



Rustlers Roost and Quest 29 Open-Cut Mine Redevelopment

Draft Environmental Impact Statement (EIS)

Section 8 - Other Environmental Factors

Prepared pursuant to the Environment Protection Act 2019

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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 8 Other Environmental Themes and Factors

This section briefly reviews the Other Environment Themes and Factors that have been identified in the ToR during stakeholder engagement or have emerged through the development of the assessment process.

Whilst these factors have been identified through the assessment process, they are not considered to be of material significance, either due to the low level of likelihood, or consequence and will be managed and mitigated through implementation of Project commitments, the environmental management measures identified to address the key environmental factors and the MMP which is required to be developed in order to obtain the Mining Authorisation under the *Mining Management Act 2001*.

At the referral stage, the NT EPA's Statement of Reasons concluded:

"The Referral Report submitted by PGO considered potential impacts to each of the other environmental factors and objectives covered by the Guide to NT EPA environmental factors and objectives. Impacts to those factors are not considered to be significant and can be avoided and mitigated through routine management measures documented in the Mining Management Plan (MMP) required to obtain a Mining Authorisation under the Mining Management Act. As a result the draft TOR does not include any further information requirements for these factors."

Table 8-1 summarises the potential impacts, mitigation measures and outcomes for each of the Other Environment Themes and Factors. With the exception of the human health factor under the people theme, no new or additional environmental factors or themes were identified through this Draft EIS, nor raised as part of the stakeholder consultation to date, that require additional management measure that have not already been identified and addressed in the Key Environmental Factors (Section 7).

Section 8 Other Environmental Themes and Factors

Table 8-1 Other Environmental Factors

Theme	Factor and Objective	Potential Impact	Justification / Conclusion
Land	Landform: Conserve the variety and integrity of distinctive physical landforms.	Therefore, the proposed activities are unlikely to have a significant impact on the Environmental Factor for Landforms.	Mount Bunday is a distinctive landform located immediately to the north of Quest 29 and approximately 8 km east of Rustlers Roost. There are a number of established quarry operations that extract granite and other materials from Mount Bunday, and the proposed activities will not directly impact on Mount Bunday or any other landform. A significant portion of the development envelope has been historically disturbed from past mining activities and new areas of disturbance within the Project area will be minimised where possible. The Project has sought to utilise existing disturbed landforms to the greatest extent possible and the Project area does not maintain physical landforms that are distinctive from the wider region nor significant for tourism or aesthetic purposes. Furthermore, the site is well set back from publicly accessible locations.
Sea	Coastal Processes: Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.	The proposed activities are unlikely to have a significant impact on the Environmental Factor for Coastal Processes	The Project is located over 100 km from the coast and geophysical and hydrological processes for the coast are highly unlikely to be influenced by the Project. Therefore, this factor has not been considered in this EIS.
	Marine Environmental Quality: Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.	The proposed activities are unlikely to have a significant impact on the Environmental Factor for Marine Environmental Quality	The Project is located over 100 km from the coast and the influence on quality and productivity of water, sediment and biota within the marine environment is expected to be insignificant. Therefore this factor has not been considered in this EIS.
	Marine Ecosystems: Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	In the event of a major catastrophic tailings dam embankment failure, there is a potential for this factor to be adversely impacted. Refer to Section 8.1 below for further consideration.	The Project is located over 100 km from the coast and the influence on quality and productivity of water, sediment and biota within the marine environment is expected to be insignificant or temporally limited. However, it is acknowledged that the downstream extents of the receiving environments (Adelaide River and Mary River) contain estuarine environments which constitute part of the marine ecosystem. Major catastrophic failures from the TSF could conceivably release material that would reach the estuarine environment of these systems and therefore this factor has been considered further in Section 8.1 below.

Section 8 Other Environmental Themes and Factors

Theme	Factor and Objective	Potential Impact	Justification / Conclusion
Air	Air Quality: Protect air quality and minimise emissions and their impact so that environmental values are maintained.	The proposed activities are unlikely to have a significant impact on the Environmental Factor for Air Quality.	Qualitative assessment of impacts for the air quality have been identified with consideration of proposed Project activities and their proximity to receiving environments and sensitive receptors. Air quality impacts from the Project are most likely to occur from wind erosion of exposed areas, resulting in localised increases in airborne particulate matter and deposition. No impacts to sensitive residential receptors are anticipated due to the distance from the Project. Localised impacts to terrestrial and aquatic ecosystems in immediate proximity to the work areas are expected to either be inconsequential to flora and fauna health or appropriately manageable with regard to watercourse deposition and sedimentation. Potential impacts and management measures are discussed in Section 7 above (Refer to Section 7.2 and Section 7.6)
	Atmospheric Processes: Minimise greenhouse gas emissions so as to contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050.	The Project will contribute GHG emissions to the atmosphere during the stages of construction, operation and decommissioning. Per annum the total emissions estimate for the Project per annum during operation is approximately 217,111 t CO ₂ -e or 1.36% of NT emissions ¹⁹ (refer to Table 8-7).	The Project will produce GHG emissions as part of the operations. In appreciation of the NT Government's goal to achieve net zero GHG by 2050, PGO have identified and assessed the predicted GHG contribution (refer to Section 8.2 below). In accordance with the NT Government policy, PGO have worked to incorporate GHG reduction measures into the planning and design of the Project. The Project, as initially referred to the NT EPA in February 2021, proposed trucking of LNG to site for operation of the process plant and diesel generators to power the accommodation camp. Through Project refinement and consideration of avenues to reduce both costs, fuel consumption and consequently GHG emissions, PGO is seeking to link the process plant directly to an existing gas pipeline and link the accommodation camp to the mains network. This will result in two aspects of GHG emissions reduction. Firstly, this removes the emissions from trucking diesel and LNG to site and secondly use of main power which is generated from LNG power stations emits lower carbon dioxide equivalents (CO₂-e) for the power generated. A range of measures are provided in Section 8.2.3 to further reduce GHG emissions generated by the Project during both the construction and operational phases. Furthermore, PGO is committed to continual review and improvement of performance during operation. Section 10 outlines the company environmental management approach for the Project, which includes:

¹⁹ Total emissions for the Northern Territory in 2018 were 16.0 Mt t CO₂-e (DISER 2020).

Section 8 Other Environmental Themes and Factors

Theme	Factor and Objective	Potential Impact	Justification / Conclusion
			- Regular audits and inspections to determine environmental concerns and areas for improvement including fuel burning and GHG emissions; - Ensuring that procurement and contracting strategies reflect environmental performance requirements (i.e., seeking a high standard of compliance, including for emission reductions from suppliers); and - Ensure that specifications and contracts include performance requirements in relation to energy and water efficiency and other measures to reduce resource consumption and waste generation.
People	Cultural and Heritage: Protect sacred sites, culture and heritage	The proposed activities are unlikely to have a significant impact on sacred sites, culture and heritage.	Whilst there are no recorded or known sacred sites within the Project area, there are several sites in the downstream environment and the significance of both the Adelaide River and Mary River floodplains for cultural heritage values is acknowledged. The relevance of the downstream environment to cultural heritage values and ongoing use by Aboriginal parties has been identified in Section 7 – Key Environmental Factors. Furthermore, potential impacts from the Project on these areas and values are addressed in respective sections, most notably Section 7.4 – Inland Environmental Water Quality. As such, it is considered this factor is adequately addressed with consideration of the key environmental factors and no further information has been identified during preparation of the Draft EIS that would warrant further consideration under the Cultural and Heritage factor.
	Human Health: Protect the health of the Northern Territory population.	The Project has identified that there will be interaction with naturally occurring radioactive materials (NORMs). Although this has not been identified as a significant risk, it has been identified through geochemical analysis undertaken during preparation of the Draft EIS documentation and is addressed in Section 8.3 below.	The Project will likely with NORMs in the form of Uranium and Thorium when intersecting specific lithologies. NORMs are not an uncommon element managed safely within the resource sector. Levels will be managed by standard practices to prevent harm to the environment, employees and the wider community.

8.1 Sea – Marine Ecosystems

NT EPA Environmental Factor	Marine Ecosystem
NT EPA Environmental Objective	Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.
Relevant Policy and Guidance	- Australian Water Quality Guidelines for Fresh and Marine Waters (ANZG 2018); and - Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure (ANCOLD 2019).

A dam break consequence assessment commissioned by PGO (Appendix F) identified that there is potential for the Project to have an impact on marine ecosystems in the event that there is a catastrophic embankment failure of the TSF was to occur. Whilst the Project is located approximately 100 km inland from the coast, the estuarine environment of the Adelaide River and Mary Rivers extends approximately 70 km upstream (Figure 8-1). Any adverse impacts to the surrounding river systems, may reach the marine ecosystem through the dispersing of contaminants through waters and sediments via the rivers and floodplains, which all flow to the estuarine environment. These impacts however are expected to be limited spatially and temporally.

8.1.1 Environmental Values

Regionally the Project area is located between the major waterways of the Adelaide River (west) and Mary River (east) and associated floodplains that ultimately flow to the estuarine environment and discharge to the Van Diemen Gulf (Figure 8-1).

The Adelaide River coastal floodplain is a seasonally inundated freshwater floodplain that is intersected by a major and permanent tidal river. The Adelaide River coastal floodplain comprises a mix of tidal and seasonal wetland habitats, dominated by grass and sedge communities and is bordered by open woodland with patches of monsoon forest (McGuire *et al.* 2009). The area has an 'International' significance rating, which is attributed to it supporting a large number of waterbirds including those of international significance like the Magpie Goose and the Whistling Duck; and providing habitat for 10 threatened fauna species and four threatened flora species (McGuire *et al.* 2009).

The Adelaide floodplain system meets the five of the six criteria noted by the Directory of Important Wetlands Australia (DIWA) (McGuire *et al.* 2009). These criteria are:

- Criteria 2 – It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- Criteria 3 – It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail;
- Criteria 4 – The wetland supports 1% or more of the national populations of any native plant or animal taxa;
- Criteria 5 – The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level; and
- Criteria 6 – The wetland is of outstanding historical or cultural significance.

Section 8 Other Environmental Themes and Factors

The Adelaide River coastal floodplain includes the following DIWA wetland types:

- A6 – Estuarine waters; permanent waters of estuaries and estuarine systems of deltas;
- A7 – Intertidal mud, sand or salt flats;
- A8 – Intertidal marshes; includes salt-marshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater marshes;
- A9 – Intertidal forested wetlands; includes mangrove swamps, nipa swamps, tidal freshwater swamp forests;
- B1 – Permanent rivers and streams; includes waterfalls;
- B4 – Riverine floodplains; includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna;
- B9 – Permanent freshwater ponds;
- B10 – Seasonal/intermittent freshwater ponds and marshes on inorganic soils; includes sloughs, potholes; seasonally flooded meadows, sedge marshes;
- B14 – Freshwater swamp forest; seasonally flooded forest, wooded swamps; on inorganic soils; and
- C1 – Water storage area; reservoirs, barrages, hydro-electric dams, impoundments (generally >8 ha).

The complex structure of the Mary River coastal floodplain is comprised of numerous river channels that flow out to sea. The Mary River coastal floodplain is poorly drained, and the inflow channel seeps into large seasonal swamps before reaching the ocean through the available tidal channels. These features result in great areas of wetland habitats flooded over extended periods and a complex and productive ecosystem (Harrison *et al.* 2009).

The Mary River coastal floodplain has an 'International' significance rating, attributed to it supporting habitation to international significant species like the Magpie Goose, whilst also providing a major breeding area for fish. The Mary River coastal floodplain provides habitat and supports 12 threatened species, including the Vulnerable Yellow Chat (Harrison *et al.* 2009).

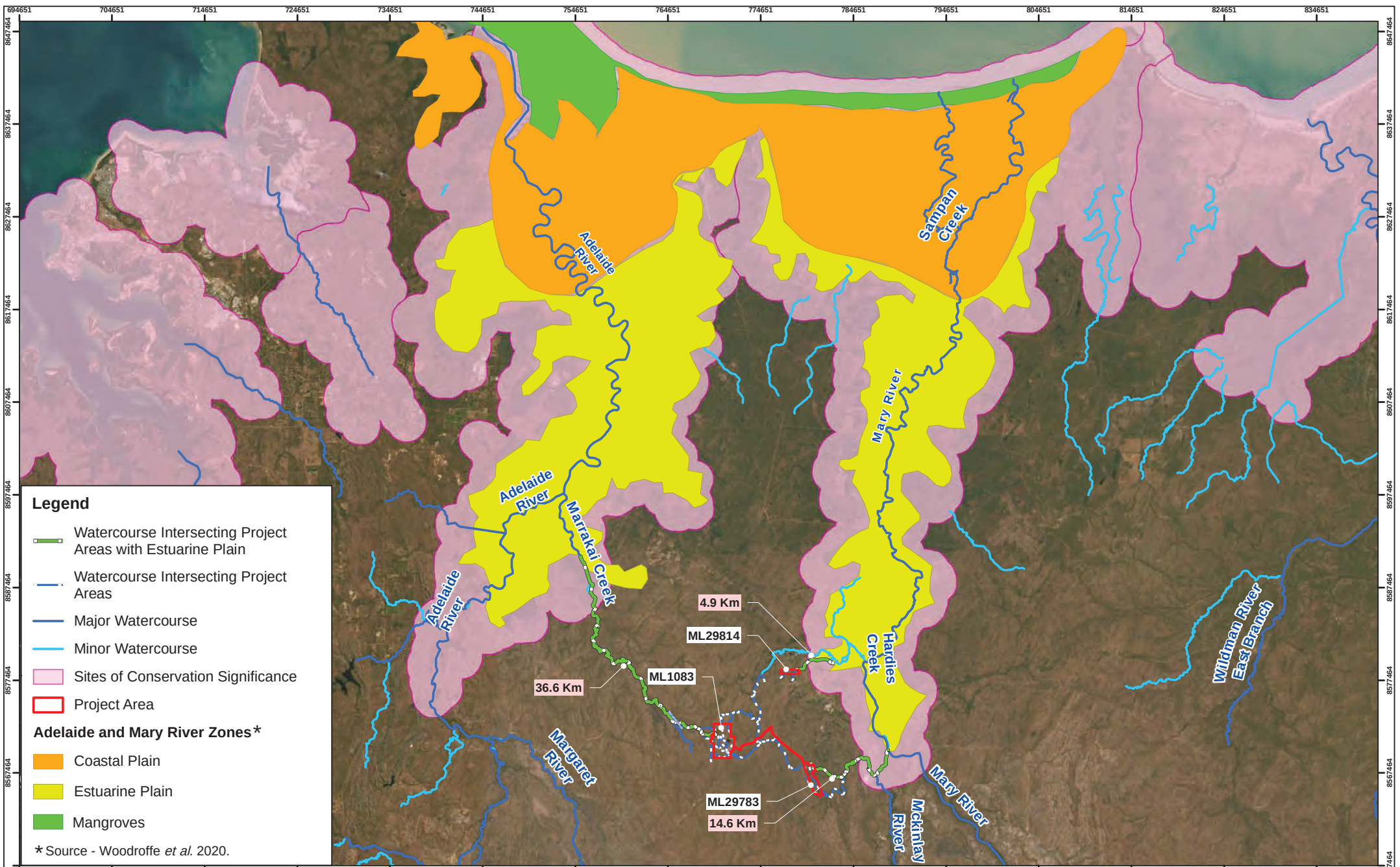
The Mary River floodplain system also meets the five of the six criteria noted by DIWA (Harrison *et al.* 2009). These criteria are:

- Criteria 2 – It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- Criteria 3 – It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail;
- Criteria 4 – The wetland supports 1% or more of the national populations of any native plant or animal taxa; and
- Criteria 6 – The wetland is of outstanding historical or cultural significance.

Section 8 Other Environmental Themes and Factors

Additionally, the Mary River is comprised of the following DIWA wetland types:

- A6 – Estuarine waters; permanent waters of estuaries and estuarine systems of deltas;
- A7 – Intertidal mud, sand or salt flats;
- A8 – Intertidal marshes; includes salt-marshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater marshes;
- A9 – Intertidal forested wetlands; includes mangrove swamps, nipa swamps, tidal freshwater swamp forests;
- B1 – Permanent rivers and streams; includes waterfalls;
- B4 – Riverine floodplains; includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna;
- B9 – Permanent freshwater ponds;
- B10 – Seasonal/intermittent freshwater ponds and marshes on inorganic soils; includes sloughs, potholes; seasonally flooded meadows, sedge marshes; and
- B14 – Freshwater swamp forest; seasonally flooded forest, wooded swamps; on inorganic soils.



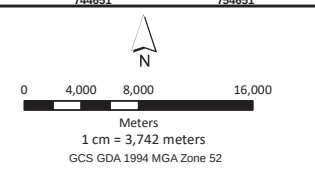
- Legend**
- Watercourse Intersecting Project Areas with Estuarine Plain
 - Watercourse Intersecting Project Areas
 - Major Watercourse
 - Minor Watercourse
 - Sites of Conservation Significance
 - Project Area

Adelaide and Mary River Zones*

- Coastal Plain
- Estuarine Plain
- Mangroves

* Source - Woodroffe *et al.* 2020.

R	Details	Date	©COPYRIGHT CDM SMITH This drawing is confidential and shall only be used for the purpose of this project.			
1	Final	09/09/21	DESIGNED	SS	CHECKED	TK
-	-	-	DRAWN	SS	CHECKED	TK
-	-	-	APPROVED	TK	DATE	09/09/21
-	-	-	Notes:			



DISCLAIMER
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DATA SOURCE
NT Government Open Source Data

DESIGNER CDM Smith	CLIENT PRIMARY GOLD	Figure 8-1 Mary River and Adelaide River Coastal Floodplains
		DRG Ref: 1001087-EIS-08-8.1

8.1.2 Potential Impacts and Risks

Marine ecosystems have been identified as an environmental factor that has the potential to be impacted from activities in relation to unplanned embankment failure of the TSF wall(s). The impact to marine ecosystems, from the Project, is not considered to be significant, with consideration to the extremely low likelihood of occurrence, and distance from the source. Despite the low likelihood, PGO have taken the opportunity to address the risks, impacts and proposed mitigation measures through this assessment process.

A dam breach assessment was conducted by Knight Piésold Consulting (2021) (Appendix F) to determine the level of impact should a failure occur and not on the likelihood of the failure occurring. The assessment was performed under the assumption that there would be a significant loss of material. Therefore, the TSF dam break assessment was performed with consideration to the worst-case scenario, using the assumption that the TSF was at maximum tailings storage capacity, for the potential impact to the environment.

In the event of a breach of western embankment of the TFS, tailings have potential to enter the Marrakai Creek (40 km downstream) and then onwards into the Adelaide River (47 km downstream). This would then pose the potential risk of entering the Adelaide River coastal floodplain. Similarly, in the event of a breach of the eastern TSF embankment, the tailings have the potential to travel into the Mary River (58 km downstream) and onwards and outwards through the Mary River coastal floodplain.

On a conservative basis, the impacts from a TSF dam break assessment on the natural environment with consideration to a worst-case scenario would be catastrophic. Remediation would be difficult due to the high runout distance and impact area. Should material from a TSF at maximum capacity enter the waterways, containment would be difficult and over 20 km² would be impacted, due to the low-lying topography (Knight Piésold Consulting 2021).

Once contaminants from the TSF are in these systems, the downstream impacts may adversely affect the marine ecosystem, as the contaminants may spread further throughout the associated floodplains, through the breeding and foraging habitats of marine species and out to sea.

8.1.3 Avoidance, Mitigation and Management

A strategy of a hierarchical approach of avoidance, mitigation and management to minimise the potential impacts to the environmental values for marine ecosystems is presented below.

Table 8-2 Avoidance, Mitigation and Management

Potential Impacts	Measures
Overtopping, embankment failure or seepage from the new TSF at Rustlers Roost leading to uncontrolled release of tailings material to surrounding environment. (Risk #: TEQ – 2, IWEQ – 4, AE – 4)	- TSF to be planned, designed, constructed and operated in accordance with approaches detailed in the guideline Tailings Management: Leading Practice Sustainable Development Program for the Mining Industry (Australian Government 2016). - Design TSF to contain a range of design storm and rainfall sequences events up to and greater than the required design criteria. - An operational emergency spillway to be constructed as part of each embankment raise. - Development of Monitoring Plan / Operational Manual which includes weekly inspections of the TSF, survey pins to monitor the embankment and piezometers to measure pore water pressure. - Tailings performance monitoring (e.g. TSF water volume, collection efficiency of underground system). - Install seepage control and underground drainage including a cut-off trench, compact soil liner, basin underdrainage collection system, underdrain collection sump and embankment toe drain. - Groundwater monitoring to check quality and any seepage.

Section 8 Other Environmental Themes and Factors

Potential Impacts	Measures
	▪ Implementation of AMDMP and WMP. ▪ Manage the site water balance to reduce any build-up of water.
Geotechnical instability and failure of pit wall, TSF or WRD walls. (Risk #: TEQ – 6)	▪ Detailed design and quality assurance/control of TSF, WRD and pit wall designs. ▪ Geotechnical studies and regular assessment to ensure structural stability. ▪ Engineering design to ANCOLD standard. ▪ WMP. ▪ Weekly inspections to check sufficient freeboard and structural integrity.

8.1.4 Outcomes

It is recognised that the Project has the potential to affect marine ecosystems. This has been discussed through the evaluation of a failure of the tailings dam wall and assessed under the assumption that the tailings dam would be at full capacity at the time of hypothetical failure. To ensure that there is negligible to no significant impact to the marine ecosystem, PGO will adhere to the relevant ANCOLD guidelines; and are committed to developing and implementing the required management plans and procedures to monitor, evaluate and adapt to reduce the likelihood of a breach in the tailings dam wall to ALARP, mitigating any impact to the marine ecosystem. PGO believe that the mitigation measure already identified in Section 7.1 - Terrestrial Environmental Quality, 7.4 - Inland Water Environmental Quality and 7.5 - Aquatic Ecosystems will be adequate to manage risks to the marine ecosystem.

8.2 Air – Atmospheric Processes

NT EPA Environmental Factor	Atmospheric Processes
NT EPA Environmental Objective	Minimise greenhouse gas emissions so as to contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050.
Relevant Policy and Guidance	▪ <i>National Greenhouse and Energy Reporting Act 2007</i> (NGER Act); ▪ National Greenhouse and Energy Reporting Regulations (NGER Regulation) 2008; ▪ National Greenhouse Accounts Factors (DotEE 2017); ▪ State and Territory Greenhouse Gas Inventories 2018 (DISER 2020); and ▪ Greenhouse Gas Emissions Management for New and Expanding Large Emitters (DEPWS 2021).

Greenhouse Gases (GHG) are gases in the Earth's atmosphere that trap heat, allowing the temperature of the Earth to be kept at a level that is necessary to maintain life. An increase in the levels of these gases in the atmosphere results in an increase in the amount of heat being trapped, leading to warming of the Earth's surface and oceans commonly known as the enhanced greenhouse effect, or more commonly as global warming.

The following section presents an analysis of the anticipated GHG emissions for the construction and operational phases of the Project in accordance with Table 2 of the ToR, which requires an estimate of the annual GHG emissions including scope 1 and 2.

8.2.1 Legislative Requirements

Australia's International Commitments

International commitments regarding climate change and global action are addressed by the United National Framework Convention on Climate Change (UNFCCC). There are currently 192 Parties to the UNFCCC including Australia. Australia's global commitments to climate change is overseen by the Department of Industry, Science, Energy and Resources (DISER).

The Kyoto Protocol is an international agreement created under the UNFCCC in Kyoto, Japan in 1997. Australia ratified the Protocol in 2007, and this came into effect in 2008. The Kyoto Protocol aims to reduce global GHG emissions by requiring developed countries to meet internationally agreed emission reduction or limitation targets for the period 2008-2012, which was extended to 2020.

Under the Paris Agreement, the most recent progression of the UNFCCC, Australia has set a target to reduce emissions by 26-28% below 2005 levels by 2030, building on the 2020 target of reducing emissions by 5% below 2000 levels. The objectives of the Paris Agreement include: a goal to limit the increase in global temperatures to well below 2 degrees and pursue efforts to limit the rise to 1.5 degrees; a commitment to achieve net-zero emissions, globally, by the second half of the century; differentiated expectations for developed nations, including Australia, that they will reduce their emissions sooner than developing nations; and a five year review and ratchet process which is likely to lead to more ambitious commitments from countries in the future.

The greenhouse gases reportable under international commitments are:

- Carbon dioxide (CO₂);

- Methane (CH₄);
- Nitrous oxide (N₂O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulfur hexafluoride (SF₆).

These gases vary in effect and longevity in the atmosphere, however a system named Global Warming Potential (GWP) allows them to be described in terms of CO₂, called carbon dioxide equivalents (CO₂-e). A unit of one tonne of CO₂-e is the basic unit used in carbon accounting.

8.2.1.1 Commonwealth

National Greenhouse Energy Reporting Act 2007

The *National Greenhouse Energy Reporting Act 2007* (Cth) (NGER Act) establishes a national framework for the reporting of GHG emissions and the production and consumption of energy. It is applicable when a corporation or single facility (including typically mineral and energy companies) exceeds the threshold values as detailed in s13 of the NGER Act. The NGER Act is administered by the Clean Energy Regulator with details and allowable calculation methodologies contained in the:

- National Greenhouse and Energy Reporting Regulations 2008 (NGER Regulation); and
- National Greenhouse and Energy Reporting Determination 2008 (NGER Determination).

Registration and reporting are mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. Current NGER Act reporting thresholds are summarised in Table 8-3.

Table 8-3 NGER Reporting Thresholds

	Threshold Type		
	GHG (kilotonnes CO ₂ -e) Scope 1 and Scope 2	Energy Consumption (TJ)	Energy Production (TJ)
Facility	25	100	100
Corporate	50	200	200

Per annum the total operational emissions estimate for the Project is 217,111 t CO₂-e or 1.36% of Northern Territory emissions²⁰ (refer to Table 8-6). On this basis, the Project will trigger the corporate reporting threshold under the NGER Act, which is 50,000 t CO₂-e per annum (Table 8-3).

²⁰ Total emissions for the Northern Territory in 2018 were 16.0 Mt t CO₂-e (DISER 2020).

8.2.1.2 Northern Territory

Northern Territory Climate Change Response: Towards 2050

The *Northern Territory Climate Change Response: Towards 2050*²¹ presents the NT response to the challenge of climate change. The NT's objective is to progressively reduce net greenhouse gas emissions, with the goal of achieving net zero emissions by 2050. This long-term objective sets expectations about future emission constraints to help NT's industries and businesses plan and adapt. Aiming to achieve net zero emissions aligns the NT with all other States and Territories across Australia. The objective of net zero emissions is proposed to be achieved by strategies and actions aimed at reducing emissions, investing in renewable energy and supporting opportunities for carbon sequestration and storage.

Greenhouse Gas Emissions Management for New and Expanding Large Emitters

The Northern Territory Government's 'Greenhouse Gas Emissions Management for New and Expanding Large Emitters' policy (DEPWS 2021) identifies the minimum requirements for the management of GHGs from new or expanding industrial and land use development projects. It has been established in recognition of the Northern Territory's target of net zero GHGs by 2050. The policy applies to all new and expanding existing projects that are likely to be large emitters which includes mining activities that meet an emission threshold of 100,000 t CO₂-e of scope 1 emissions in any financial year over the life cycle of a project, not counting emissions generated from land clearing directly associated with the project. The Project annual scope 1 operational emissions are estimated to be in the order of 215,318 t CO₂-e (refer to Table 8-6) and therefore the policy applies to the Project (refer to Section 8.2.3).

Draft Greenhouse Gas Emissions Offset Policy and Technical Guidelines

The Northern Territory Government recently release a draft GHG offset policy and technical guideline for public consultation. The policy establishes how and when to use offsets in the Northern Territory to compensate for emissions. The policy applies to offsets in relation to emissions only and biodiversity offsets are subject to a separate biodiversity offset policy and technical guidelines. Where an emissions offset is considered appropriate, the decision maker for the approval may require residual emissions to be offset as a condition of the approval (an emissions offset approval condition). This may require proponents to deliver on their offset proposal or may apply different offset requirements than those proposed by the proponent.

8.2.2 Greenhouse Gas Assessment

The GHG emissions assessment determined the carbon dioxide equivalent (CO₂-e) emissions from the Project according to international and national guidelines. The DISER monitors and compiles databases on anthropogenic activities that produce GHGs in Australia. The DISER has published GHG emission factors for a range of anthropogenic activities. The methodology for calculating GHG emissions is published in the National Greenhouse Accounts Factors (NGA Factors) workbook (DotEE 2017). This workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported, as defined by the NGA Factors workbook is determined by whether the activity is within the organisation's boundary (Scope 1 – Direct Emissions) or outside the organisation's boundary (Scopes 2 and 3 – Indirect Emissions). Emission factors are used to estimate emissions to the air from various sources based on the quantity of a substance emitted from a source to a measure of activity associated with the source. Emission factors used in this assessment have been derived from either the DotEE database, site-specific information or from operational details obtained from similar emission sources.

²¹ The Northern Territory Climate Change Response: Towards 2050 -

https://depws.nt.gov.au/_data/assets/pdf_file/0005/904775/northern-territory-climate-change-response-towards-2050.pdf

Section 8 Other Environmental Themes and Factors

The NGER Act states that the following gases must be reported:

- Carbon dioxide – associated with fuel combustion;
- Methane – associated with consumption of natural gas;
- Nitrous oxide – associated with the use of explosives in mines;
- Hydrofluorocarbons – used for refrigeration and air conditioning;
- Perfluorocarbons – occurs during the manufacture of semi-conductors and used as a refrigerant; and
- Sulfur hexafluoride – used in the production of magnesium and as an electrical insulator.

It is expected that GHG emissions will be produced by:

- Vegetation clearing – 383.13 ha of Eucalyptus woodland and 6.27 ha of Eucalyptus open forest;
- Vehicle and machinery – diesel combustion;
- Landfill – gas emissions;
- Water treatment plant – gas emissions;
- Power Station – powered by LNG; and
- Accommodation camp – temporary diesel generator (combustion) during construction (Stage 1) and electricity consumption from the existing NT Power and Water network at Toms Gully during operation of the camp.

Carbon dioxide (from diesel combustion) and methane (LNG) are the only gases included in the GHG assessment. Although the Project is expected to use explosives (nitrous oxide) and hydrofluorocarbons for refrigeration and air conditioning during construction and operation, negligible quantities of these gases are expected to be used/generated and therefore, these gases have been excluded from the assessment. All emissions data have been converted into quantities of carbon dioxide. GHG emissions were calculated in accordance with the GHG protocol emissions scopes. The assessed scopes are defined as follows:

- Scope 1 Emissions: direct (or point source) emission factors give the kg of CO₂-e (kg CO₂-e) emitted per unit of activity at the point of emission release (i.e., fuel use, energy use, manufacturing process activity, mining activity, and onsite waste disposal);
- Scope 2 Emissions: indirect emissions from the generation of electricity purchased and consumed by an organisation as kg of CO₂-e per unit of electricity consumed; and
- Scope 3 Emissions: various emissions from sources not owned or directly controlled by the corporation including:
 - Burning fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels
 - Consuming purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Section 8 Other Environmental Themes and Factors

Scope 1 emissions include those from diesel combustion used by vehicles and machinery and temporary use of diesel generator during construction of the accommodation camp (Stage 1), consumption of LNG for the power station and gas emissions from the landfill and water treatment plant. Although there will be a back-up diesel generator for the accommodation camp during operation, this has not been accounted for as it may not be used in any given year.

Scope 2 emissions are from any generation of electricity purchased. The accommodation camp will consume electricity from the existing grid at Toms Gully and therefore, this has been included in this assessment.

Scope 3 emissions include all sources not owned or controlled by PGO. This is not applicable for the Project and therefore, it has been excluded from this assessment.

8.2.2.1 Project Data Input

For this assessment, Scope 1 and Scope 2 emissions have been calculated in accordance with the NGA Factors Workbook (DotEE 2017) methodology as indicated in Table 8-4.

Table 8-4 Emission Factor

Scope	Emission Source	Emission Factor
1	Combustion emissions from diesel (stationary)	69.9 kg CO ₂ -e/GJ
	Combustion emissions from diesel (transport)	69.9 kg CO ₂ -e/GJ
	Consumption of LNG (power station)	51.4 kg CO ₂ -e/GJ
	Landfill emissions	1.2 t CO ₂ -e/t waste
	Water treatment plant emissions	NA
	Vegetation Clearing	NA
2	Electricity consumption from grid (accommodation camp)	0.64 kg CO ₂ -e/kWh

Source: NGA Factor (DotEE 2017)

Emissions were calculated for both the construction and operations phase of the Project. The data input for the calculation of emissions of both of these Project phases is included below.

Section 8 Other Environmental Themes and Factors

Construction Phase Data Input

The construction phase emissions have been calculated based on the required diesel for vehicles and machineries (including staff movements and deliveries) and for the temporary generator at the accommodation camp. Additionally, estimated landfill emissions were also considered (refer to Table 8-5).

Table 8-5 Construction Annual Emissions (Tonnes CO₂-e)

Emission Source ¹	Scope	Amount of Material	Emissions (t CO ₂ -e)
Generator Emissions (tonnes CO₂-e)			
Temporary diesel generator at accommodation camp	1 (Direct)	216 kL	583
Sub-Total 1			583
Construction Machinery Fuel Emissions (tonnes CO₂-e)			
1 Excavator - 30-t class	1 (Direct)	10.9 kL	29.5
4 Trucks - 90 – 100-t class	1 (Direct)	171 kL	460.9
2 Dozer - 50-t class	1 (Direct)	160 kL	433.3
1 Grader - 4.3-m Moldboard	1 (Direct)	55 kL	148.4
1 Water Cart - 80 kL	1 (Direct)	10 kL	27.0
1 Fire tender - TBD	1 (Direct)	50 kL	134.9
1 Service truck - TBD	1 (Direct)	30 kL	80.9
5 Light vehicles - Various	1 (Direct)	14.6 kL	39.4
Sub-Total 2			1,354.4
Transport Fuel Emissions (tonnes CO₂-e)			
Staff Movements	1 (Direct)	1.8 kL	4.7
Material Deliveries	1 (Direct)	6.1 kL	16.5
Sub-Total 3			21.3
Other Activities Emission (tonnes CO₂-e)			
Gas emission from landfill	1 (Direct)	1,000 t	200
Sub-Total 4			200
Vegetation Clearing (tonnes CO₂-e)			
Vegetation Clearing	1 (Direct)	368.86 ha	36,517.14
Sub-Total 5			36,517.14
Total			38,675.84

1 – Where relevant, emission source includes emissions from Rustlers Roost and Quest 29.

The total emissions during the construction phase are approximately 38,676 tonnes CO₂-e.

Section 8 Other Environmental Themes and Factors

Operational Phase Data Input

The operational phase emissions have been calculated based on the required diesel for vehicles and machineries (including staff movements and transport of ore from Quest 29 to the processing plant at Rustlers Roost). The transport fuel emissions are based on 120 staff travelling a 30 km round-trip in 5 buses per day and 10 trucks travelling a 30 km round-trip from Quest 29 to Rustlers Roost per day. Consumption of gas by the power plant and electricity consumption from the grid at the accommodation camp have also been included. Additionally, estimated landfill and water treatment plant emissions were also considered (refer to Table 8-6).

Table 8-6 Operational Annual Emissions (Tonnes CO₂-e)

Emission Source ¹	Scope	Amount of Material	Emissions (t CO ₂ -e)
Operational Machinery Fuel Emissions (tonnes CO₂-e)			
Excavator - 125 – 200-t class	1 (Direct)	575 KL	1,551
Excavator - 30-t class	1 (Direct)	6.6 KL	18
Trucks - 90 – 100-t class	1 (Direct)	1,993 KL	5,377
Dozer - 50-t class	1 (Direct)	193 kL	520
Grader - 4.3-m Moldboard	1 (Direct)	110 KL	295
Water Cart - 80 kL	1 (Direct)	51 KL	138
Drill - Track mounted top hammer	1 (Direct)	41 KL	110
MMU - Open pit unit	1 (Direct)	11 KL	30
Stemming loader - 3-m3 class	1 (Direct)	7.3 KL	20
Crusher loader - 6.5-m3 class	1 (Direct)	548 kL	1,477
Fire tender - TBD	1 (Direct)	0.1 KL	0.2
Workshop truck - TBD	1 (Direct)	22 KL	59
Service truck - TBD	1 (Direct)	22 KL	59
Boiler makers truck - TBD	1 (Direct)	11 KL	30
Light vehicles – Various	1 (Direct)	280 KL	756
Lighting plants – 5 Head LED	1 (Direct)	131 KL	355
Crane – 25 t	1 (Direct)	18 KL	49
Forklift - TBD	1 (Direct)	3.7 KL	10
Sub-Total 1			10,854
Transport Fuel Emissions (tonnes CO₂-e)			
Staff Movements	1 (Direct)	4.4 kL	12
Haul trucks	1 (Direct)	6.1 kL	17
Sub-Total 2			29
Other Activities Emission (tonnes CO₂-e)			
LNG consumption by process plant power station	1 (Direct)	1,642,000 GJ	84,398.8
Gas emission from landfill	1 (Direct)	100,000 t	120,000
Gas emissions from water treatment plant	1 (Direct)	200 people	36.83
Electricity consumption from grid (accommodation camp)	2 (Indirect)	2,800,000 kWh	1,792
Sub-Total 3			206,227.63
Total			217,111

1 – Where relevant, emission source includes emissions from Rustlers Roost and Quest 29.

Section 8 Other Environmental Themes and Factors

The total emissions during the operational phase are estimated to be approximately 217,111 tonnes CO₂-e.

Calculated Emissions

The activity description and their respective annual emissions during construction and operation are summarised in Table 8-7 and shown in Figure 8-2. The major contributors for the Project's GHG emissions are the landfill and water treatment plant, followed by the consumption of gas by the power station and vegetation clearing.

Table 8-7 Summary of Annual Emissions (Tonnes CO₂-e)

Activity	Annual Emission (tonnes CO ₂ -e)
Generator fuel	583
Machinery fuel	12,208.4
Transport fuel (including staff, delivery and haulage)	50.3
LNG from power station	84,398.8
Gas emission from landfill and water treatment plant	120,236.83
Electricity consumption from grid (accommodation camp)	1,792
Vegetation Clearing	36,517.14
Total	255,786.47

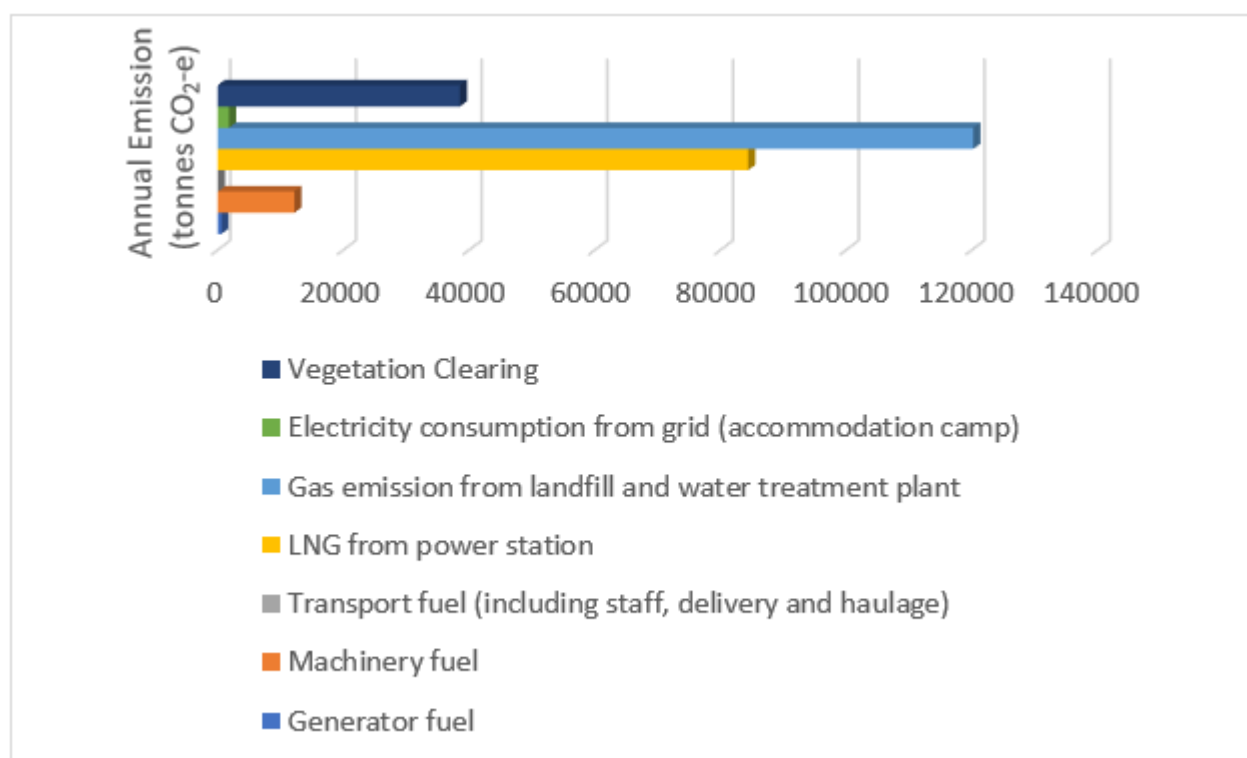


Figure 8-2 Total Annual CO₂-e Emission per each Project Activity

8.2.3 Mitigation Measures

The Project will adopt a range of the mitigation and abatement measures during planning and design, construction and operation to reduce emissions, energy consumption and energy costs. A Greenhouse Gas Abatement Plan (GGAP) will be developed and implemented prior to construction activities. The proposed mitigation measures for each phase of the Project are outlined below. These will be further expanded through the provision of GHG abatement, which is required for the Project in accordance with the Policy on Greenhouse Gas Emissions for New and Expanding Large Emitters.

- Construction
 - Development and implementation of a GHG abatement strategy that includes reduced mining equipment diesel consumption load optimisation, route optimisation and production scheduling as well as reduced idle time;
 - Implementation of operating guidelines to promote efficient operation of vehicles and machinery;
 - Use of low energy lighting systems in the accommodation camp;
 - Equipment and vehicles will be maintained in good working condition to maximise fuel efficiency; and
 - Procurement policies that encourage the selection of energy efficient equipment and vehicles.
- Operation:
 - Positioning of the accommodation camp in proximity to the HV network and connection to remove the requirement for using diesel generators;
 - Use of buses to transport staff to different portions of the Project to reduce the use of light vehicles and thus diesel consumption;
 - Regular assessment, review and evaluation of GHG reduction opportunities;
 - Use of low energy lighting systems in the accommodation camp and processing plant;
 - No burning of rubbish or open fires will be permitted onsite and cleared vegetation will be composted, utilised for timber milling or chipped for rehabilitation;
 - Promote and facilitate bussing and car-pooling arrangements for employees travelling to and from site;
 - Study the viability of implementing solar for the accommodation camp to reduce use of mains power (i.e., generated from burning of LNG);
 - Progressive rehabilitation program will be employed to reduce disturbance to the environment and revegetate cleared areas that are no longer required for the Project activities; and
 - Monitoring and maintenance of equipment in accordance with manufacturer recommendations.

8.2.3.1 Inspection and Monitoring

As identified in the above sections, the Project is expected to emit GHG emissions above the NGER threshold limit for reporting (Table 8-3) and therefore, PGO will be required to calculate and report GHG emissions associated with the Project in accordance with regulatory requirements under the NGER Act. The NGER Scheme reporting requires energy use and GHG emissions to be estimated on an annual basis in line with the requirements of the NGER Act and its associated regulatory instruments. In addition, PGO will continually undertake reviews of the GHG management actions and look for opportunities to reduce its GHG emissions. Periodic reviews will also be conducted and where corrective opportunities exists, management procedures will be revisited and where practicable procedures will be adapted to better minimise the release of GHG emissions.

8.2.3.2 Carbon Credits (Carbon Farming Initiative) Act 2011 (Cth)

The Carbon Farming Initiative has been developed to give farmers, forest growers and landholders the ability to generate accredited domestic offsets for access to domestic voluntary and international carbon markets.

It is considered unlikely that the Project will generate any offsets at this stage, although this will be further investigated through the development of a GGAP for the Project.

8.3 People – Human Health

NT EPA Environmental Factor	Human Health
NT EPA Environmental Objective	<i>Protect the health of the Northern Territory population.</i>
Relevant Policy and Guidance	▪ Code of Practice for the Near-Surface Disposal of Radioactive Waste in Australia (NHRMC 1992); ▪ National Directory for Radiation Protection (Radiation Protection Series 6) (ARPANSA 2017a); ▪ Radiation Protection Series G-1 - Guide for Radiation Protection of the Environment (ARPANSA 2015); ▪ Radiation Protection Series G-2 - Guide for Radiation Protection in Existing Exposure Situations (ARPANSA 2017b); ▪ Radiation Protection Series G-4 - Guide for Classification of Radioactive Waste (ARPANSA 2020); and ▪ Radiation Protection Series RPD 15 -Safety Guide – Management of Naturally Occurring Radioactive Material (ARPANSA 2008).

Geochemical studies have identified the potential for the Project to expose Naturally Occurring Radioactive Material (NORM) in the ore bearing material. As such, it is considered prudent to address the human health factor under the people theme. NORMs are considered to be those radioactive materials (mainly uranium - (U-238) and thorium (Th-232)) which occur naturally, however, certain work activities, such as the extraction of raw materials, can increase the level of exposure and pose a risk to human health (World Nuclear Association 2020).

A geochemical assessment was undertaken by Land and Water Consultants (2021), with technical oversight from CDM Smith, which indicated presence of uranium and thorium in the sampled material (Appendix D). The presence of these elements is not unusual in the area, however, through the environmental impact assessment investigation, PGO have considered the potential impacts and proposed mitigation measures to ensure the impacts on human health are identified and managed.

8.3.1 Environmental Values

The land and soil values are discussed in detail in Section 5.1.1 and Section 7.1. A desktop assessment and analysis of soil, water, ore and tailings geochemical properties for the Project was undertaken to inform baseline assessments and environmental management planning. Analysis of tailings from the metallurgical studies showed signs of being acid forming, with a pH of 2.4. The tests also indicated that the tailings may contain radionuclides of uranium and thorium. The desktop studies indicate that key lithologies within the pit target areas may be the source and have potential to release a range of metals and radionuclides upon oxidation (Appendix D).

The Waste Characterisation Study (Appendix D) undertaken at the Rustlers Roost site reported that the deposit contains a thorium bearing fluorapatite (a phosphate, up to 6% of tested samples). This may indicate that there is potential for discrete areas of Rustler Roost to exhibit levels of total activity, higher than those recorded in the radionuclide sampling. There was no evidence of the thorium fluorapatite in the four samples from Quest 29.

Following on from the initial analysis, the principle lithologies for Rustlers Roost and Quest 29 were further analysed for the head of chain radionuclides uranium and thorium content. The geochemical assessment was undertaken, and their total uranium and total thorium content was determined. The results are discussed further in Appendix D.

Section 8 Other Environmental Themes and Factors

Under the guidance the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) a material is deemed radioactive if the concentration of any radionuclide in the uranium and thorium decay chain is above the exemption values in schedule 4 of the National Directory for Radiation Protection, June 2017 (ARPANSA 2017a). The exemption value for the activity concentration of natural uranium and thorium is 1 becquerel/gram (Bq/g) for each isotope in the uranium and thorium decay chain.

The total activity of the uranium and thorium of each lithology were calculated from the total content of the sample and were compared against the exemption value of 1 Bq/g. All lithologies reported a total activity value of less than 1 Bq/g (below exemption level). Nevertheless, it is noted that some samples contained a considerable amount of fluorapatite which was found to be thorium bearing (up to 6% of weight of the samples tested). Thus, there are likely areas of Rustlers Roost where total activities may be higher than documented in the Material Characterisation Study (Appendix D) and based on the data, an exemption could be possible.

The tailings samples are considered representative of the LOM tailings at Rustlers Roost and did not contain the thorium fluorapatite. However, the tailings for the Project do have a reasonable concentration of uranium and thorium, 4 ppm and 15.4 ppm respectively. This discrepancy may be derived from either:

- The tailings have been processed in such manner that the fluorapatite is no longer crystalline and therefore it has not been measured; or
- The tailings samples did not contain high levels of the fluorapatite resulting in the final concentration to present below the detection of the analysis using the XRD technique.

Further geochemical assessment of the fluorapatite bearing zones will be completed and should a value above the exemption value of 1 Bq/g be recorded, the Project will adhere to all relevant guidance and standards provided by the ARPANSA.

8.3.2 Potential Impacts and Risks

Human health has been identified as an environmental factor that has the potential to be impacted from activities undertaken through the approval of the Project, particularly in relation to exposure of radioactive material in the form of NORMs. NORMs are not uncommon in the environment and are widespread in sands, clays, soils and rocks, and many ores and minerals. Although the concentration of NORMs in most natural substances are low, an operation where material is extracted from the ground and processed can potentially concentrate NORMs in product, by-product or waste and residue streams. This has the potential to lead to exposures to both Project employees and members of the public, along with environmental impacts (ARPANSA 2008). The potential environmental impacts have been discussed previously in Section 7.

A total of 19 potential hazards were identified as a potential risk from the Project. These were identified through the risk assessment of the following Environmental Factors:

- Terrestrial Environmental Quality (Section 7.1)
- Terrestrial Ecosystems (Section 7.2)
- Hydrological Processes (Section 7.3)
- Inland Waters (Section 7.4)
- Aquatic Ecosystems (Section 7.5).

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Human health can be affected from NORMs through both internal (inhalation and injection) and external (absorption and radiation) pathways. Due to the recorded low levels of radioactive material, the Project is unlikely to emit gamma radiation levels that will cause any health impacts, and this has not been discussed further.

Radium is present in most rocks, soils and minerals and can give rise to radon and thoron (radioactive decay of radium). In general, radon levels in open air are not high enough to be a cause for concern. However, under certain circumstances, such as the breaking up of rock and soil by blasting and mining operations, these activities can increase the natural release of radon to the surrounding environment. Due to the short half-life of thoron (55.6 seconds), thoron does not normally pose a significant radiological hazard, unless it is directly inhaled (ARPANSA 2008).

Dust from wind, blasting, material handling has the potential to carry particulates, which may contain NORMs. Additionally, activities including the cleaning, maintenance and repair of plant and equipment have the potential to provide exposure pathways that can impact on human health.

The ingestion of NORMs has the potential to occur from the leaching of radionuclides from the storage of waste or residue, or from the surface water run-off. The radionuclide material from wastewater or tailings, could potentially enter the groundwater, or the surface water may enter an environment which is used in agriculture (irrigation and stock watering), entering the food chain and be consumed by humans (ARPANSA 2008).

Finally, there is a potential risk that NORMs will be handled by Project personnel and this can cause the radionuclides to be deposited on the skin or on clothing. Ingestion may occur if personnel do not carry out appropriate hygiene practices, including washing hands and changing clothes before eating or leaving site (ARPANSA 2008).

8.3.3 Avoidance, Mitigation and Management

PGO conducted a risk assessment which identified the following activities in Table 8-8, that may have a potential impact on human health.

The overall aim for the management of NORMs is to ensure that radiation is controlled in the design stage of the Project using a risk-based management approach. The design and operation of the Project will be reviewed to determine the likely sources of radiation and levels, and suitable control measures for identified risks. Appropriate mitigation measures will be selected with consideration given to the effectiveness and adhering to the hierarchy of controls as much as reasonably practicable.

As defined by the National Directory for Radiation Protection, June 2017, a material is deemed radioactive if the concentration of any radionuclide is above the exemption values detailed in Schedule 4. For uranium and thorium the exemption for the activity level is set at 1 Bq/g. While the combined activity levels of the material sampled onsite have been recorded below this level it is possible there are areas of Rustlers Roost where total activities may be higher than documented. Should further analysis of the fluorapatite bearing zones identify a value above the exemption level, PGO will treat all material in accordance with the relevant ARPANSA guidance material to ensure the health and safety of the employees and the community.

The Project will apply the ALARP principle (radiation doses to be kept as low as reasonably practicable, with consideration to the social and economic factors), both in design, operations and closure. This will be undertaken by implementing radiation management actions, which will require regular senior management review of, and response to, the data generated by any monitoring performed during the Project.

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Table 8-8 Avoidance, Mitigation and Management Measures

Potential Impacts	Measures
Overtopping, embankment failure or seepage from the new TSF or WRD at Rustlers Roost and Quest 29 leading to uncontrolled release of tailings material to surrounding environment. <i>Note: Exposure from NORMS if waste rock is used as part of the construction material</i> (Risk #: TEQ – 2, IWEQ – 4, AE – 4)	Mitigate - Install seepage control and underground drainage including a cut-off trench, compact soil liner, basin underdrainage collection system, underdrain collection sump and embankment tow drain. - Finalised TSF lining design requirements will be determined from the geochemical characterisation of the ore. - Capping of the WRDs to reduce ongoing water infiltration and seepage. Manage - Implementation of AMDMP and WMP. - Development of Monitoring Plan / Operational Manual which includes - Weekly inspections of the TSF, survey pins to monitor the embankment and piezometers to measure pore water pressure. - Weekly inspections of the process water dams. - Manage the site water balance to reduce any build-up of water. - Groundwater and surface water monitoring to check quality and any seepage.
Indiscriminate use of existing waste rock for construction. Storage of waste rock outside of pit footprint for too long. (Risk #: TEQ-7, HP-7, IWEQ-8)	Mitigate - Waste rock will be deposited in surface WRDs and will be used to backfill a number of pits where mine scheduling permits. Manage - Geochemical testing of waste rock for AMD, heavy metals and NORMS prior to use as on or offsite construction material. - Tracking of the waste rock and dumping locations. - WRD plan. - ESCP to prevent mobilisation of NORMs. - Implementation of AMDMP and WMP. - Maximisation of placement of waste rock within pits.
Unfinished/unsuccessful rehabilitation of Project, leading to an alteration of ecological characteristics, including chemical, physical, biological and aesthetic qualities. If NORMS are released from site. (Risk #: TE-8, TE-9)	Mitigate - Progressive rehabilitation of disused disturbed areas. - Infrastructure design to withstand extreme events. - Improve site drainage controls. Manage - Implementation of detailed mine closure plan. - Ongoing management of levels in water infrastructure.
Pit and groundwater dewatering exposing PAF and causing AMD.	Mitigate - Implementation of AMD Management Plan including ore and waste rock controls and tailings controls. - Visual inspection of pit walls to identify locations and volumes of acid producing material.

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Potential Impacts	Measures
<i>Note: Waste oxide material may also be used in the haul road formation with potential to cause offsite impacts if the material used contains NORMS</i> (Risk #: HP-8, IWEQ – 9)	Manage ▪ Treatment of pit and underground water to within site specific trigger values criteria. ▪ Sump below pit base to reclaim contaminated water
Poor handling and management of tailings and waste rock <i>Note: Waste oxide material may also be used in the haul road formation with potential to cause offsite impacts if the material used contains NORMS.</i> (Risk #: HP-13, IWEQ – 14, AE – 11)	Mitigate ▪ Tailings and waste rock will be managed in accordance with the Tailings Management Plan and Operational Manual (including inspections). ▪ Daily monitoring of waste rock handling and tailings disposal. ▪ Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines with regard to riparian vegetation in drainage lines to reduce sedimentation risk. Manage ▪ Groundwater monitoring.
Poor water quality released from site during wet season (stormwater) or poor water quality released from site during wet season (stormwater). <i>Note: Depending on geochemistry of the waste rock material to be exposed in the new pits and the placement on site, runoff may also contain heavy metals and NORMS</i> (Risk #: IWEQ-7, AE – 6, AE – 7, AE – 8, AE – 9)	Avoid ▪ All water storage facilities geotechnically stable and engineered ANCOLD guidelines. Mitigate ▪ Compliance with the WDL. ▪ Implementation of AMDMP and WMP. ▪ Implement erosion and sediment controls in accordance with an ESCP. ▪ Adhere to buffer widths recommended by the Northern Territory Land Clearing Guidelines with regard to riparian vegetation in drainage lines to reduce sedimentation risk. Manage ▪ Groundwater / surface water quality monitoring ▪ Weekly inspections of freeboard, structural integrity and pipelines. ▪ Manage the site water balance to reduce any build-up of water. ▪ Development of Monitoring Plan / Operational Manual which includes weekly inspections of the pits.
Radiation Control during mining	Mitigate ▪ Restricting access to the main mining areas to ensure that only appropriately trained and qualified personnel are able to access the work areas. ▪ Ensuring that all heavy mining equipment is air conditioned to minimise impacts of dust. ▪ Minimising dust using standard dust suppression techniques (e.g. wetting of materials before handling, wetting of roadways, provision of dust collection systems on drills)

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Potential Impacts	Measures
	and protective measures to reduce subsequent exposure (e.g. use of respiratory protection). Manage - Monitoring the levels of dust generated during tipping of material onto stockpiles and implementing standard dust control techniques as necessary. - A separate wash-down pad within the site for vehicles that have come from the mine area. - Develop and implement a Dust Management Plan
Radiation control during Processing	Mitigate - Crushers and conveyor systems fitted with appropriate dust control measures such as dust extraction - Use of scrubbers or bag houses where appropriate - Bunding to collect and contain spillages from tanks containing radioactive process slurries, with bunding to capture 110 per cent of the largest tank within the bund in the event of a catastrophic failure - Pipeline corridors banded to control spillage of tailings or process residues due to pipeline failures - Sufficient access and egress for mobile equipment to allow clean-up where there is the possibility for large spillages - Wash-down water points and hoses supplied for spillage clean-up. Manage - Procedures to control exposures during the maintenance of the ventilation systems and plant work. - If the monitoring shows that there are elevated levels of dust in the workplace, respiratory protection will be used until a more permanent means to reduce dust is established. - There will be defined control areas in the processing plant that would require installed shielding, with access restrictions. - Spillage will be contained with wash down via concreted sloped flooring and sump. - Develop and implement a Dust Management Plan

8.3.4 Outcomes

It is recognised that the Project has a low potential to have an effect on human health. This has been discussed through the evaluation of the presence of NORMS and potential impacts to the Project workforce and the broader community. To ensure that there is negligible to no significant impact to the human health, PGO will adhere to the relevant ARPANSA guidelines should analysis identify exceedance of the exemption value; and are committed to developing and implementing the required management plans and procedures to monitor, evaluate and adapt to ensure there will be no significant impact to the health of employees or the community from the Project.

Due to the potential presence of naturally occurring radiation in the area, it is considered that the Project would have a minor to negligible impact to the surrounding environment within the Project area and surrounds.

A Radiation Safety Management Plan will be developed for the Project if further analysis identifies exceedance of the exemption value. The aim of the Radiation Safety Management Plan would be to assess the exposure of workers and controls to limit radiation exposure when material with measurable radiation levels is moved between or off site.

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The closure goals for the Project are to ensure that radiation levels are consistent with measured background levels, prior to operation. Therefore, it is anticipated that there will be no long-term impacts from the NORMS to the environment from Project following closure.

The impact to people and human health from the Project, is not considered to be significant, with consideration to the extremely low likelihood of occurrence. PGO is confident that the mitigation measures already identified in Sections 7.1 – Terrestrial Environmental Quality, 7.2 – Terrestrial Ecosystems, 7.3 – Hydrological Processes, 7.4 – Inland Water Environmental Quality and 7.5 – Aquatic Ecosystems, and the additional mitigation measures identified for radiation control during mining and processing, will be adequate to manage impacts to the human health.