCLAIMER CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.				DESIGNER		CLIENT		FIGURE 5-4					
1	First Draft	13/08/21		DESIGNED		SS		CHECKED		TK						DATA SOURCE NT Government Open Source Data								Vegetation Types and Riparian Areas			
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5.1.3.2 Fauna

Field surveys for fauna were undertaken in the region during November 2016 and May 2017 for the locations of Rustlers Roost and Quest 29 by LES. Rustlers Roost recorded 316 observations of fauna over the 2016 and 2017 survey period, primarily comprised of birds, accounting for 245 of the records. Other groups of animals included amphibians (19 observation), arthropods (2 observations), mammals (28 observations) and reptile (22 observations). Quest 29 recorded a total of 257 fauna observations. Similarly, the survey results were dominated by birds, accounting for 206 observations, followed by mammals (28 observations), reptiles (13 observations), amphibians (8 observations) and arthropods (2 observations). A single location was surveyed at the location of the accommodation camp as part of the Toms Gully Mine Project resulting in a limited number of fauna observations (55) recorded at survey site ST3. Birds accounted for 42 of the observations, with five observations of amphibians, seven mammals and one reptile. No arthropods were recorded at survey site ST3.

During the field surveys, five fauna species classified under the TPWC Act as threatened, near threatened and data deficient were recorded during the 2016 and 2017 field surveys (LES 2017). The NT threatened species included the Merten's water monitor (*Varanus mertensi*) recorded at Rustlers Roost in 2017. Two near threatened species were recorded at Rustlers Roost in 2017; these were the orange leaf-nosed bat (*Rhinonictis aurantia*), and Arnhem sheath-tailed bat (*Taphozous kapalgensis*). Two data deficient species were recorded. These were the red-cheeked dunnart (*Sminthopsis virginiae*), and black-spotted ridge-tailed monitor (*Varanus baritji*), both species were recorded during the 2016 survey at Rustlers Roost. No fauna species listed as migratory were recorded during either survey (LES 2017).

The survey effort undertaken by LES during November 2016 and May 2017 (Appendix K) was targeted towards the conservation significant species and habitats, as well as introduced flora and fauna species. These included the Black-footed tree-rat (*Mesembriomys gouldii gouldii*); Bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniat*); Northern quoll (*Dasyurus hallucatus*); Fawn antechinus (*Antechinus bellus*); Pale field-rat (*Rattus tunneyi*); Yellow spotted monitor (*Varanus panoptes*), Mitchell's water monitor (*Varanus mitchelli*); Partridge pigeon (*Geophaps smithii smithii*); Red goshawk *Erythrorchis radiatus*) and Gouldian finch (*Erythrura gouldiae*). It is acknowledged that despite the survey efforts, it is possible that some species of significance may be present but have not been detected to date. The two species of particular concern highlighted by the NT EPA were the Yellow-snouted gecko (*Lucasium occultum*) and the sub-shrub *H. macrothrix* (LES 2017).

Six species of introduced fauna were recorded during the November 2016 and May 2017 field surveys. These were cane toads, horses, house mice, cattle, water buffalo and pigs. Feral cats are also known to be present in the area, however, none were recorded during the field surveys.

Due to the historic disturbance, the Project area is considered unlikely to support any important fauna populations. The disturbance has reduced the potential food source, shelter and potential breeding sites for threatened species common in the region (LES 2016).

5.1.4 Hydrology

The Project area traverses two river basins (Adelaide River and Mary River) and three sub-catchments. The Rustlers Roost portion of the Project area is predominantly located in the upper Mount Bunday Creek sub-catchment of the Mary River system. A portion of the western section of Rustlers Roost is located in the Marrakai Creek sub-catchment of the Adelaide River system (refer to Figure 5-5 and Figure 5-6). The Rustlers Roost portion of the Project area has only a small external catchment area, measured at approximately 2.2 km². This means that the Rustlers Roost area is unlikely to be affected by riverine flooding (i.e. flooding generated from further upstream), and that the dominant flooding mechanism is expected to be the rapid generation of overland flow in response to local catchment rainfall.

The Quest 29 area of the Project is predominantly located in the McKinlay River sub-catchment, which also flows into the Mary River system. A minor northern portion of Quest 29 is located in the upper Mount Bunday Creek sub-catchment of the Mary River system as is the haul road and accommodation camp (refer to Figure 5-5 and Figure 5-6).

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

The landscape has been altered due to prior mining and processing operations at both mining sites within the Project area. There are two permanent water bodies located at the Rustlers Roost site – the pit lake and Annie’s Dam, while there are six permanent waterbodies at the Quest 29 site consisting of the five historic pits and the heap leach ponds. Water stored in the pits is a combination of stormwater runoff, incidental rainfall and (possibly) groundwater, whilst Annie’s Dam is a combination of predominantly stormwater runoff and incidental rainfall.

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

5.1.4.1 Mount Bunday Creek – Mary River

During the wet season, drainage lines downstream of both Rustlers Roost and Quest 29 sites discharge to the north into the receiving Mount Bunday Creek, which flows into the main branch of the Mary River approximately 35 km downstream. Mount Bunday is an ephemeral creek that has limited flow and contains isolated pools during the dry season (Primary Gold 2020). The creek flow is dependent on localised rainfall and historically the creek flows for 3-4 weeks annually (Primary Gold 2020). The creek is utilised primarily when flowing by the Mount Bunday Station Pastoralist for livestock drinking water and supports aquatic flora and fauna at the upper and lower sections of the creek.

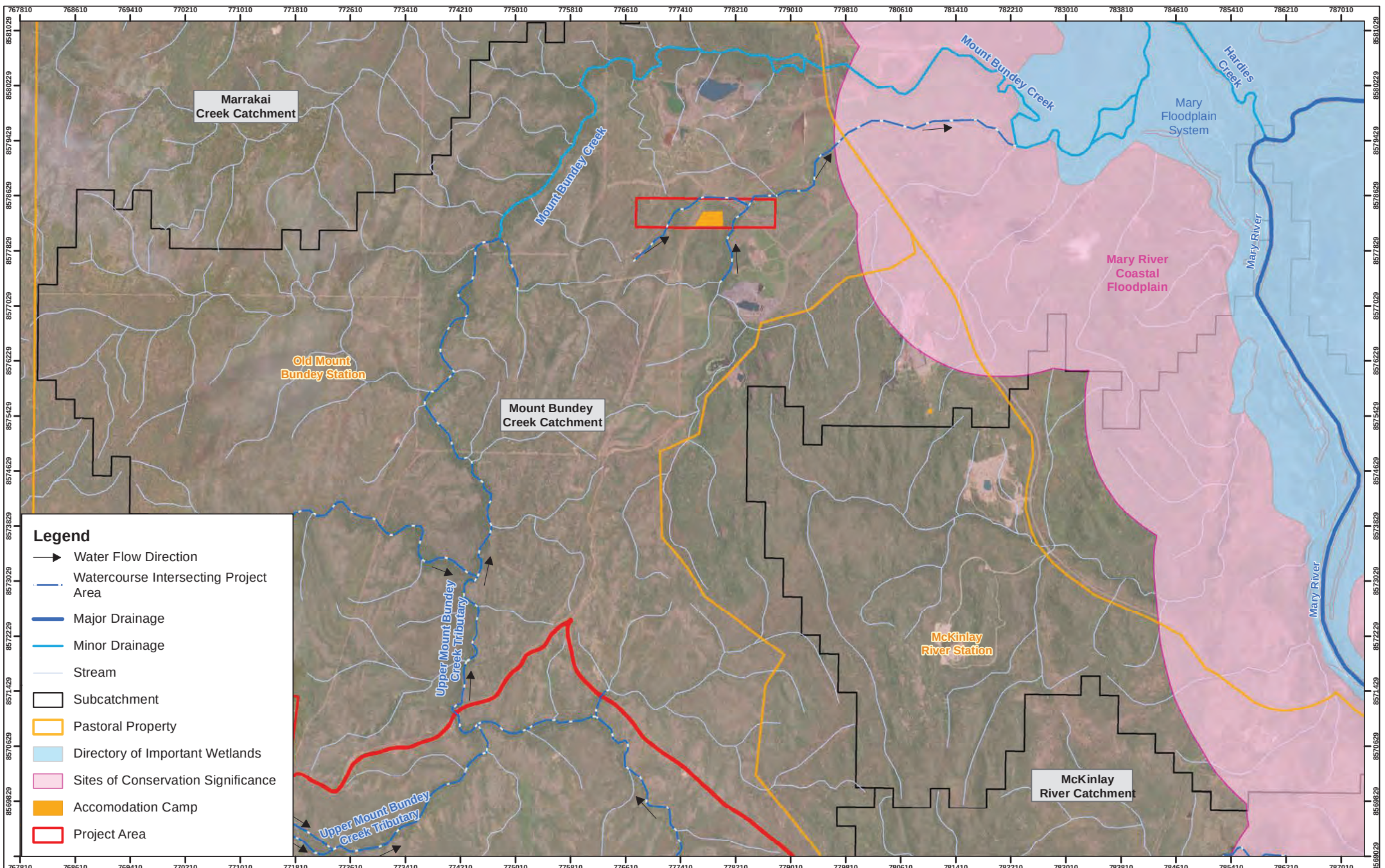
Mount Bunday Creek and the Mary River main branch are considered important watercourses, with beneficial uses declared under the *Water Act 1992*. The declared beneficial uses for Mount Bunday Creek are for stock water supply for approximately a 7 km section at the Arnhem Highway flowing north-east (approximately 25 km downstream of the Project area), and aquatic ecosystems protection for the remainder (approximately 30 km downstream of the Project area). The declared beneficial uses and objectives for the Mary River region is for environment, riparian and cultural uses. Sections of Mount Bunday Creek and the Mary River downstream of the Project area are protected in the Mary River National Park (refer Section 5.2.4).

5.1.4.2 McKinlay River – Mary River

The majority of the Quest 29 mine site (eastern and southern parts) are located in the McKinlay River catchment. Unnamed ephemeral drainage lines downstream of the site discharge to the east through floodplains towards the McKinlay River main branch, which is approximately 15 km downstream of the Project area. From this location, the McKinlay River flows north and discharges to the Mary River at a location 2 km upstream from the Arnhem Highway Mary River Bridge.

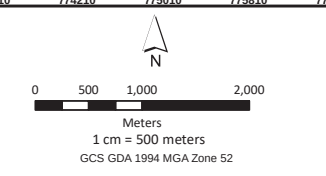
5.1.4.3 Marrakai Creek – Adelaide River

The headwaters of Marrakai Creek, a tributary of the Adelaide River, is located downstream of the western parts of the Rustlers Roost mine site. The site is approximately 37 km upstream of the Adelaide River confluence. The Adelaide River and associated floodplain system is considered environmentally significant, and an overview of the system is provided in Section 5.2.6.



- Legend**
- Water Flow Direction
 - Watercourse Intersecting Project Area
 - Major Drainage
 - Minor Drainage
 - Stream
 - Subcatchment
 - Pastoral Property
 - Directory of Important Wetlands
 - Sites of Conservation Significance
 - Accommodation Camp
 - Project Area

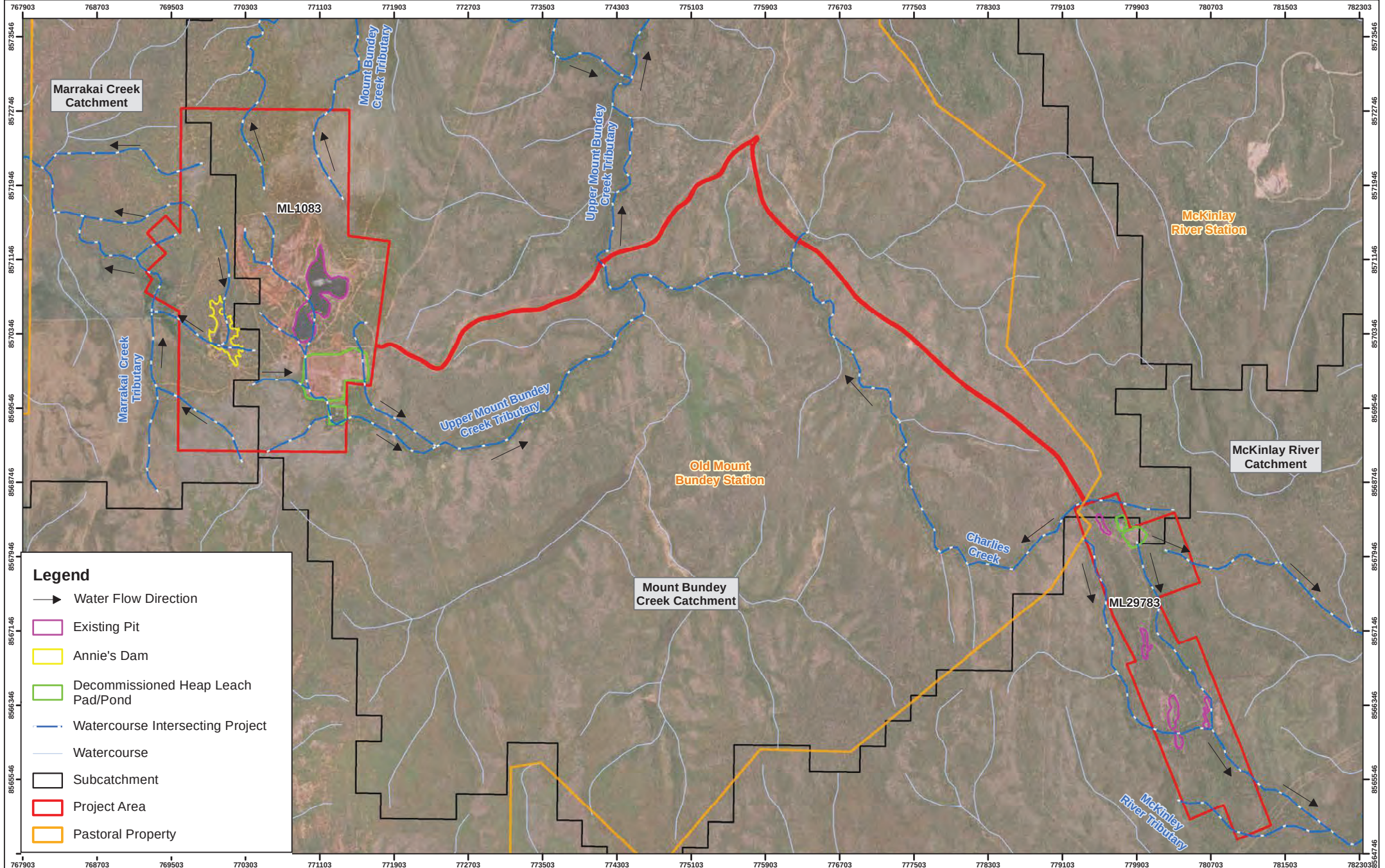
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DATA SOURCE
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DESIGNER	CLIENT	FIGURE 5-5
		Map of Project Area Hydrology (North)
		DRG Ref: 1001087-EIS-05-5.5



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5.1.5 Groundwater

The regional groundwater system is comprised of intermediate-scale aquifers associated with unconsolidated sediments and local-scale aquifers associated with fractured and weathered rocks with minor groundwater resources (Tickell 2019). The Site is situated near the northern flank of the Pine Creek Geosyncline. Aquifers, where they occur, are typically associated with increased structural deformation of the metasediments and are recharged by direct infiltration of rainfall and stream run-off. A single monitoring well (MB01) is located on the Rustlers Roost site, immediately downstream of the heap leach pad (Figure 7-31).

Groundwater monitoring provides the following observations:

- The water table typically occurs within basement rocks, and in Cainozoic sediments where they occur in topographic lows;
- Apart from the earliest field measurements of physico-chemical parameters, EC and pH remain relatively stable between wet and dry seasons;
- With the exception of aluminium, many of the dissolved metals display a reducing concentration trend that may be associated with wet season recharge; and
- Groundwater quality is similar to end of dry season surface water quality, potentially indicating groundwater and surface water connectivity.
- Available site data indicates the following regarding groundwater flows:
 - Aquifer transmissivity ranges between 80 and 110 m²/d; and
 - Aquifer storativity ranges between 10⁻⁵ and 2x10⁻³.

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

The majority of the Project area lies within the declared beneficial uses and objectives area of the Mary River. The beneficial use and objectives apply to both surface water and groundwater. The beneficial uses of groundwater are for environmental, riparian and agricultural uses. The surface water is for environmental, riparian and cultural uses. This section of the region is not within a Declared Water Control District (WCD) or Management Zone. Further information regarding Project area specific groundwater flows is provided in Section 7.3.

There are no mapped groundwater dependent ecosystems (GDEs) that intersect any portions of the Project area. The Bureau of Meteorology (BoM) GDE Atlas classifies the Mount Bunday, Marrakai Creek and Mary River system as having a moderate to high potential for aquatic and terrestrial GDE occurrence. The closest mapped potential GDE (an aquatic inflow dependent ecosystem) is a layer covering Mount Bunday Creek, approximately 80 m north (downstream) of the existing haul road bridge and 40 m from the Project area. There is a low-moderate potential for terrestrial GDEs, at two locations approximately 2-3 km downstream, north-east of Rustlers Roost, and one low potential terrestrial GDE, approximately 5 km downstream, north-west of the Quest 29 portion of the Project area.

5.1.6 Climate

The climate of the Darwin Katherine region is tropical monsoonal with two distinct seasons; a dry season (May to October) and wet season (November to April). The annual rainfall occurs predominantly in the wet season, with rainfall

intensities typically being high. During the dry season there can be no rainfall for six months or more; surface water resources gradually diminish and groundwater levels drop.

There are on average 7.7 days per season when a cyclone is present. These cyclones and associated winds may affect the site. The rainfall is affected by the cyclones, with 95% of the annual rainfall arriving in the region between December and March (typical cyclone season). This wet season can deliver 1,511 mm/yr on average (as recorded at Toms Gully Mine, EcOz 2020b).

Climate observations are made by the BoM. The Middle Point Rangers Station (Station no. 014090) is the closest BoM weather monitoring station to the Project area, located approximately 40 km south-west of the Project area and where data have been collected since 1957. Average annual rainfall recorded at this station is 1,420.0 mm (1957 to 2021) with the highest rainfall occurring in January and the lowest in July. The average annual regional evaporation is 2,400 mm and exceeds the average annual rainfall (refer to Figure 5-7). Evaporation is highest in October and lowest in February. Refer to Figure 5-8 for mean monthly rainfall (1957 to 2021) and evaporation data (1965 to 1998). The intensity frequency duration curves for the Project area are provided in Figure 5-9.

The hot dry-wet transition occurs from October to November where humidity can be high and winds can be variable. The mean daily maximum temperature on site is reportedly 31.3°C in the cooler months and 35.6°C in the hotter months. Refer to Figure 5-10 for mean monthly maximum and minimum temperature data (1965 to 1998).

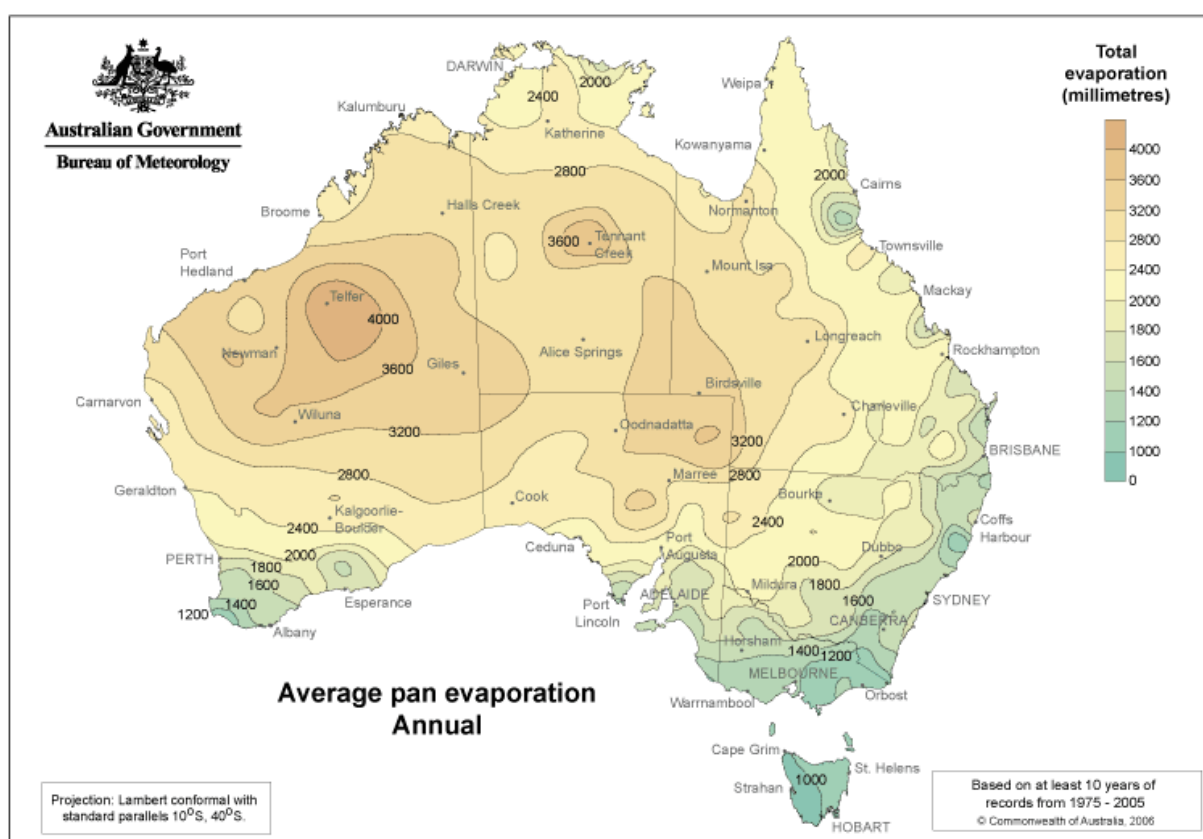


Figure 5-7 Annual Regional Average Evaporation

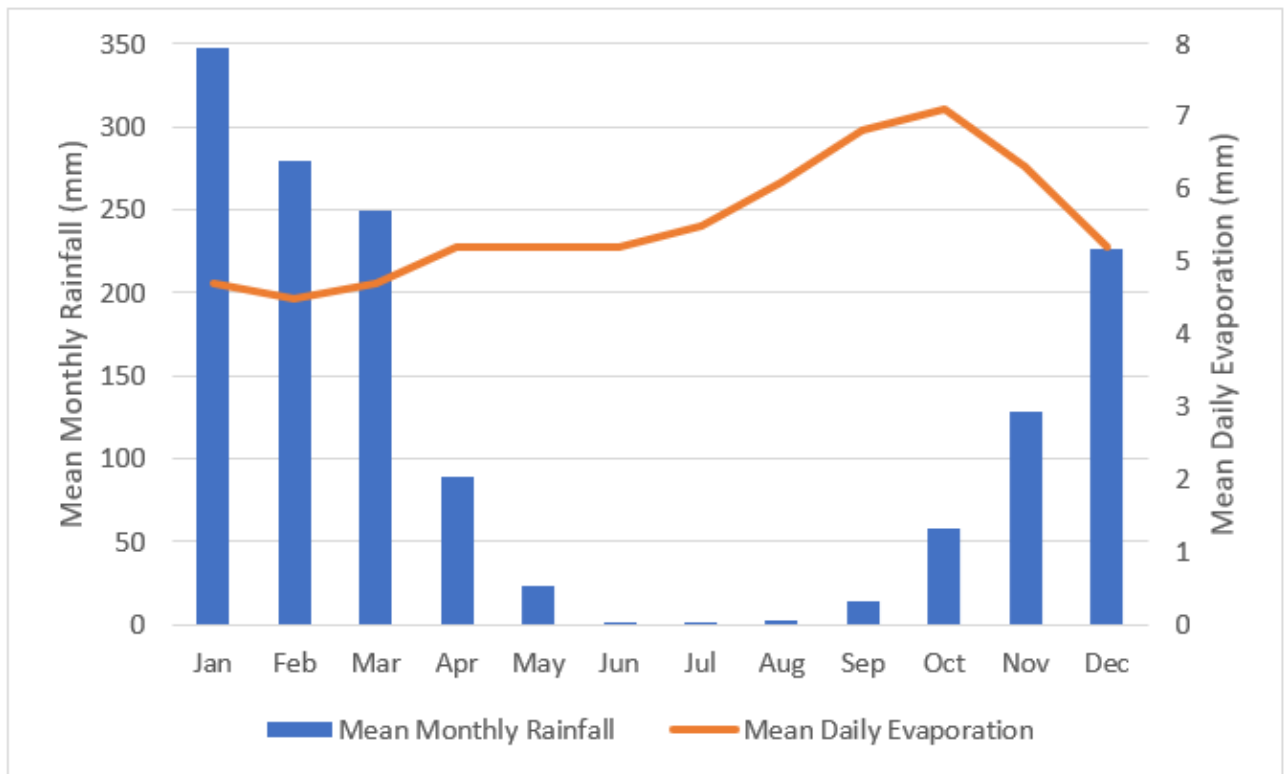


Figure 5-8 Mean Monthly Rainfall and Evaporation Data at nearest BoM Station (Source: BoM 2021)

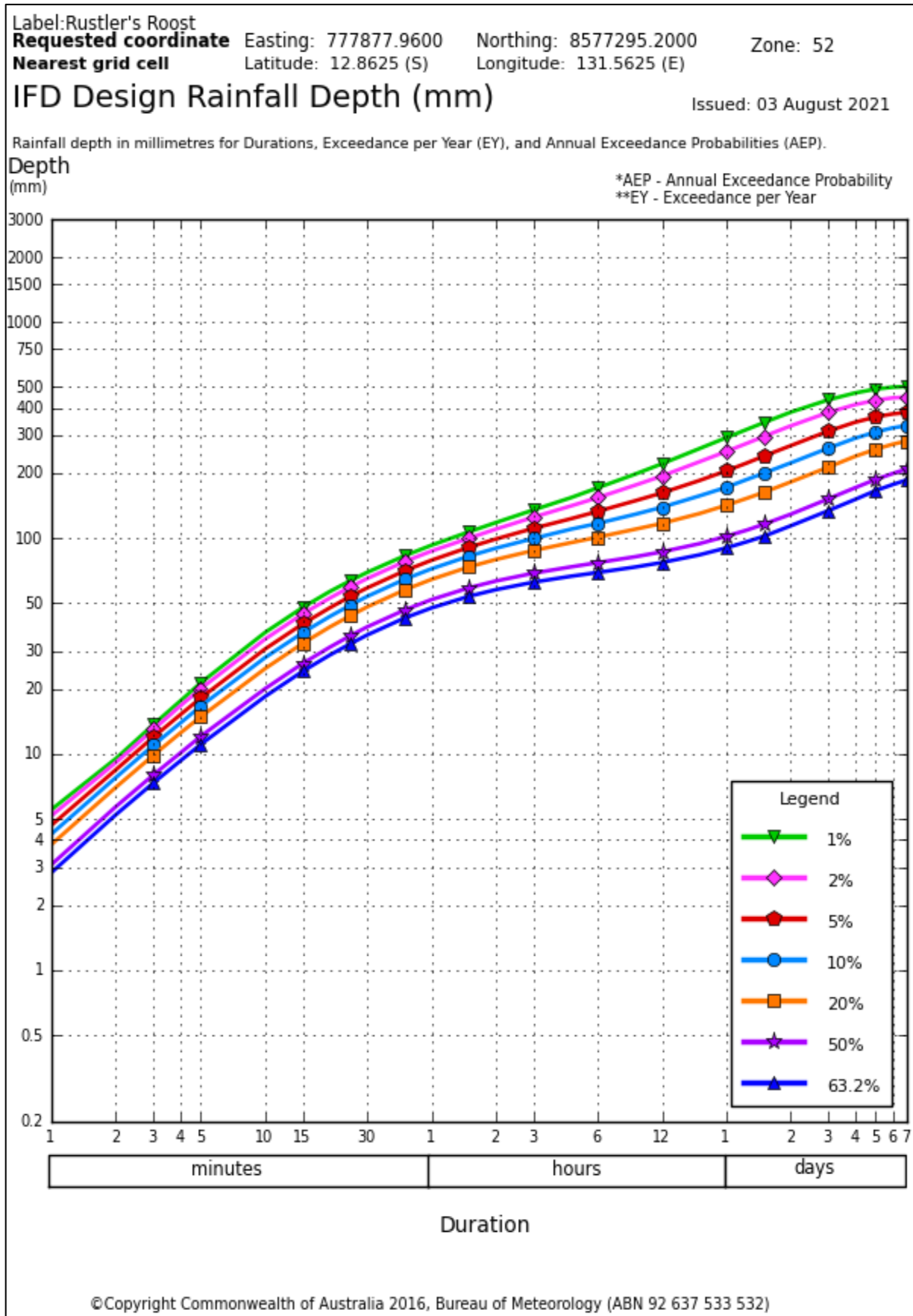


Figure 5-9 Rustlers Roost Intensity Frequency Duration Curves

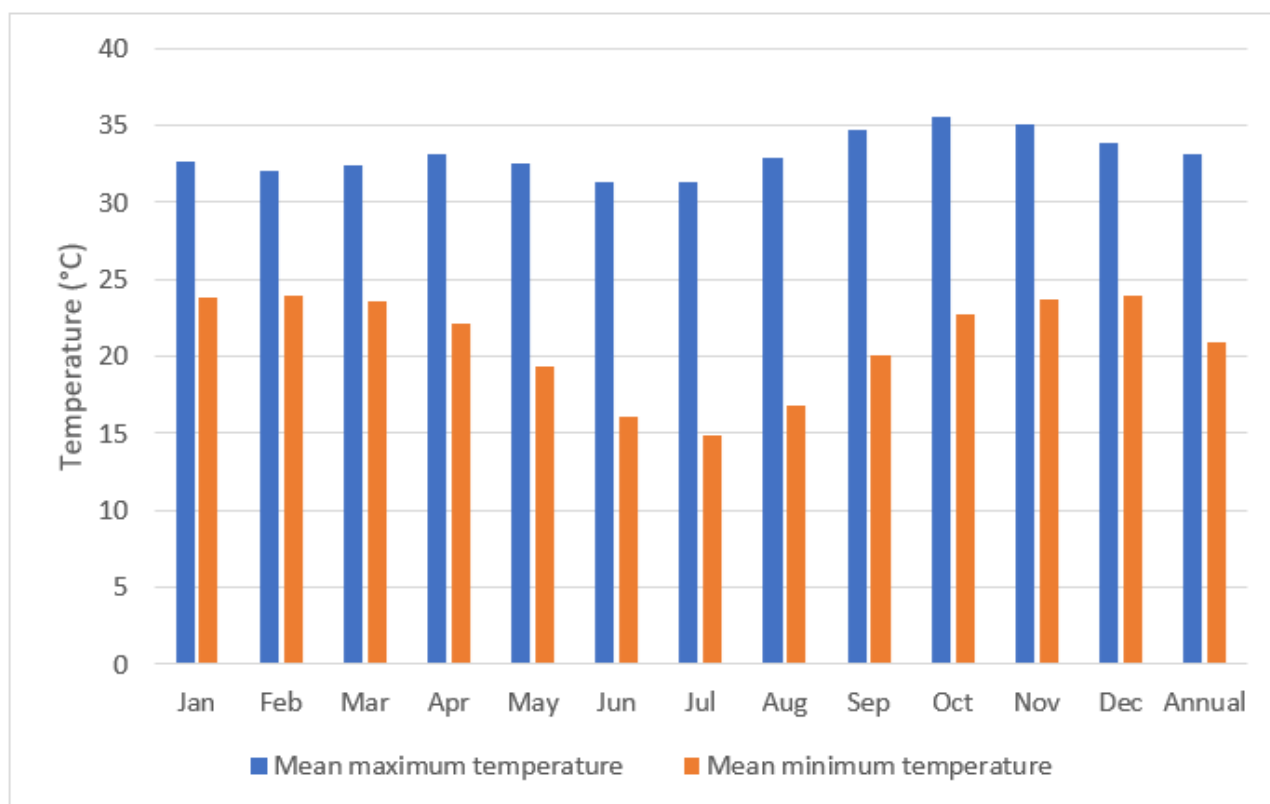


Figure 5-10 Mean Monthly Maximum and Minimum Temperature at nearest BoM Station (Source: BoM 2021)

Although some distance from the Project area, wind roses produced for the Darwin Airport BoM station show winds in the morning are predominantly from the east and south-east, whereas in the afternoon winds are predominantly from the north or north-west (Figure 5-12).

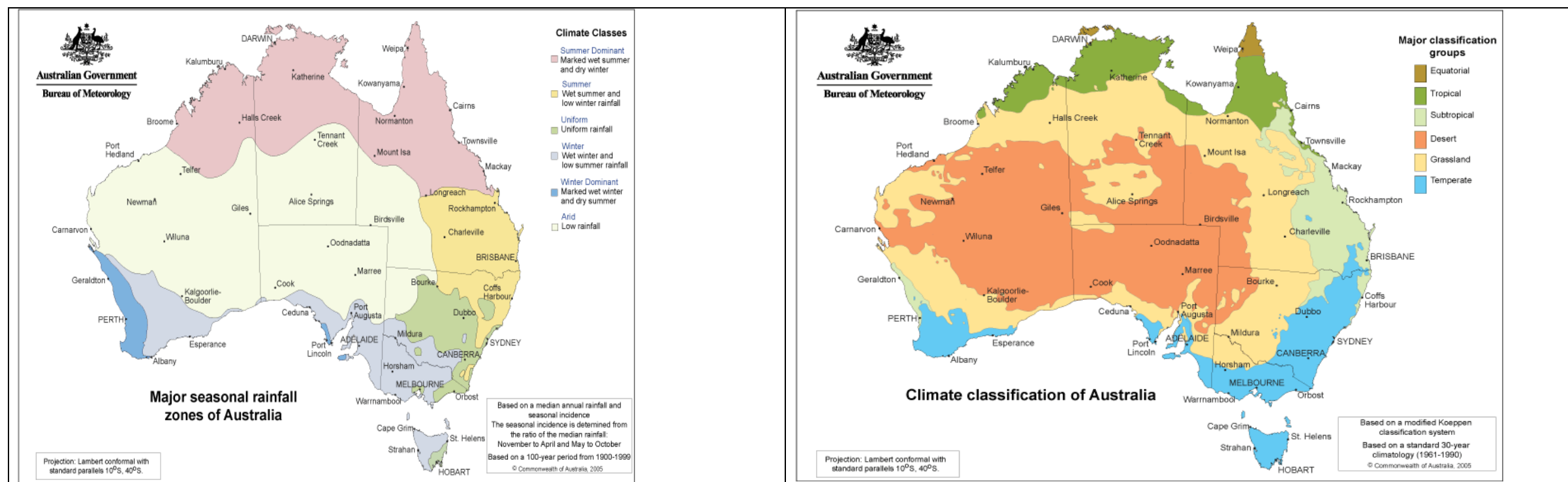


Figure 5-11 Major Seasonal Rainfall Zones and Climate Classification (Source: BoM 2021)

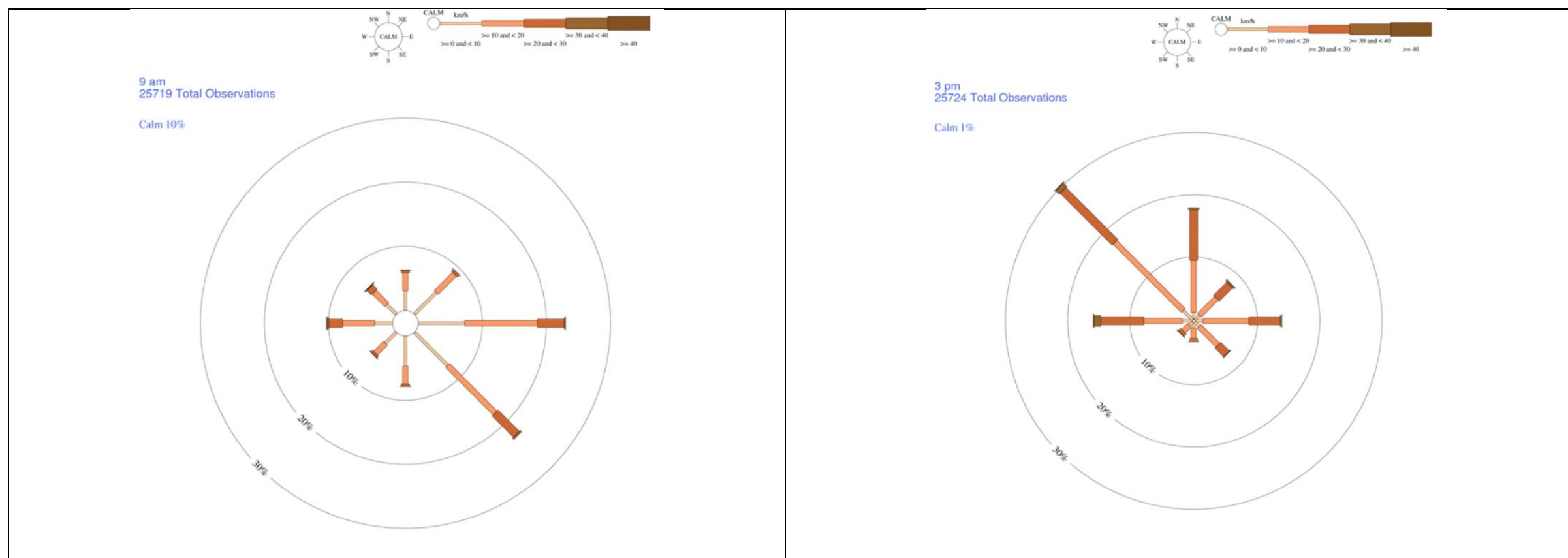


Figure 5-12 Annual Wind Roses for Darwin Airport⁶ (Source: BoM 2021)

⁶ No Wind Roses available for Middle Point Rangers station. The closest is from Darwin Airport station (014015).

5.2 Significant Sites or Features

Important sites and features in proximity to the proposed action are summarised below and shown in Figure 5-13.

5.2.1 Communities

The Project is located in a remote area, where the nearest residences are the Old Mount Bunday homestead located approximately 10 km north-northeast and the McKinlay River homestead located 15 km east of the Rustlers Roost portion of the Project area. In the case of Quest 29, the homesteads are 8.7 km north-east and 6 km north-east respectively. The homesteads are the nearest groundwater users to the Project area. The closest residential subdivision is Marrakai, 10 km north-west of the Project area.

5.2.2 Culturally Important or Sacred Sites

Historically, there have been a number of AAPA Certificates issued over the Project area. Most recently, PGO was issued an Authority Certificate in 2016, for the purpose of exploration activities and ongoing maintenance of the Rustlers Roost and Quest 29 mines (C2016/168). No recorded or registered sacred sites were identified within the current Project area and the closest site to the Project area is approximately 1.5 km north-west of the accommodation area. Several registered sacred sites also occur downstream and in the wider Mount Bunday locality (Figure 5-13). An application for an Authority Certificate covering the current Project area has been submitted and is being processed.

5.2.3 Heritage Sites

An archaeological survey was undertaken at Rustlers Roost, and recorded four sites of prehistoric materials, which included background scatters (Kinhill 1993). No archaeological surveys have been undertaken on the Quest 29 mining leases.

Correspondence with the Northern Territory Government Heritage Branch in August 2020 determined that no nominated, provisional or declared heritage places were registered as a result of the above archaeological investigation. A number of the sites recorded were removed or disturbed as part of previous development and expansion of the mine.

The Heritage Branch did not express any heritage or archaeological concern within the Project area, due to the level of disturbance, proximity of the Arnhem Highway and previous archaeological investigation undertaken. However, the advice provided by the Branch indicates that in the event that potential archaeological sites are discovered, all works in the immediate area should cease and the Heritage Branch will be contacted for comment.

The AAPA notes that a restricted works area (RWA 10) is designed to the north of the Quest 29 Project area. In addition, the Authority adds that there are known sacred sites downstream of the proposed activities in both the Mary River and Adelaide River catchments.

5.2.4 Sites of Conservation Significance

There are 67 Sites of Conservation significance (SoCS), sites identified as the most important sites for biodiversity, that need further protecting in the Northern Territory. Sites of Botanical Significance (SoBS) are defined as areas that have botanical features distinguishing them from the surrounding landscape, and that are important for general plant conservation and for specifically mentioned species. At its closest point, the Mary River coastal floodplain SoCS lies roughly 4.6 km to the east of the Quest 29 location of the Project area and 1 km from the accommodation camp. There are no SoBS within 20 km of the Project area (LES 2017).

The Mary River coastal floodplain is located 90 km east of Darwin and is unusual in the fact that it lacks a single major river channel through the floodplain to the ocean. The floodplain is poorly drained, and the inflow channel diffuses into vast seasonal swamps before reaching the sea through a number of tidal channels. This feature results in a greater area of wetland habitats that are flooded over extended periods and presents an extremely complex and productive system. The floodplain is dominated by a mix of sedge and grass communities and large paperbark forests in the north and fringed by open eucalypt woodland and pockets of monsoon forest (Harrison *et al.* 2009).

The Mary River coastal floodplain is of international significance and provides a reliable breeding site for Magpie Goose in the Northern Territory. Numbers of the Magpie goose can exceed 400,000 birds in some years. The floodplain environments provide a major breeding area for many fish species, notably Barramundi. Twelve threatened species are known to occur in the floodplain, including the vulnerable Yellow Chat (Harrison *et al.* 2009).

The environmental values of the Mary River coastal floodplain have been impacted by the increase in the presence of weeds (including *Mimosa pigra*, olive hymenachne and para grass) and exotic animals (mainly feral pig). Condition assessments of the Mary River system have concluded that environments across the area are suffering substantial degradation as a result of impact from exotic species and fire (Harrison *et al.* 2009).

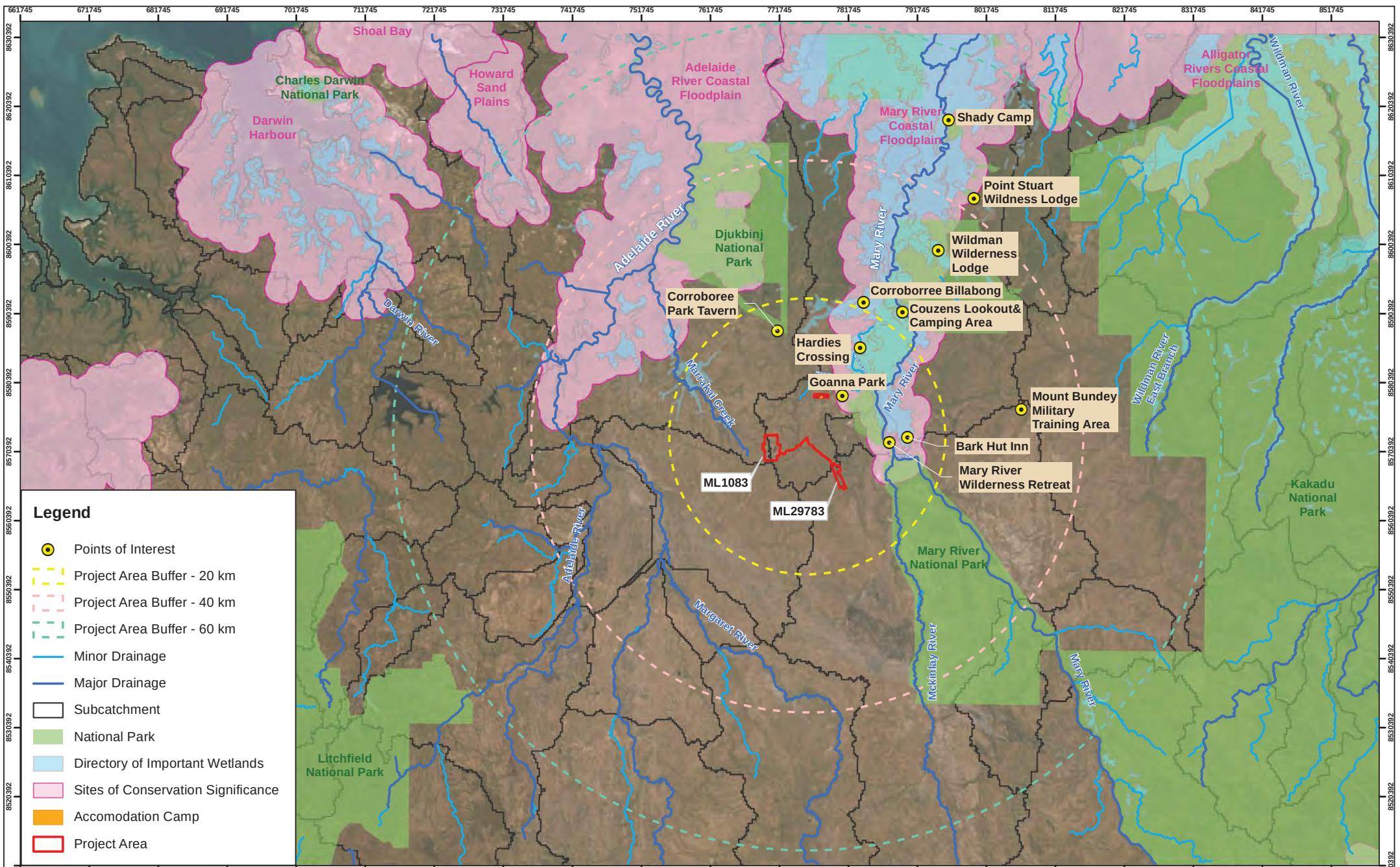
5.2.5 Mary River Floodplain System and National Park

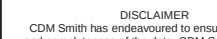
The Mary River National Park is located downstream of the Project area, approximately 6.5 km east of Quest 29 at its closest. The Mary River Floodplain System is protected within the Mary River National Park and is defined as a SoCS. The Mary River National Park is managed under a Joint Management Plan between the Limilngan and Uwynmil Traditional Owners of the park (PWCNT 2015). The park contains biodiversity values of national and international significance, as it provides a complex mosaic of wet and dry habitats that supports a diverse population of waterbirds (PWCNT 2015), as well as cultural, natural, recreational and historical significance for tourism in the Top End.

The Mary River floodplain is a major tourist and recreational fishing attraction for the region. Recreational fishing locations downstream within the Mary River system includes Hardies Creek (approximately 10 km downstream from the Arnhem Highway crossing), Corroboree Billabong (approximately 20 km downstream) and Shady Camp (approximately 60 km downstream).

5.2.6 Adelaide River Floodplain System

Located 6 km downstream (north-west) of the Rustlers Roost portion of the Project area, is the southern portion of the Adelaide River floodplain system. Collectively, the Adelaide River floodplain system is of natural and cultural importance. Floodplains are important environmental feature in the Northern Territory (NTG 2019). They provide essential ecosystem services and support a wide diversity of flora and fauna., the Adelaide River floodplain is also a major tourist attraction for recreational fishing in the region.



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5.3 Demography and Economy

The Project area is located in the Mount Bunday region and is remote from any communities. The closest major town is Humpty Doo, which is located approximately 46 km north-west. The Marrakai residential subdivision is located 10 km north of the Project area. The Australian Census for the Marrakai community, indicates a population of 517 people with a median age of 39 (ABS 2016). Marrakai is predominantly comprised of small dwellings occupied mostly by recreational fishers and holiday makers on weekends and during holiday periods. Any direct or indirect economic and social impacts resulting from the development of the Project are likely to be most observable within their statistical areas.

The economic input of the region is predominantly based on extracting civil and building material, and pastoral properties utilised for cattle farming. Ranging from 3 km to 9 km from Quest 29 are a number of quarries which provide construction material for civil and residential buildings around the Northern Territory (Figure 7-53).

The broader Mount Bunday locality includes the Mary River, the portion of the Mary River National Park south of the Arnhem Highway, the Mary River Wilderness Retreat and the Mount Bunday Military Training Area in the east (Figure 11-1). The Mary River National Park is utilised for environmental conservation, tourism and recreational purposes. The Mary River Wilderness Retreat is located 8.5 km north-east of the Project. The Mount Bunday Military Training area encompasses 117,300 ha east of the Mary River and is operated by the Commonwealth of Australia (Figure 11-1).

The most extensive land use in the vicinity of the Project area is pastoral, involving the grazing of beef cattle over the woodland terrain. There has been some improvement to pasture on Old Mount Bunday station. Land use in the region includes agriculture (orchards and pastoral operations) and mining, with historic iron ore mining at Mount Bunday and gold mining at Toms Gully, Quest 29 and Rustlers Roost mines.

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

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

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

With regard to the existing economic environment of the area, the median weekly household income for residents of the Marrakai State Suburb Code (SSC) area, was significantly less than the Northern Territory median (\$1,387 compared to \$1,983). However, this was only \$51 less than the Australian average (ABS 2016). The Marrakai (SSC) unemployment rate of 9.6% was 2.6% above the Northern Territory average and 2.7% above the Australian average of 6.9% at the time of the census (ABS 2016).

Manual labour industries are the top employers for the Marrakai area (SSC). Whereas top employing industries in Humpty Doo and the Northern Territory are dominated by Territory and Federal Government (e.g. education, health, government administration and defence), Marrakai's top industry is horticultural (vegetation growing) (ABS 2016). Out of the top eight occupations listed by the ABS, Marrakai had a slightly higher proportion of blue collar manual occupations (40.9%) than Humpty Doo (40.5%) and the Northern Territory as a whole (30.9%) (ABS 2016).

Of the employed people in Marrakai (State Suburbs), 15.3% worked in Vegetable Growing Outdoors). Other major industries of employment included Other Construction Material Mining 3.8%, Fruit and Vegetable Retailing 3.8%, Road Freight Transport 3.8% and Accommodation 3.2%.

Section 6 Risk Assessment of Environmental Factors

6.1 Introduction

In accordance with the environment impact assessment guidance for proponents prepared by the NT EPA, and standard good practice, a risk assessment has been developed for the Project. The risk framework and assessment as described below has been used to identify the nature of risks and potential impacts associated with the Project and informed the development of appropriate management measures detailed in the Draft EIS.

In accordance with Table 1 of the NT EPA Environmental Impact Assessment Guidance for Proponents (Rev1) (NT EPA 2021a), the risk assessment framework for the Project has been developed and implemented in accordance with international best practice standard methodologies including:

- Australian/New Zealand Standards (AS/NZS) ISO 31000:2018: Risk management— Principles and guidelines (Standard); and
- HB 203:2006: Environmental risk management — Principles and process (Guide).

This risk assessment has also been developed with consideration of the NT EPA Environmental Factors and Objectives (NT EPA 2021b), inputs from stakeholders during Project consultation and submissions received on the Project referral documentation, and subsequent ToR. The framework has been developed and an assessment completed to ensure that residual impacts can be managed in a manner that the objectives of each environmental factor and stakeholder expectations can be met.

The Project and associated activities have been subject to a site-specific risk assessment. The objective of the risk assessment is to ensure that any significant risks are identified, evaluated and 'treated' to mitigate these risks. The risk assessment framework provides a mechanism for PGO to identify and proactively address potential significant risk. It also demonstrates to stakeholders and regulators that the proposed Project risks have been considered in accordance with relevant guidelines and good practice, and that risk mitigation is appropriate to minimise any potential impacts.

While the assessment is specific to this Project, the basis of the framework stems from the risk assessment developed for PGO's Toms Gully Mine Underground Project. The risk framework for that project was submitted with the Draft EIS, but reconfigured and resubmitted in the Supplement to the EIS where it addressed comments from the NT EPA. Given the NT EPA's acceptance of the updated risk framework for the Toms Gully Mine Underground Project, and with alignment with the contemporary approach to risk assessment and evaluation, the same framework has been broadly utilised for this Project.

6.2 Relevant Environmental Factors

In accordance with the ToR, the NT EPA considers that the proposed action has the potential to significantly impact environmental values associated with six environmental factors. Environmental factors are broad divisions of the environment (e.g. terrestrial ecosystems, hydrological processes and inland water) that may be impacted by a proposed action (NT EPA 2021b). The factors and corresponding objectives offer a system for organising environmental information for the purpose of environmental impact assessment, and allow for the identification of values, the assessment of the significance of potential impacts to those values, and the setting of benchmarks to protect those values (NT EPA 2021b).

An environmental objective for each factor has been developed that reflects the targeted outcomes for these parts of the environment. These objectives provide an indicator against which to assess whether the objects of the EP Act can be achieved and are used by the NT EPA to determine whether the environmental impact of a proposed action may be

Section 6 Risk Assessment of Environmental Factors

significant and ultimately whether a proposed action is likely to be acceptable (refer to Table 6-1). A full summary assessment of the Project against each factor objective is provided in the Draft EIS conclusion (refer to Section 12).

These factors are broad divisions of the environment that may be impacted by a proposed action. The environmental objectives are the desired outcome, goal or direction for change identified for each environmental factor. The factors are outlined in the ToR and are listed in Table 6-1.

Table 6-1 Relevant Environmental Factors and Objectives

Theme	Factor	Objective
Land	Terrestrial Environmental Quality	Protect the quality and integrity of land and soils so that environmental values are supported and maintained.
	Terrestrial Ecosystems	Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.
Water	Hydrological Processes	Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.
	Inland Water Environmental Quality	Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.
	Aquatic Ecosystems	Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.
People	Community and Economy	Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians

The ToR did not include environmental factors in relation to landforms, factors related to the sea or air themes, culture and heritage, and human health. Nevertheless, in accordance with the NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a), these components have been addressed in the 'Other Environmental Themes and Factors' and 'Holistic Impacts' sections (Section 8 and Section 11, respectively).

6.3 Risk Assessment Process and Methodology

The requirement for a risk assessment for the Project was identified in the EIS ToR, with specific reference to considering impacts to terrestrial ecosystems and hydrological processes. In accordance with NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a), the risk assessment accounts for all six environmental factors listed in the EIS ToR (Table 6-1).

This section describes how potential environmental risks from the implementation of the Project have been identified, evaluated and treated. PGO has considered risks arising from all phases of the Project as described in Section 4, including recommissioning, operation, temporary shutdowns, care and maintenance, decommissioning and closure.

PGO has undertaken consultation with the relevant stakeholders (outlined in Section 3) to determine the perceived key risks associated with the Project. Through this consultation, PGO has collaborated with relevant stakeholders and developed the risk assessment and management of key risks in consideration of stakeholder feedback.

The risk assessment will be re-evaluated annually during the LOM (or when a significant change is made to the Project). This will ensure any new risks can be identified and treated to be maintained at a ALARP level.

6.3.1 Risk Identification

Risk relates to the effect of uncertainty on objectives. These objectives are primarily environmental goals within the Draft EIS, as well as the objectives of the NT EPA for each environmental factor applicable to the Project. Risks are

Section 6 Risk Assessment of Environmental Factors

determined and assessed using a combination of the likelihood of occurrence and the consequence of an event. Identifying risks for the Project recommissioning, operational, decommissioning and closure phases are based on the failure of control(s) associated with the environment, people, infrastructure or equipment in hazardous situations. The assessment considered potential direct, indirect and cumulative impacts.

A standard qualitative risk matrix was used to identify the source of the risk, the likelihood of occurrence and the consequence of that occurring; the treatment or mitigation of the risk to reduce its impact and determining the remaining residual risk has been undertaken (Table 6-2). This process is aligned to the AS/NZS ISO 31000:2018 standard. This framework also aligns with the NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a), which states:

“Provide information that permits the general reader to understand the likelihood of occurrence and severity of each potentially significant environmental impact presented by the proposal. Consideration of risks presented by the proposal may be guided by undertaking a risk assessment consistent with the AS/ISO 31000 risk management series.....the analysis, including development of likelihood and consequence ratings for inherent and residual risk assessments, is to be based on referenced and relevant actual data and modelled predictions as appropriate.” (p.15 - 16)

The NT EPA decision to require an EIS for the Project was based on risks detailed in the Statement of Reasons for the decision. These included risks to:

- Threatened species;
- Sensitive vegetation;
- Aquatic ecosystems; and
- Community safety.

An initial risk assessment was undertaken early, at the preliminary stage of the Draft EIS development to identify the key environmental, community and cultural risks. The initial assessment identified key risks to guide the site-specific technical studies that needed to be undertaken. This initial risk assessment was supported by two internal risk assessment workshops held in June and July 2021.

The initial workshop was completed by a group of experienced environmental professionals with wide-ranging expertise in environmental assessment and the relevant technical aspects. The first workshop was aimed at identifying known risks and completing the initial risk assessment. This allowed for an informed second workshop involving the same practitioners (including suitably experienced environmental scientists and hydrogeologists) and technical mining personnel from PGO. The risk assessment workshop focused on the following key risk areas:

- Failure of existing / new infrastructure;
- Acid, Neutral and Saline Mine Drainage;
- Implication from geochemistry of the overburden material;
- Water management;
- Erosion and Sedimentation;
- Biodiversity;
- Human Health and Safety;
- Rehabilitation and Closure;

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- Cultural Heritage; and
- Community and economic impacts.

A preliminary risk register was developed as a result of this initial risk assessment workshop. Once all technical assessments for the Draft EIS were completed, the assessment was revisited to confirm any additional risks that had been identified through the technical assessment, and to validate inherent and residual risk conclusions, and update these conclusions where relevant. The methodology is presented in Figure 6-1.

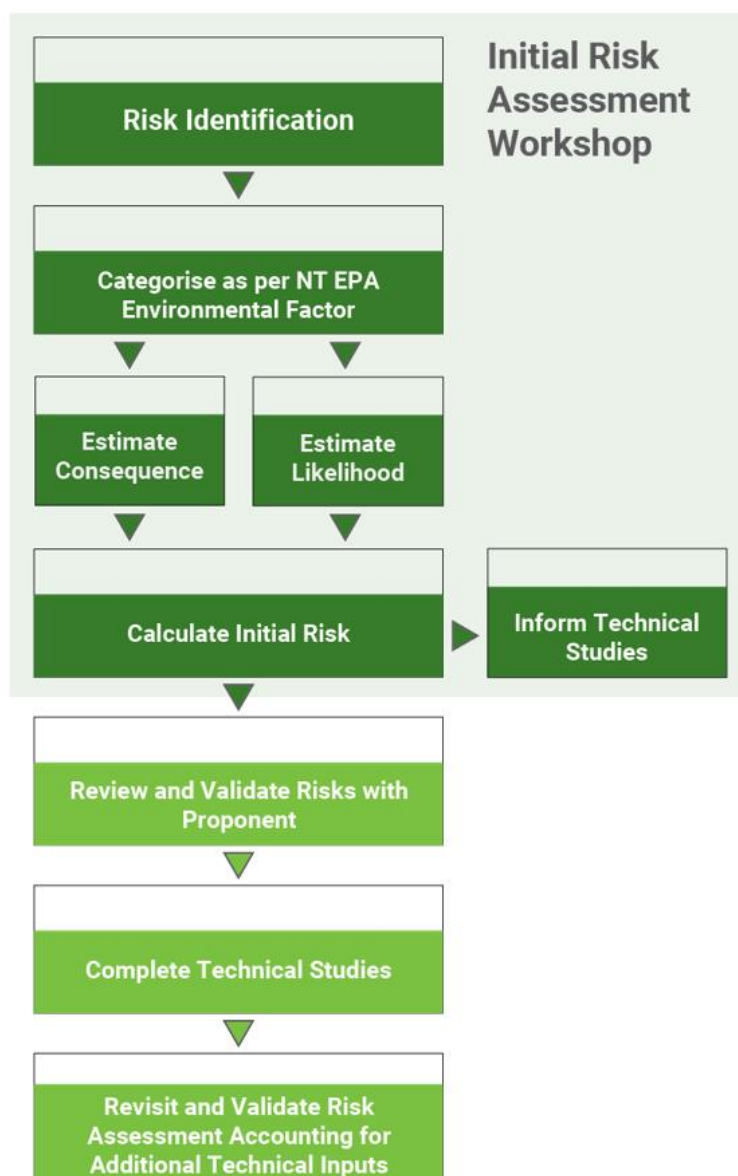


Figure 6-1 Project Risk Assessment Methodology

The risk assessment process is generally consistent with the basic methodology for hazard analysis presented in the NSW Guidelines for Hazard Analysis (Department of Planning 2011); however, it has been refined to align better with the NT EPA EIS development process and informed by an iterative review of risks once technical studies were completed.

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6.3.2 Risk Matrix

Assessment of risk has been conducted through pragmatic 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. While prioritisation has been given to avoidance as per the environmental decision-making framework, mitigation is proposed, where possible, to achieve a reduced residual risk (risk after mitigation) to below “Extreme” or “High” risk outcomes to the extent reasonably practicable.

Table 6-2 provides a summary of the qualitative risk matrix adopted and the levels of risk for the various consequence and likelihood combinations. Each cell is allocated a number which corresponds to the range assigned to the four bands of risk. As per the Table 6-3, higher values correspond to lower assigned risk and low values correspond to higher assigned risk.

Table 6-2 Qualitative Risk Analysis Matrix

Likelihood	Consequence				
	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Significant
(A) Almost certain	High (15)	High (10)	Extreme (6)	Extreme (3)	Extreme (1)
(B) Likely	Moderate (19)	High (14)	High (9)	Extreme (5)	Extreme (2)
(C) Possible	Low (22)	Moderate (18)	High (13)	Extreme (8)	Extreme (4)
(D) Unlikely	Low (24)	Low (21)	Moderate (17)	High (12)	Extreme (7)
(E) Rare	Low (25)	Low (23)	Moderate (20)	High (16)	High (11)

Table 6-3 Risk Range

	Lower Range Value	Upper Range Value
Extreme	1	8
High	9	16
Moderate	17	20
Low	21	25

Definitions of likelihood are provided in Table 6-4. Likelihoods are categorised around the probability of occurrence, within the context of reasonable timeframes and frequencies given the Project life. A brief description of each risk classification and interpreted outcome is also provided below in Table 6-5.

Table 6-4 Definition of Likelihood Classification

Rating	Likelihood	Frequency	Probability	Occurrence as Percentage
A	Almost certain	More than once per month	The event is expected to occur at some time as there is a history of continuous occurrence with similar projects/activities	91-100%
B	Likely	Less than once per month, but more than once per year	There is a strong possibility the event will occur as there is a history of frequent occurrence with similar projects/activities.	61-90%
C	Possible	Less than once per year, but more than once per five years	The event might occur at some time as there is a history of infrequent occurrence of similar issues with similar projects/activities.	41-60%
D	Unlikely	Less than once per five years	Not expected, but there's a slight possibility it may occur at some time.	11-40%
E	Rare	Unlikely to ever occur	Highly unlikely, but it may occur in exceptional circumstances.	0-10%

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Table 6-5 Description of Risk Classification

Rating	Definition
Extreme	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 to reduce the level of risk.
High	Typically relate to significant to critical consequences (e.g. a major 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
Moderate	As suggested by the classification, medium level risks span a group of risk combinations varying from relatively low consequence / high likelihood to mid-level consequences / 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.

Table 6-6 describes the types of consequences that have been identified and assessed as part of the risk assessment process. These are grouped into the NT EPA environmental themes and factors, to demonstrate direct line-of-sight of the evaluation of risk with the key environmental factors as per the NT EPA objectives.

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Table 6-6 Consequence Classification

NT EPA Themes and Factors		Consequence				
Theme	Factors	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Significant
Land	Terrestrial Environmental Quality	Negligible impact to isolated area	Contained low impact, not impacting on any environmental values of soil or land	Uncontained impact, able to be rectified in short-term without causing pollution or contamination to soil or land	Extensive hazardous impact on an environmental value requiring long-term remediation of soil or land	Uncontained hazardous impact with residual effect, even with long term remediation of soil or land
	Terrestrial Ecosystem	Alteration or disturbance to an isolated area that is unlikely to affect the habitat, species or ecosystem functioning	Alteration or disturbance to less than 5% of a habitat, species or ecosystem functioning resulting in a minor, recoverable impact within 1 year	Alteration or disturbance to 5-30% of a habitat, species or ecosystem functioning resulting in a moderate, recoverable impact within 1-2 years	Alteration or disturbance to 30-70% of a habitat, species or ecosystem functioning result in a major, recoverable impact within 3-10 years	Alteration of more than 70% of a habitat, species or ecosystem functioning resulting in an extinction or permanent change or reduce threshold level below 30%. Recovery, if possible is greater than 10 years
Water	Hydrological Processes	Negligible impact to hydrological processes in Project area (surface or groundwater) and no consequence to the use of water	Contained low impact to hydrological processes in Project area (surface or groundwater) with minor recoverable impact within 1 year	Uncontained impact to hydrological processes that will affect the use of the water including outside the Project area but can be remediated in the short-term (1-2 years)	Extensive impact to hydrological processes that will affect the use of the water including outside the Project area and requires long-term remediation (3-10 years)	Uncontained hazardous impact to hydrological processes with residual effect, even with long-term remediation (greater than 10 years)

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NT EPA Themes and Factors		Consequence				
Theme	Factors	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Significant
Water	Inland Water Environmental Quality	Negligible impact to water quality (surface or groundwater) in Project area and no consequence to the human or ecological uses of the water	Contained low impact to water quality (surface or groundwater) in Project area with minor recoverable impact within 1 year	Uncontained impact to water quality that will affect the human or ecological use of the water including outside the Project area but can be remediated in the short-term (1-2 years)	Extensive impact to water quality that will affect the human or ecological use of the water including outside the Project area and requires long-term remediation (3-10 years)	Uncontained hazardous impact to water quality with residual effect, even with long-term remediation (greater than 10 years)
	Aquatic Ecosystems	Negligible impact to aquatic ecosystems through quality or flow changes in Project area, but unlikely to affect the habitat, species or ecosystem functioning	Contained low impact to aquatic ecosystems through quality or flow changes in Project area, with minor recoverable impact within 1 year	Uncontained impact to aquatic ecosystems through quality or flow changes, with moderate consequence to habitat, species or ecosystem functioning including outside the Project area but can be remediated in the short-term (1-2 years)	Extensive impact to aquatic ecosystems that will affect the species or ecosystem functioning including outside the Project area and requires long-term remediation (3-10 years)	Uncontained impact to aquatic ecosystem with residual effect, even with long-term remediation (greater than 10 years)
People	Community and Economy	Incident with or without minor injury. No impact on human health or very minor short term inconvenience or symptoms OR Adverse local social or economic implications that are brief or periodic	Injuries requiring first aid treatment. Minor short term inconvenience or symptoms to human health OR Adverse local or regional, social or economic implications that last for 1 year	Injury or illness requiring medical treatment. Short term or reversible disabling effect (impairment) to human health OR Adverse local or regional, social or economic implications that last for 1-2 years	Injuries requiring hospitalisation. Serious long term or permanent disabling effects on human health Adverse local, regional or territory-wide, social or economic implications that last for 3-10 years	Loss of life / fatality or long term or permanent disabling effects on human health Adverse local, regional territory-wide or national, social or economic implications that last for greater than years

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The level of certainty surrounding the proposed risk rankings was also assessed in accordance with Table 6-7. Where proposed mitigation measures resulted in a reduction in risk ranking from inherent risk to residual risk. Furthermore, corresponding justifications were also provided where a reduction in risk ranking occurred.

Table 6-7 Level of Certainty

Control Rank	Description	Guidance
C1	Low	Risk ranking is based on subjective opinion or relevant past experiences.
C2	Moderate	Risk ranking is based on similar conditions being observed previously and/or qualitative analysis.
C3	High	Risk ranking is based on testing, high fidelity modelling or simulation, use of prototype or experiments. Analysis is based on verified models and/or data. Assessment is based on an historical basis.

6.3.3 Risk Treatment

In accordance with the NT EPA Guidance on preparing an Environmental Impact Statement (NT EPA 2021a), when considering risk mitigation, the environmental decision-making hierarchy has been used to guide the identification and selection of appropriate controls. As per the guideline, proponents must demonstrate that the environmental decision-making hierarchy has been applied to avoid or mitigate potentially significant environmental impacts where practicable. Section 26 of the EP Act states the environmental decision-making hierarchy is as follows:

- a. *“Ensure that actions are designed to avoid adverse impacts on the environment;*
- b. *Identify management options to mitigate adverse impacts on the environment to the greatest extent practicable; and*
- c. *If appropriate, provide for environmental offsets in accordance with the Act for residual adverse impacts on the environment that cannot be avoided or mitigated.*

In making decisions in relation to actions that affect the environment, proponents must ensure that the potential for actions to enhance or restore environmental quality is identified and provided for to the extent practicable.”

This hierarchy has been used in developing the risk assessment matrix to assist in applying appropriate mitigation measures where risks cannot be avoided. Generally, mitigation measures for significant environmental risks include adaptive management or ongoing monitoring. Each of the key environmental factor sections also provide an avoidance, mitigation and management sub-section that prioritises measures to avoid in accordance with the hierarchy.

6.3.4 Risk Evaluation and Assessment

The risk evaluation and assessment section provides a discussion of the key outcomes of the risk assessment. The risk assessment provides a good understanding of the Project risk profile and has enabled priority risks to be highlighted in order to minimise the likelihood of occurrence and / or the consequence severity. Risk assessments were based on the outcomes of planned mitigation and monitoring to detect incipient or actual failure of management systems.

It is important to note that the likelihood and consequence of risks vary across the Project stages. For example, the risk of impacts from vegetation clearing are considered to be highest during the construction stage, whereas failure from the tailings dam may be greatest during operations. The risk assessment process has considered the applicable stages and based the assessment of residual risk on the stage for which the greatest risk is expected.

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6.3.4.1 Identified Risks

In total, 47 different sources of environmental, health, social and economic risks were identified and evaluated. Of these, 26 of the risks applied to the land theme, 29 to the water theme and 11 to the people theme. The risk assessment was completed against each of the environmental factors and many of the risks applied to multiple factors. A full list of the identified risk and the applicable factors is provided in Table 6-8. While the risk or source of potential impact may be the same, the consequence is different based on the environmental factor considered (e.g. a chemical spill has different consequences to terrestrial environmental quality (land and soil) then to aquatic ecosystems). These differences have been considered in the risk assessment.

Table 6-8 Identified Risks and Relevant Factors

No.	Risk / Potential Source of Impact	Relevant Factor					
		Terrestrial Environmental Quality	Terrestrial Ecosystem	Hydrological Processes	Inland Water Environmental Quality	Aquatic Ecosystems	Community and Economy
1	Vegetation clearing for the Project	✓	✓	✓	✓	✓	
2	Overtopping, embankment failure or seepage from the new TSF at Rustlers Roost leading to uncontrolled release of tailings material to surrounding environment.	✓	✓	✓	✓	✓	
3	Overtopping, embankment failure or seepage from the process water storage ponds at Rustlers Roost leading to uncontrolled release of process water to surrounding environment.	✓	✓	✓	✓	✓	
4	Embankment failure or seepages from the new WRDs at Rustlers Roost and Quest 29 to surrounding environment.			✓	✓	✓	
5	Embankment failure of Annie's Dam water storage and uncontrolled water and sediment release (temporary risk noting closure of dam for Rustlers Roost TSF).	✓		✓	✓	✓	
6	Poor quality runoff or seepage from the historic WRDs and heap leaches.	✓			✓	✓	
7	Groundwater drawdown			✓			
8	Poor water quality released from site during wet season (stormwater).		✓		✓	✓	
9	Geotechnical instability and failure of pit wall, TSF or WRD walls.	✓					
10	Indiscriminate use of existing waste rock for construction. Storage of waste rock outside of pit footprint for too long.	✓		✓	✓		
11	Pit and groundwater dewatering exposing PAF and causing AMD			✓	✓		
12	Failure of process tanks/pipes/pumps.	✓					
13	Planned pit over topping or release to surface water features during extreme rainfall and flooding events.			✓	✓	✓	

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No.	Risk / Potential Source of Impact	Relevant Factor					
		Terrestrial Environmental Quality	Terrestrial Ecosystem	Hydrological Processes	Inland Water Environmental Quality	Aquatic Ecosystems	Community and Economy
14	Unplanned pit overtopping or release to surface water features during extreme rainfall and flooding events.			✓	✓	✓	
15	Erosion of site infrastructure leading to sedimentation	✓		✓	✓		
16	Release of hazardous chemicals or materials during storage and handling onsite.	✓	✓	✓	✓	✓	
17	Release of hazardous chemicals or materials during transportation to site.	✓	✓				
18	Poor handling and management of tailings and waste rock			✓	✓	✓	
19	Production of domestic waste and storage of the waste onsite	✓	✓	✓	✓		
20	Unfinished/unsuccessful rehabilitation of Project due to inadequate funds or natural disaster (e.g. cyclone).	✓	✓	✓	✓	✓	
21	Long term positive water balance.			✓		✓	
22	Pit lake becomes a groundwater source.				✓	✓	
23	Inability to establish native vegetation by local provenance species with resultant cover comparable to nearby areas	✓	✓				
24	Lack of rehabilitation materials leads to inadequate tailings closure and poor quality site rehabilitation.	✓	✓		✓	✓	
25	Inappropriate management of the decommissioned site, post closure landform.	✓	✓	✓	✓	✓	✓
26	Ineffective operational implementation of site environmental management system, plans and procedures.	✓	✓	✓	✓	✓	
27	Use of Project machinery, equipment, vehicles and activities causing fire through sparks or heat ignition source.	✓	✓		✓		
28	Dust generation from Project activities such as vehicular movements and earthworks.	✓	✓		✓		
29	Noise and vibration emissions from construction and operational activities (e.g. vehicle movements and blasting).		✓				
30	Emissions or Project infrastructure visible in publicly accessible lands.						
31	Construction and operational activities (incl. vegetation clearing) result in introduction of new weeds and spread of existing weeds into new areas.		✓			✓	
32	Increased density of weed infestations.		✓				

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No.	Risk / Potential Source of Impact	Relevant Factor					
		Terrestrial Environmental Quality	Terrestrial Ecosystem	Hydrological Processes	Inland Water Environmental Quality	Aquatic Ecosystems	Community and Economy
33	Emissions from clearing, dust, noise, artificial light associated with construction and/or operation of the mine site.						✓
34	Vehicle/machinery interaction with terrestrial fauna.		✓				
35	Inappropriate liquid and solid waste disposal.	✓		✓	✓	✓	
36	As part of closure and rehabilitation, creeks and drainage alignments are not consistent to the surrounding landforms and catchment area.			✓			
37	Financial capacity or feasibility to implement Project becomes unviable due to Au price change, fuel cost increases or change in metallurgical recoveries of ore.						✓
38	Major mechanical failure of processing plant				✓	✓	✓
39	Ore Reserve modelling estimation error						✓
40	Skilled labour shortages						✓
41	Additional highway commuter traffic and associated road safety concerns.						✓
42	Influx of workers to the local community seeking housing						✓
43	Influx of workers to the local community in general						✓
44	Increased demand for local services and supplies						✓
45	Disturbance of sites/objects of heritage significance heritage items or places and sacred sites.						✓
46	Artificial light emissions from construction and/or operation of the mine site.		✓				
47	Construction of waterway crossing altering flow regimes with increased risk of erosion and sedimentation.					✓	

6.3.4.2 Risk Assessment Results

Table 6-9 summarises the outcomes of the risk assessment process. The specific consequence and likelihood scenarios are detailed in Appendix B along with the residual risk rating, based on a reasonable assumption of effective implementation of the control measures described. Ongoing monitoring and management will be required to validate the effectiveness of these controls, audit their implementation and identify other measures or different approaches that may be required to achieve and maintain acceptable risk levels.

The results of the risk assessment have been used to inform an assessment of whether the Project achieves the NT EPA objectives for the relevant environmental factors (refer to Table 12-1). Each of the subsequent key environmental factor sections (Section 7) provide a summary of the risk assessment outcomes, while Appendix B presents the complete assessment.

Table 6-9 Summary of Risks

Risk Level	Land				Water						People	
	Terrestrial Environmental Quality		Terrestrial Ecosystems		Hydrological Processes		Inland Water Environmental Quality		Aquatic Ecosystems		Community and Economy	
	Inherent	Residual	Inherent	Residual	Inherent	Residual	Inherent	Residual	Inherent	Residual	Inherent	Residual
Extreme	2	0	2	0	4	0	5	0	5	0	2	0
High	12	0	13	1	8	1	9	0	8	0	2	0
Moderate	6	11	4	12	7	9	9	12	7	11	2	2
Low	0	9	0	6	1	10	1	12	1	10	5	9
Total	20	20	19	19	20	20	24	24	21	21	11	11

6.3.5 Indirect and Cumulative Impact

In accordance with the ToR and NT EPA Environmental Impact Assessment Guidance for Proponents (NT EPA 2021a), the risk assessment has identified and considered potential indirect and cumulative impacts from the Project and other activities at varying spatial extents from the Project. The objective of the assessment is to identify the potential for the Project to have compounding or additive effects with similar impacts from other projects or foreseeable activities that are either proposed or currently under development.

An indirect impact is one that may occur from a third party as a result of the Project or may be resultant from the Project in an indirect manner. Cumulative impact may be described as the total impact on environmental factors that is caused from the proposed Project activities in conjunction with past and future activities. These are impacts of the action when combined with the impacts of other (related and unrelated) actions. The assessment methodology for considering indirect and cumulative is provided in Section 6.3.5.1 below.

6.3.5.1 Assessment Approach

This section provides an overview of the approach adopted for considering the Project's potential indirect and cumulative impacts.

Indirect and cumulative impacts can include:

- Social and economic effects, including changes to land use, demand for local services and employment;
- Impacts on local, regional and Territory traffic, transport and road users;
- Changes to local and regional amenity, including noise, vibration and air quality; and
- Environmental changes including effects on water quality, hydrology and biodiversity.

The following methodology was applied to assess cumulative impacts, as described further in the key environmental factor sections:

- Identify the impacts of the Project on baseline conditions (as detailed in the key environmental impact sections and technical reports);
- Identify significant projects proposed within either a 150 km radius from the Project or within the bioregion. In accordance with the ToR, the property, catchment and region scale cumulative impacts were also quantified; and
- Screen significant projects to identify relevant projects with the potential to interact cumulatively with the Project.

The identified projects and assessment of indirect and cumulative impacts is discussed within each key environmental factor section in Section 7.

6.3.5.2 Identification of Relevant Projects and Actions

The Project is located in a relatively remote location within the Marrakai-Douglas Daly unincorporated area. Despite the remote location, there are numerous existing activities and proposed projects within the wider region that have the potential to generate cumulative impacts with the Project. These include mining projects, extractive resource operations, government infrastructure projects, military activities and agricultural operations. The Project involves redevelopment of a historic mining sites with existing environmental impacts from past activities. These legacy conditions could also contribute to the cumulative impact of the Project.

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Relevant projects which may result in cumulative impacts within a 150 km radius or within the bioregion were identified by searching the following databases:

- NT EPA environmental impact assessment register;
- NT EPA consultation hub (open and closed consultations);
- Department of Chief Minister and Cabinet Major Projects; and
- Department of Planning, Infrastructure and Logistics list of government projects.

The projects identified by this search were then screened for development status. Projects whose approval had been revoked or withdrawn were excluded, as were existing operational projects.

The remaining projects were then screened for potential spatial and temporal interaction with the Project. The final list of relevant projects identified is provided below:

- Mining:
 - Toms Gully Mine (approved and pending development) – The Toms Gully Mine, adjacent to the Project accommodation camp, is the closest mining development to the Project. The Toms Gully Mine is an underground gold mining project also proposed by PGO. The Toms Gully Mine will involve the extraction of approximately 0.9 Mt of ore and processing this through CIL process onsite.
 - Rum Jungle Mine (historic legacy mining site) – Rum Jungle site is located approximately 60 km west of the Project and currently under rehabilitation by the Northern Territory and Commonwealth Governments.
 - Browns Oxide Mine (care and maintenance) – The Browns Oxide Mine is located 65 km south of Darwin and 53 km west of the Project. The mine is under care and maintenance but anticipated to be recommissioned for operation in the near future.
 - Woolwonga Mine (exploration stage) – Bacchus Resources have been undertaking exploration activity at the Woolwonga project site, located approximately 47 km south of the Project area since 2017. There is no evidence to suggest that the Woolwonga project will move into mining operation within the Project life.
 - Hayes Creek Mine (undergoing assessment) – The proposed Hayes Creek Mine project is located approximately 58 km south of the Project. The proposal involves mining polymetallic ore bodies at Mount Bonnie and Iron Blow and process ore at Fountain Head over a total of eight years. The resultant concentrates of zinc and gold/silver would be transported by truck to the Port of Darwin for shipment to international markets. A ToR for a project EIS was release in August 2019.
 - Fountain Head Gold Mine (undergoing assessment) – the Fountain Head Gold Mine is proposing reactivation of a historic mining site located approximately 90 km south-west of the Project. The proponent is working through the pre-feasibility and environmental approvals assessments. First production is anticipated to be in 2022.
 - Union Reefs Gold Mine (care and maintenance) – The Union Reefs Gold Mine location approximately 60 km south-west entered care and maintenance in March 2020. There are indications the mine will be reactivated.
 - Frances Creek Iron Ore Mine (operational) – The Frances Creek iron ore mine located approximately 75 km south of the Project was shut down in 2015. A Mining Management Plan for the project was approved in

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March 2020 to allow existing ore stockpiles to be processed and first shipments are understood to have occurred in June 2021.

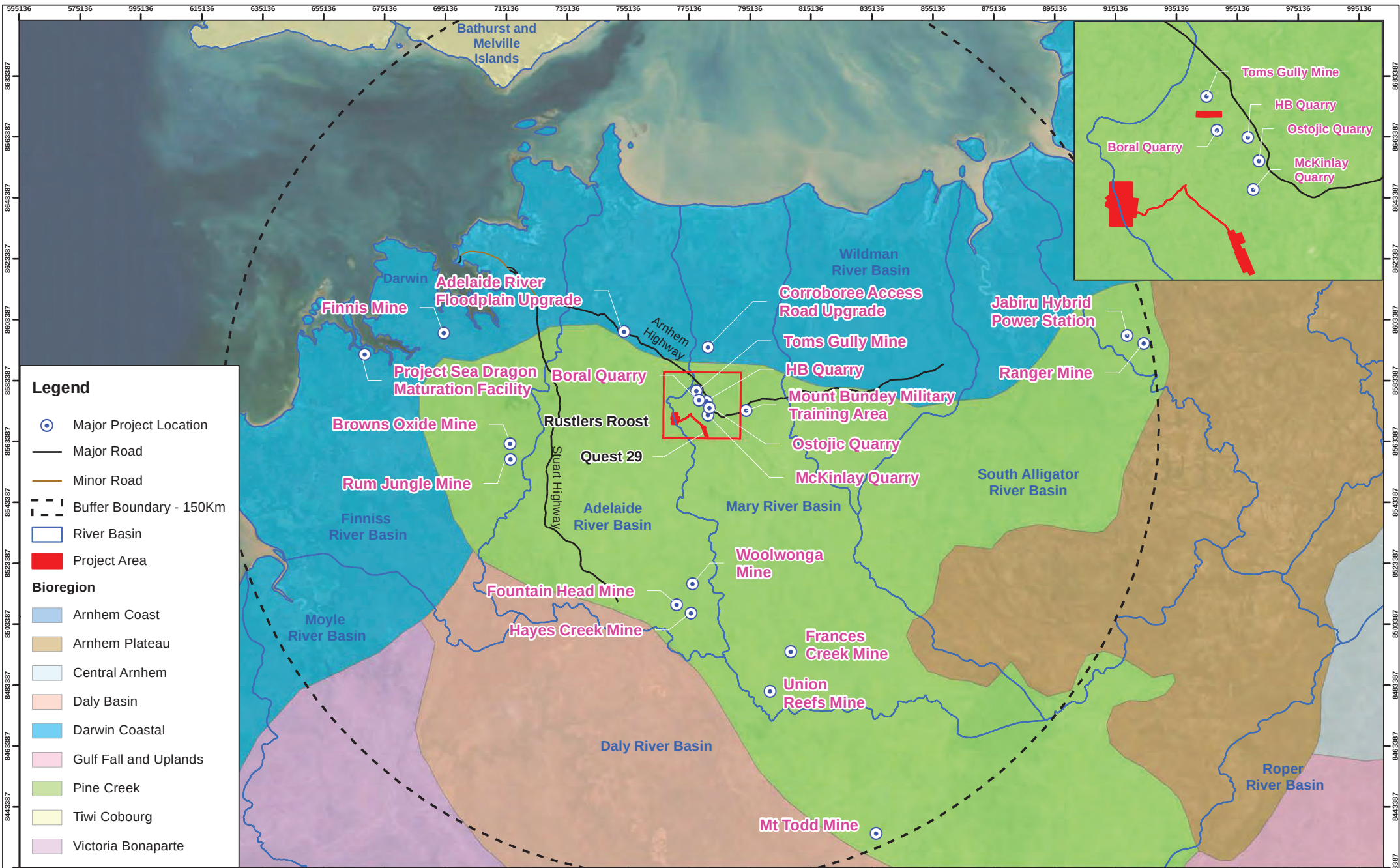
- Finnis Lithium Mine (approved pending development) – Finnis Lithium Project is located just south of Darwin Port and roughly 80 km north-west of the Project. The project received approval of their MMP in early 2020. The project team are forecasting operations to commence before the end of 2021, with first production anticipated before the end of 2022.
- Mt Todd Gold Mine (approved and pending development) – Vista Gold Australia Pty Ltd is proposing to expand the Mount Todd Gold Mine, approximately 55 km north-west of Katherine and 138 km south of the Project, adjacent to the Edith River. The project was approved by the NT EPA in 2014 and by the Commonwealth Government in 2018.
- Ranger Uranium Mine (closed) – located 150 km directly east of the Project entered closure in January 2021.
- Extractive resources:
 - HB Quarry (operational) – the HB Quarry is located just over 2 km from the Project area. The quarry is understood to operating since 1993 with an upgrade in 2012 increase the capacity. The quarry is understood to have capacity for capacity to produce around 100,000 tonnes of material per month and up to 4,000 tonnes of aggregate per day. The quarry is within the Mount Bunday Creek sub-catchment for which a portion of the Project surface water runoff is directed.
- McKinlay Quarry (operational) – the McKinlay Quarry is an active granite extractive operation. The quarry is located 3.5 km north of the Quest 29 portion of the Project and is outside the sub-catchments for the Project area.
 - Boral Quarry (operational) – the Boral Quarry is located roughly 700 m to the south of the Project area around the accommodation camp. At the peak of the Ichthys LNG project, the Mount Bunday plant employed or contracted up to 30 personnel and had an output of 100,000 tonnes per month. The quarry output is now understood to be in the order of 250,000 tonnes per annum. It continues to produce concrete and sealing aggregates, construction, drainage and bedding materials, plus manufactured sand. The quarry is within the Mount Bunday Creek sub-catchment.
 - Ostojic Quarry (operational) – the Ostojic Quarry is located approximately 4.4 km south-east of the Project area around the accommodation camp. The quarry has a capacity to produce up to 40,000 tonnes per month. Rock is extracted by drill and blast methods before being transported to the processing plant where the rocks are crushed and screened into various sized aggregates and other products.
- Government:
 - Arnhem Highway Adelaide River Floodplain Upgrade (under construction) – this is a \$77.88 M project involving the upgrade of 6.5 km of the Arnhem Highway across the Adelaide River floodplain. The project will reduce road closures during the wet season along the Arnhem Highway due to flooding of the Adelaide River, resulting in economic and safety benefits for road users. The upgraded section of the highway will be built next to the existing road alignment, which will include raising the height of the road and drainage structures (13 bridge structures) along the new alignment. The Arnhem Highway project commenced in October 2020 and is due for completion in late 2021. Therefore, construction will be complete prior to Project construction commencing.
 - Corroboree Access Road Upgrade (under construction) – this is a \$11 M project to upgrade and seal 2.6 km of the Corroboree Billabong Access Road from the end of the existing seal up to the cattle grid. A key project objective is to provide improved access for recreational fishing. Construction of the Corroboree Access Road

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began in April 2021 and was due to be completed in July 2021. Therefore, construction will be complete prior to Project construction commencing.

- Mount Bunday Military Training Area (operational) – The Mount Bunday Training Area is a large training area located approximately 120 km east-southeast of Darwin and is over 100,000 ha (DoD 2017). The property is used by Defence for a variety of military training activities including mechanised battle group sized field firing and manoeuvre training and aerial bombing. Prior to the property being acquired by the Commonwealth of Australia in the mid-1980s, it was used for commercial grazing. The property was first used as a military training area in 1992 (DoD 2017).
 - Activities include the use of firing ranges and impact areas. There is potential for accumulation of chemical contamination, unexploded ordnance and explosive ordnance, and other debris in these high explosive impact areas (DoD 2017). Other activities include vehicle wash-down facilities and the storage and distribution of fuel/oil from above ground storage tanks (ASTs) and drums. The area is outside the Project sub-catchments but within the Mary River catchment.
 - Jabiru Hybrid Power Station (under construction) – The Northern Territory Government is developing the Jabiru Hybrid Power Station to supply power to the township of Jabiru (approximately 140 km west). The current power supply for Jabiru is provided by ERA via aging diesel generators that are part of the Ranger Uranium Mine. The mine entered its closure phase from 8 January 2021 and continued electricity supply from ERA's ageing generators is not an option in the medium to long-term. The Arnhem Highway is the primary transportation route for the Project.
 - The proposed Project footprint consists of 15.28 ha situated on a lot approximately 1 km north of Jabiru and 4.8 ha of largely disturbed areas adjacent each side of El Sherana Road. The total Project area is 20.08 ha. The power station commenced construction recently and is due to be complete by the end of January 2022 (prior to construction for the Project).
- Other Private:
- Project Sea Dragon Maturation Facility (approved and under construction) – Project Sea Dragon proposes to establish a core breeding centre at Point Ceylon, Bynoe Harbour, (about 100 km to the north-west of the Project) to be used for the development, production and selection of high performing prawn stock. The top performing individual prawns would be transferred to a proposed broodstock maturation centre also at Point Ceylon to produce commercial numbers of broodstock for use in a hatchery. An assessment report for the EIS was issued by the NT EPA in 2017. Construction of Stage 1a has recently begun.

The locations of projects listed above and considered in the respective key environmental factor cumulative impact assessment sections are shown in Figure 6-2.



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R	Details	Date		©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.																		DISCLAIMER CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.				DESIGNER		CLIENT		FIGURE 6-2																	
1	First Draft	04/08/21		DESIGNED				SS		CHECKED				TK						DATA SOURCE NT Government Open Source Data								Projects and Actions Considered for Cumulative Impact																			
-	-	-		DRAWN				SS		CHECKED				TK																																	
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6.3.5.3 Degree of Cumulative Impacts for Relevant Projects

The degree of cumulative impact between the Project and identified nearby projects and activities was determined based on the potential for spatial and temporal interaction. The following classifications were used:

- High – There is likely to be direct spatial and temporal overlap of impacts;
- Medium – Impacts are not likely to directly overlap spatially but are so close in space that assimilation of combined impacts is unlikely. Additionally, impacts are so close in time that impacts are not dissipated before further impacts occur; and
- Low – Impacts do not directly overlap spatially and are separated in space such that assimilation of combined impacts is likely. Impacts may be either close or separated in time.

Table 6-10 lists the classification for each of the Projects identified in Section 6.3.5.2 and is ordered from distance from the Project.

Table 6-10 Assigned Classification of Projects relevant to Cumulative Impacts

Project	Distance from Project ⁷	Degree	Rationale
Toms Gully Mine	0 km	High	Spatially adjacent to the Project, located in the Mount Bunday Creek catchment and temporally may be developed concurrent to the Project.
Boral Quarry	700 m	High	Spatially close, within the same bioregion and within the same sub-catchment for the Project and utilises the same transport route (Arnhem Highway).
HB Quarry	2 km	High	Spatially close, within the same bioregion and within the same sub-catchment for the Project and utilises the same transport route (Arnhem Highway).
McKinlay Quarry	3.5 km	Moderate	Spatially close, within the same bioregion, but within a separate sub-catchment and utilises the same transport route (Arnhem Highway).
Ostojic Quarry	4.4 km	Moderate	Spatially close, within the same bioregion, but within a separate sub-catchment and utilises the same transport route (Arnhem Highway).
Mount Bunday Military Training Area	9 km	Moderate	Training area and associated activities are located in the same Mary River Basin but is outside the Project sub-catchments. Military activities may temporarily overlap with the Project and used of the Arnhem Highway.
Corroboree Access Road Upgrade	16 km	Low	Upgrade to be completed prior to construction starting on the Project.
Arnhem Highway Upgrade	30 km	Low	Upgrade to be completed prior to construction starting on the Project.
Woolwonga Mine	47 km	Moderate	Spatially distant, within a river basin relevant to the Project (Adelaide River); however, only in exploration stage and no publicly available information to consider impacts. Also, Operations may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.

⁷ Approximate distance from Project area

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Project	Distance from Project ⁷	Degree	Rationale
Browns Oxide Mine	53 km	Low	Spatially distant, located in a separate river basin and no clear indication of reactivating within the timeframe of the Project.
Hayes Creek Mine	58 km	Moderate	Spatially distant, within a river basin relevant to the Project (Adelaide River) and within the same bioregion. Operations may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.
Rum Jungle Mine	60 km	Low	Spatially distant, located in a separate river basin and the activities are associated with rehabilitation of a legacy site only.
Union Reefs Gold Mine	60 km	Moderate	Spatially distant, within a river basin relevant to the Project (McKinlay River that feeds the Mary River) and within the same bioregion. Project in care and maintenance and no certainty on reactivation. Operations may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.
Frances Creek Iron Ore Mine	75 km	Moderate	Spatially distant but within the Mary River Basin. Operations may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.
Finnis Lithium Mine	80 km	Moderate	Spatially distant, within a river basin relevant to the Project (Adelaide River) but located in a separate bioregion (Darwin Coastal Bioregion). Based on publicly available information the construction and operational periods for the mine and the Project could occur concurrently. Finnis Mine would utilise different transport routes and affect different communities to the Project.
Fountain Head Gold Mine	90 km	Moderate	Spatially distant, within a river basin relevant to the Project (Adelaide River) and within the same bioregion. Operations may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.
Project Sea Dragon Maturation Facility	100 km	Low	Spatially distant from the Project, within different catchment and bioregion. Construction of Stage 1a has begun and construction for the Project may overlap subsequent stages but are not within the same area of activity.
Mount Todd Gold Mine	138 km	Low	Spatially distant, within a separate river basin. Temporally development may occur concurrent to the Project but no certainty on timeframes and would utilise different transport routes and affect different communities to the Project.
Jabiru Hybrid Power Station	140 km	Moderate	Spatially distant from the Project, within separate river basin; however, within the same bioregion (Pine Creek Bioregion) and will utilise the same transportation route for the Project. The power station would be operational at same time as the Project.
Ranger Uranium Mine	150 km	Low	Spatially distant from the Project. In separate catchments. Utilises the same primary transport route (Arnhem Highway) however has transitioned into closure and rehabilitation.

6.3.5.4 Significance of Cumulative Impacts

For those projects with a high degree of cumulative impact, either qualitative or quantitative assessments were undertaken to consider the significance of cumulative impacts on identified relevant environmental values. Quantitative assessment was undertaken for terrestrial ecosystems (refer Section 7.2.2 for further detail) and also considered projects with a moderate degree of impact where located in the same bioregion. This considered data on the extent of clearing of native vegetation communities and clearing within the same bioregion. Mitigation measures for significant cumulative impacts were identified where required.