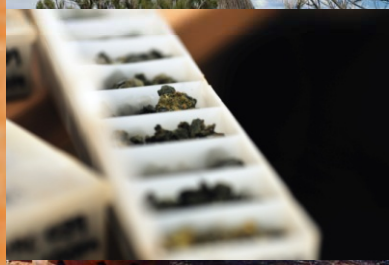
Tropicana Gold Project: Public Environmental Review

9. Risk Based Approach to Environmental Impact Assessment







INDEPENDENCE GROUP NL

360 environmental

9. RISK BASED APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT

This chapter discusses the risk assessment process utilised to identify risks associated with the Project and details the outcomes of this process.

The Joint Venture has held exploration leases in the area around the Tropicana and Havana deposits since 2002. Since that time, exploration activities have increased in breadth (extending exploration activities into new areas) and intensity (progressing from widely spaced regional exploration activities to closely spaced resource definition drilling). As the breadth and intensity of activities have increased, so too has the potential risk of significant damage to the environment. With this, the Joint Venture and its environmental consultants have consulted regularly with key stakeholders (e.g. the DEC and the Federal DEWHA) and various experts (e.g. Museum of Western Australia, Dr Joe Benshemesh) for advice and to identify potential risks, impacts and management measures. The Joint Venture has also increased its environmental survey effort to identify and describe the environmental values across the Project area to better enable it to understand the potential impacts.

As potential impacts were identified, such as alteration to the habitat of threatened species, targeted surveys for those species were commissioned to determine how exploration/ mining activities could be managed to minimise risk. Management of environmental risk in the exploration phase has included the identification and avoidance of areas of preferred habitat of the Marsupial Mole (assumed to be *Notoryctes typhlops*) and *Conospermum toddii* (the Great Victoria Desert Smokebush), both of which are protected under the WC Act 1950 and the EPBC Act 1999. This avoidance strategy has carried into the planning and design aspects of the Project, through the avoidance of *C. toddii* and minimisation of impacts to Marsupial Mole habitat.

The environmental management strategy adopted by the Joint Venture follows the EPA's mitigation hierarchy of Avoidance – Minimisation – Rectification – Reduction - Offset. The Joint Venture has demonstrated its precautionary approach to the management of environmental risk during the exploration phase at Tropicana and Havana by:

- avoidance of critical habitat;
- deferring potential high risk activities until adequate data is available to confidently determine the level of risk; and,
- if available data did not enable the Joint Venture to be satisfied that the potential risk of their activities was insignificant or manageable, then Joint Venture representatives have engaged with the relevant decision making authorities for advice (e.g. DEC, DEWHA).

This precautionary approach has continued into the planning and design phases of the proposed Project as demonstrated by the following examples:

- The Joint Venture has continued to engage with key stakeholders and specialists during planning and has incorporated their concerns and suggestions where appropriate (e.g. combining the Mine Access Road and Mine into a single referral for the EPA and DEWHA as a risk mitigation strategy against being responsible for a road to nowhere should the road but not the mine be approved):
- Undertaking detailed site-specific and regional surveys for flora and fauna (further details in Chapter 6). The Joint Venture has supported other research in the wider region by the DEC and independent specialists (e.g. DEC survey of the Neale Junction Nature Reserve and Marsupial Mole survey of the western portion of the Great Victoria Desert by Dr Joe Benshemesh). These surveys have enabled the Joint Venture to put greater environmental context around the proposed impact areas of the Project:
- Establishing a Peer Review Panel of community representatives and experts in the fields of botany and zoology to engage in discussion of the environmental and social issues related to the Project, review

documents contributing to the formal environmental impact assessment and to have general input into the environmental and social management of the Project (refer Chapter 12); and,

- Designing the layout of the Operational Area to avoid impacts to listed species where practicable. For example, one early option for the placement of the tailings storage facility was to locate the tailings storage facility in an area of sand dunes to the west of the deposits. Environmental surveys of the area determined that this area represented preferred habitat of the Marsupial Mole and *C. toddii* and so this option was abandoned in favour of a location away from this habitat type (see section 3 for further detail).

9.1. FORMAL RISK ASSESSMENT PROCESS

A formalised and detailed risk assessment process for the proposed Project was initiated as the Joint Venture progressed from exploration into pre-feasibility analysis, prior to commencing the formal environmental assessment process of which this PER document forms a part. The risk assessment process has been based on principles and methodology outlined in HB 203:2006 – Environmental Risk Management – Principles and Processes and AS/NZS 4360:2004 – Risk Management. The primary aim has been to identify potential environmental consequences to all activities and to assign an appropriate response to reduce environmental risk. As risk assessment is not a one-off process, the Joint Venture will regularly re-assess environmental risks and mitigation strategies throughout the life of the Project as part of the project's Integrated Management System (refer Chapter 5).

The formal risk assessment process for the Project began in January 2008 with a series of risk identification workshops attended by the Joint Venture and 360 Environmental staff involved in the exploration phase, design, environmental impact assessment and/ or environmental management of the Joint Venture's activities. The risk workshop attendees were selected to provide technical understanding of the proposed project and/ or the environmental setting, and to facilitate the identification of environmental aspects, specific activities or events and their potential consequences.

Workshops were held on the following topics:

- processing, crushing and tailings management;
- mining and waste material management;
- supporting infrastructure (e.g. Mine Access Road, power supply and aerodrome); and,
- project-wide activities (e.g. hydrocarbon management, waste, and internal roads).

At each workshop, the Joint Venture staff member with key responsibility for the area under discussion (e.g. engineer responsible for the design of the processing plant) provided a general introduction to the facility/ project aspect to be assessed. The workshop proceeded as a brainstorming session to identify impacts associated with each aspect at key time periods of the Project (Planning/ Design, Construction, Commissioning, Operation and Closure/ Decommissioning).

In addition to the internal risk workshops, feedback has also been obtained from key stakeholders (DEC, DMP, NGO's) on their view on what the key environmental risks are for the Project. This information plus input from the Peer Review Panel has been incorporated into the project risk register and risk rankings.

Over 2,000 activities or events associated with an environmental risk were identified. (Note that many of these are relatively minor in nature, and/ or are readily managed by standard procedures/ mitigations. For example, leaking taps can provide fauna with increased access to water; this is mitigated by appropriate inspection, reporting and maintenance). Once the specific activities and events were identified a qualitative risk analysis ensued with consequences and likelihoods assigned according to Tables 9.1 and 9.2, and risk calculated according to Table 9.3. A qualitative analysis was selected rather than a quantitative analysis - primarily because of the difficulty in establishing a justifiable environmental quantification of consequence for some of the more complex impacts. For

example, the environmental consequence of increased visitor access to the region encompasses increased pressure on Nature Reserves in the region and altered impacts due to a change in the demographic of regional visitors.

This initial assessment progressed under the assumption that environmental management controls failed or were non-existent. Therefore, the calculated risk is the inherent environmental risk of the activity or event. Controls were then assigned to each activity/ event and the residual environmental risk was calculated (i.e. the risk of the activity/ event assuming that the controls were successful). Control options, in order of priority, included:

- avoidance/ elimination: e.g. re-siting the tailings storage facility to avoid the preferred habitat of the Marsupial Mole;
- substitution: e.g. replacing a more hazardous substance with a less hazardous substance capable of filling the same role;
- engineering: e.g. automatic switch-off valve to prevent over-filling of a storage dam or pond;
- administrative: e.g. establishing and communicating written procedures; and,
- separation: e.g. bunding or secondary containment on a chemical storage tank.

Activities and events with a residual risk rating of Medium or Low include:

- compaction of substrate following the clearing of vegetation and collection of rehabilitation resources is rated as Low following the control action to limit vehicle traffic over recently cleared areas; and,
- loss of native flora, fauna or vegetation due to clearing outside of areas externally approved through the PER and *Mining Act 1978* processes is rated as Medium following the establishment and implementation of the following processes and procedures under the Project's Integrated Management System:
    - establish and implement an internal approval process to authorise clearing activities (secondary to external approvals); and,
    - establish and implement a clearing procedure including on-ground demarcation and pre-clearing checks where appropriate.

9.2. RESIDUAL RISK

The five key environmental factors (some overlapping) that have been identified to date for the Project are (risk-rated High) after management are:

- probable emissions (particularly greenhouse) and other potential discharges;
- impact of improved infrastructure and access into a remote area;
- possible loss of, or disturbance to, threatened species;
- impact of clearing and ground disturbance; and,
- possible damage to ecosystem functionality including terrestrial systems, groundwater and groundwater dependent ecosystems.

Potential impacts that can be managed by standard or best practice techniques or through an avoidance strategy include (risk-rated Low to Medium):

- disturbance to Indigenous/ European heritage;
- inappropriate waste disposal (industrial, general, hazardous waste etc.);

- introduction and/ or spread of weeds/ feral animals;
- unsustainable abstraction of water; and,
- discharge to land (e.g. saline water release, cyanide contaminated tails).

As several of the key impacts identified in the risk assessment process are related, and several impacts have the potential to affect the same environmental aspect, it follows that some cumulative impacts may result from the development of the Project. These impacts may affect:

- listed fauna including the Sandhill Dunnart which could be impacted by loss of habitat from clearing impacts and increased incidence of fire;
- vegetation complexes may be impacted directly by clearing and indirectly by impacts to groundwater; and,
- ecosystem functionality may be disrupted by the introduction of feral taxa (flora or fauna) and increased incidence of fire.

Table 9.1: Consequence Categories Used to Assess Risk for the Tropicana Gold Project

	Non-threatened Flora, Fauna and Vegetation	Threatened Flora, Fauna and Communities	Weeds/ Feral Species	Indigenous and European Heritage	Rehabilitation
Insignificant	Temporary alteration to: • behaviour • population dynamics • habitat connectivity. • One-off death of individuals.	The Joint Venture consider that there is no 'insignificant' impact to a threatened species precisely because they are threatened.	Identification and destruction of a weed or feral species on equipment/ goods brought to site.	Surprise discovery of an artefact scatter.	Failure of a rehab trial.
Minor	Alteration to population dynamics that is resolved during the Operational phase of the Project. Permanent loss of < 5% of suitable habitat/ vegetation community.	Temporary alteration to: • behaviour • population dynamics • habitat connectivity.	Introduction but non-establishment of a weed or feral species.	Surprise discovery of an archaeological or ethnographic site. Disturbance to an artefact scatter.	Localised rehab failure that when remediated sets rehab back for less than one year – e.g. an erosion gully caused by an isolated instance of incorrect surface preparation.
Moderate	Recurring death of a small number of individuals of a particular species. Decrease in recruitment over the Operational phase of the Project. Permanent loss of 5 < 10% of suitable habitat/ vegetation community.	Death of a small number of individuals. Alteration to population dynamics that is resolved during the Operational phase of the Project. Permanent loss of < 5% of suitable habitat.	Spread of an existing weed species Increase of a feral fauna population within the Project footprint.	Disturbance to an archaeological site.	Partial decrease in viability of rehab resources. Missed opportunity to rehab a portion of the footprint. Partial rehab failure taking 1 < 5 years to remediate – e.g. a native species dominates and not remediated until out of control.
Major	Permanent loss of 10 < 25% of individuals of a species in the area. Long term alteration to population dynamics. Long term loss of habitat/ vegetation community.	Permanent loss of 5 < 10% of individuals of a species in the area. Decrease in recruitment over the Operational phase of the Project. Permanent loss of 5 < 10% of suitable habitat/ vegetation community.	Introduction of a new weed or feral species to the area. Spread and establishment of an existing weed species outside of the Project footprint. Increase of a feral fauna population outside of the Project footprint.	Permanent removal or destruction of an archaeological site. Disturbance to an ethnographic site.	Total decrease in viability of rehab resources. Inability to establish the designed landform. Failure of rehabilitation of a facility requiring total rework – e.g. waste toxins entering ground water under a waste landform. Partial rehab failure taking 5 < 10 years to remediate – e.g. side of a tailings dump slumping
Catastrophic	Loss of a local population Extinction of a species or vegetation community. Permanent loss of >/= 25% suitable habitat.	Loss of a local population Extinction of a species or vegetation community Permanent loss of >/= 10% suitable habitat.	Introduction of a new weed or feral species, or spread of an existing weed/ feral that leads to the loss of a local population of a native species or/ permanent degradation of a local vegetation community.	Permanent removal or destruction of an ethnographic site.	Failure of rehabilitation. Inability to establish a stable landform. Irreversible damage to environment – e.g. extensive groundwater contamination and associated secondary impacts.

Table 9.1: Consequence Categories Used to Assess Risk for the Tropicana Gold Project (continued)

	Ground water	Surface Water	Substrate	Air Quality	Amenity (noise, vibration, visual)
Insignificant	Temporary reduction in water quality from a single bore.	Localised, temporary change to sheet flow with no impact on flora and vegetation. Localised, temporary reduction in surface water quality.	One off, minor contamination event which can be cleaned up immediately and results in no significant impact. One off erosion event resulting in no impact to environmental values.	One-off, localised reduction in air quality (but remaining within air quality standards).	Local nuisance issue
Minor	Short-term reduction in water quality from a single bore.	Change in sheet flow causing temporary stress to flora and vegetation. Short-term reduction in surface water quality.	Localised contamination that can be promptly remediated (e.g. spill kit) resulting in negligible impact to substrate. Localised erosion event that can be promptly remediated and results in negligible impact to environmental values.	One off, localised failure to meet air quality standards for a short period of time.	Temporary alteration in behaviour of fauna. One-off report of wind-blown rubbish
Moderate	Long-term reduction in water quality at a single bore, or short- term reduction in water quality across the borefield/ dewatering array. Short-term degradation of a groundwater dependent ecosystem (repaired during the Operational phase of the Project).	Change in sheet flow causing localised death of non-threatened flora and vegetation. Run-off resulting in the movement of a potential contaminant.	Generation of a potential Contaminated Site that can be remediated but results in a short term degradation of substrate. Erosion event that results in the loss of non-threatened flora and vegetation from a small area or, results in the movement of a potential contaminant.	Short-term alteration to air quality resulting in exceedance of standards.	Temporary exodus of fauna from the area. Repeated reports of windblown rubbish at same location
Major	Short term reduction in water quality in the region. Long-term degradation of a groundwater dependent ecosystem (repaired post-closure).	Change in sheet-flow leads to large-scale erosion/ sedimentation and smothering of flora and vegetation. Run-off facilitates a contamination pathway.	Generation of a Contaminated Site requiring substantial remediation. Widespread smothering of flora and vegetation, or, facilitation of a contamination pathway.	Long-term alteration to air quality (e.g. dust) leads to death of flora and vegetation in areas adjacent to the Project footprint.	Long-term exodus of fauna from the area (return post-closure).
Catastrophic	Permanent reduction in water quality throughout the region. Loss of a groundwater dependent species or ecosystem.	Change in sheet flow leads to permanent change in vegetation. Regional, long-term reduction in water quality.	Generation of a Contaminated Site requiring substantial, long term remediation. Regional loss of a unique landform.	Long-term alteration to air quality (e.g. dust) leads to death of flora and vegetation in the region.	Permanent exodus of fauna from the area.

Table 9.2: Risk Assessment Consequences for the Tropicana Gold Project

Code	Rating Descriptor	Explanation
A	Almost certain	Occurs in all circumstances or is a planned event.
B	Likely	50% chance of occurrence
C	Possible	5% chance of occurrence
D	Unlikely	Unusual or unexpected occurrence (approximately 1%)
E	Rare	Only occurs in exceptional circumstances

Table 9.3: Risk Matrix for the Tropicana Gold Project

			Likelihood				
			A	B	C	D	E
			Almost certain	Likely	Possible	Unlikely	Rare
Consequence	5	Catastrophic	E	E	E	E	H
	4	Major	E	E	E	H	M
	3	Moderate	E	H	H	M	M
	2	Minor	H	H	M	L	L
	1	Insignificant	H	M	L	L	L

E: Extreme risk – immediate action and formal documentation required

H: High risk – management attention and formal documentation required

M: Medium risk – management responsibility must be specified in documents

L: Low risk – manage by routine Corporate procedures/ instructions

9.3. MAJOR RISKS ARISING FROM THE RISK ASSESSMENTS

A full list of the risks identified will be transformed into a Project Risk Register with accountabilities for each risk assigned to a role. Table 9.4 details the major environmental risks identified, the inherent risk, risk management strategies and the residual risk once the management strategies are implemented. Success criteria are assigned to each risk to provide the means to judge whether the management strategy has successfully mitigated the risk identified.

The major risks to the Project can be summarised under the following themes:

- improved access to the region;
- air emissions, particularly greenhouse gases;
- potential discharges from waste rock and tailings;

- effectiveness of constructed landforms;
- disturbance to flora and fauna, particularly listed species (Managed under the Threatened Species and Communities Management Strategy [Appendix 3-E]);
- spills and leaks;
- impacts on groundwater and hydrology; and,
- disturbance to Indigenous heritage (Managed via the Heritage Management Strategy [Appendix 3F]).

The management of these risks are discussed in Chapter 7 and further addressed in the Management Strategies included in Appendix Series 3.

Table 9.4: Major Environmental Aspect Risk Assessment Before and After Management Response

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
Emissions to air/land/water	Greenhouse gas emissions	Significantly increase WA emissions (more than 1.0% increase)	C	3	H	Greenhouse footprint for the Project is predicted to peak at 330,000 t CO_{2e} for a full fossil fuel site. In 2002, net emissions in WA where 70.4 Mt CO_{2e}. The predicted increase as a result of the Project emissions are approximately 0.6%	Incorporate low energy equipment in the plant such as High Pressure Grinding Rolls Optimise mining schedule to reduce fuel consumption Build a 5-star energy rated village Optimise water recovery systems within the plant to reduce borefield abstraction	E	3	M	Complete solar thermal feasibility study. Low energy equipment installed in plant. Fuel usage less than comparable site due to low emission fleet and optimised mining schedules. 5-star energy rated village. Water recovery circuit.
		Waste of resources (e.g., poor efficiency leads to unnecessary consumption of fuel)	C	3	H			D	3	M	
		Loss of opportunity to implement renewable options	C	3	H			D	2	L	
	Overburden/ mine process discharge	Contamination of land or water	C	4	E	Manageable quantity of Potentially Acid Forming present in mine waste (<15%) plus waste material contain carbonate material. Low level of fibrous mineral present. Some of the minerals naturally exceed contaminated site ecological assessment. Groundwater within the operational area and water supply area are both hypersaline. Air quality assessment suggests that natural dust deposition should not exceed 2 g/m^2/month Assessment of groundwater within the	Co-dump NAF and Potentially Acid Forming and ensure that only NAF waste is placed on the outside of the waste landform. Implement dust control strategies to manage the potential fibre (and silica) release. Waste landform and tailings storage facility will be covered with growing medium, shaped and revegetated. Incorporate dust control and/or suppression activities into all mining and processing activities that generate dust. Mine dewater used for dust suppression and processing activities preventing the	D	2	L	Groundwater monitoring shows no leakage from waste containments.
		Safety and Health	D	4	H			E	3	M	No health or safety incidents arising from mine waste discharge.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
		Harm to fauna	B	3	H	Resource Area has determined that dewatering will be required. Volume predicted to be less than 20 L/s. Infiltration rates of the local area are high, increasing the risk of seepage from the tailings storage facility. Due to the saline nature of the processing water it is less likely that animals will be attracted to the tailings storage facility.	need for any saline water discharge to the environment. Water infrastructure will have a monitoring and maintenance schedule to prevent saline water leakage. Tailings storage facility will include impermeable HDPE sheeting in its centre and an impermeable clay layer under the remainder. Limit animal access to the tailings storage facility. Monitor water birds activities and discourage their activities where possible. Manage WAD cyanide levels in water sitting on the surface of the tailings storage facility so that it is less than 50 mg/L in accordance with the requirements of the Cyanide Code.	D	2	L	No animal death within tailings storage facility due to inappropriate cyanide management.
	Disposal of general waste	Contamination of land or water	C	3	H	The Project will result in the generation of waste, some of which will have the potential to cause contamination.	Implement a site recycling program . Manage industrial waste in accordance with *Environmental Protection (Controlled Waste) Regulations 2004* Manage the Project landfill in accordance with *Environmental Protection (Rural Landfill) Regulations 2002* and project license.	D	2	L	No contamination outside of designated site.
		Generation of a contaminated site	C	3	E			D	2	L	Landfill audit demonstrates conformance with regulations.
		Occupational Health and Safety	C	3	H			D	2	L	No health or safety incidents arising from waste generation or disposal

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
	Dust	Occupational Health and Safety	C	3	H	The generation of dust is unavoidable, particularly during the construction phase of the Project. Understandings of dust impacts from other sites	Implement a dust control strategies during high risk activities such as loading, transport and crushing Implement dust control strategies within the crushing area that will achieve 80 % effectiveness Develop a monitor program to assess impacts of dust sensitive vegetation Undertake progressive rehabilitation to reduce potential dust source from cleared areas Minimise disturbance areas to what is necessary to limit windblown dust. If saline water is used for dust suppression adopt strategies that prevent impact of adjacent vegetation such as drains, application equipment suitable to the work area	E	3	M	No health or safety incidents arising from dust.
		Loss of dust sensitive vegetation	B	3	H			D	2	L	No vegetation decline due to dust.
		Salinisation of land through dust control practices	B	3	H			D	2	L	Successful revegetation of all road and verges.
	Spills/leaks (fuel, chemicals)	Contamination of soil	A	2	H	Hydrocarbon spills around fuel storage, workshops and mobile plant can be reduced but are unlikely to be eliminated. Process chemicals will mostly be contained on sealed surfaces in bunded locations Chemical spill outside the processing	Facilities built with containment area and fully bunded Facilities compliant with AS1940: 3780 and 4452 Compulsory spill reporting and Spill emergency response procedure Construct a hydrocarbon contaminated soil remediation facility. Revegetate any areas damaged by a spill or leak following decontamination.	D	2	L	Any spills satisfactorily cleaned up.
		Loss of vegetation	C	2	M			E	2	L	Any vegetation lost from spills returned.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
Improved infrastructure and increased access to the region	Increased incidence of fire	Loss/ damage to ecosystems	C	3	H	Understanding of arid zone fire ecology. Impact on vegetation varied and depends on fire interval and intensity.	Develop fire management/ containment procedures.	D	2	L	No increase in fire incidence.
		Loss/ damage of infrastructure (waste of resources)	C	3	H		Emergency response procedures to protect infrastructure, fire sensitive vegetation and rehabilitation areas.	D	2	L	
		Occupational Health and Safety	D	4	H		Discourage unauthorized road users utilizing the Mine Access Road	E	3	M	
	Introduction/ spread of weeds and feral species	Competition with native flora	C	3	H	One declared weed species recorded on the Pinjin Station Four environmental weeds recorded in the area surrounding the Operational Area Five feral animals species recorded – mice, rabbits, cats, foxes and camels	Restrict vehicle movement by staff with private vehicles on site to minimise impact to nearby Nature Reserves and wider region	D	3	M	No new weeds established.
		Loss of threatened fauna (increased predation)	C	3	H		Consider educational initiatives throughout the region to promote environmentally friendly behaviour by visitors (e.g., signage)	D	2	L	No increase in feral animals.
	Increased use of regional Nature Reserves	Degradation of environmental values caused by introduction/ spread of feral taxa	C	3	H	Current access to regional Nature Reserves restricted by poor access and low awareness	Develop weed hygiene procedures for earthmoving equipment, light vehicle and mobile plant off-site. Weed monitoring and eradication. Work with adjacent landholders to close off unused tracks. Work with key stakeholders and adjacent land-users to implement appropriate feral animal controls Litter around site and along access roads to be collected Educate employees/ contractors regarding littering Assist with the implementation of an Indigenous Ranger/ traineeship to assist with the land management issues	C	2	M	No increase in feral animals resulting from Project.
		Degradation of environmental values caused by increased erosion from off-track driving	C	3	H			C	2	M	No increase in off track driving resulting from Project.
		Degradation of environmental values caused by increased incidence of fire	D	4	H			E	4	M	No increase in off track driving resulting from Project.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
	Inappropriate disposal of waste	Pollution	B	3	H	N/A		D	2	L	All waste correctly disposed of.
		Habituation of fauna	C	2	M			C	2	M	No wild animals habitually visiting camp or operational areas.
		Fire (e.g., glass bottles or cigarette butts acting as ignition sources)	D	4	H			E	4	M	No increase in fire incidence due to inappropriate waste disposal.
Altering landforms	Steep mine void edges	Safety to human and animals	D	4	H	The permanent pit voids will have steep drop offs	Maintain safety barriers during mine operations. Construct a mine abandonment bund in accordance with statutory guidelines	E	4	M	Safety barrier in place.
	Visual amenity	New landforms do not fit into landscape	A	3	E	Mine Operations area primarily sited in a broad sand plain valley.	Constructed waste landforms will be a maximum height of 375 mRL (~ 40 m) and will not be visible from outside the immediate broad valley. Maximum slope angle will be 15°, similar to surrounding dune slope angle. Progressive rehabilitation will re-establish local vegetation The permanent pit void will be surrounded by the constructed landforms.	D	2	L	Constructed landforms constructed to specification.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
	Groundwater	Pit void impacts on local saline aquifers	C	3	H	Mining will occur below the water table. No Stygofauna have been recorded within the operational area. Aquifer located predominately in the transported material around 20-30 m below surface and is saline 10-35,00 mg/L. Surface vegetation does not use the groundwater but appear to rely on soil stored water. Drawdown of 50 m within 1 km of the void.	Study and understand the impact of the pit void on local aquifers. Implement a management strategy based on ground water understanding.	D	3	M	No adverse impact on deep saline aquifers from pit void.
	Surface water	Modified landscape has an impact on surface water quality, flow and volume	B	2	H	Two ephemeral local drainage channels have been identified. These channels will be largely excavated to create the pit void and waste landforms. Drainage from new waste landforms will be directed into the pit void at Closure	Divert water around the Operational Area Separate potentially contaminated surface water from clean surface water Install internal drainage systems to prevent the release of potentially contaminated water from site Install toe drains at the base of the waste landform and divert surface run-off toward the pit post-closure	D	2	L	N/A
	Constructed slopes	Erosion	B	3	H	Constructed slopes in other arid and semi-arid locations have proven to be vulnerable to erosion from rain and wind.	Slopes will be maximum 15° which is predicted to be stable (Appendix 2-B11). Progressive rehabilitation Monitoring and remediation program Landforms will have precautionary toe bunds to contain possible erosion.	D	2	L	Permanent stable slopes.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
Clearing and ground disturbance	Heritage sites (European and Indigenous)	Disturbance/ damage to known sites	C	4	E	Extensive ethnographic and archaeological desktop and field surveys for sites of Indigenous significance have been undertaken across all proposed disturbance areas (roads, water supply areas, Operational Area). There are few sites and none will be impacted by the Project. A desktop assessment of potential European heritage was undertaken for the Pinjin area which is the most likely disturbance area to have significance for European heritage. No known site of significance will be impacted by the Project.	Prepare and implement a Heritage Management Strategy Implement ground disturbance and clearing internal permit systems The layout of the Operational Area and other infrastructure has been designed to avoid areas of significance Continue consultation with local Indigenous groups to document ethnographic sites	E	4	M	No heritage sites disturbed.
		Disturbance/ damage to an unidentified sites	C	4	H			E	4	M	
	Terrestrial vegetation and flora	Loss of threatened species/ ecosystems	B	4	E	Extensive field surveys have been undertaken for the Operational Area and the surrounding region. Locations of conservation interest species (Priority, Threatened and DRF) have been identified. No Threatened or Priority ecological communities have been identified in the Operational Area Potential PEC located along the two infrastructure corridors.	Operational Areas located to minimise impacts (e.g. moving tailings storage facility location from dunes to sandplain Design protect to avoid critical habitat e.g. dunes Project layout adjusted to take into consideration baseline survey threatened species locations Threatened Species and Communities Management Strategy developed	E	4	M	No loss of threatened flora species.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
		Damage to critical habitat	C	4	E	Operational Area surveyed for flora, vegetation and fauna values. Both Mine Access Road options have been surveyed for flora, vegetation and fauna values. Minigwal Trough and proposed pipeline has been surveyed for flora, vegetation and fauna values. Where necessary, targeted surveys for conservation interest species have been commissioned to better understand their biology to inform management decisions (e.g. *Conospermum toddii*).	Road routes planned to avoid preferred habitat where practicable (e.g., avoiding cutting dunes which are preferred habitat for several threatened species). Water infrastructure located to minimise ecological impacts. Design Project to avoid critical habitat – e.g. sand dunes.	D	3	M	No damage to critical habitat.
		Disruption to ecosystem function	C	4	E		Prevent unnecessary clearing. Implement dust control and minimisation strategies.	D	3	M	No permanent disruption to ecosystem function.
							Project layout adjusted to take into consideration baseline survey threatened species locations. Threatened Species and Communities Management Strategy developed.	E	4	M	No threatened species lost.
							Progressive rehabilitation including a rehabilitation research program to reinstate ecosystem function. (See Conceptual Closure and Rehabilitation Strategy)	D	3	M	No damage to fauna critical habitat.
								D	3	M	No measurable disruption to ecosystem function.
Disturbance caused by activities other than land clearing	Terrestrial flora/fauna	Loss of threatened species	C	3	H	As above, as well as: Targeted surveys for threatened fauna (e.g. Marsupial Mole and Sandhill Dunnart) have identified habitat in the disturbance and surrounding areas.	As above plus: Undertake surveys to identify critical assets/ environmental values (including conservation interest species and ecosystems) in the surrounding area.	D	3	M	Threatened species status does not change as a consequence of the Project activities.
		Damage to critical habitat	C	3	H			D	3	M	No fauna critical habitat damaged.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
		Introduction or spread of weeds/ feral animals (by Project personnel/ contractors)	C	4	E	Regional surveys have demonstrated the presence of threatened species in the wider region, including in existing Nature Reserves e.g. Neale Junction, Queen Victoria Spring.		D	2	L	No new weed species introduced to site. No increase in feral animal species or number on site.
	Groundwater and hydrology	Disturbance of surface groundwater dependent ecosystems at the Operational Area or Minigwal Trough water supply area due to inappropriate groundwater abstraction regimes	C	4	E	Assessment of the hydrogeology of the Minigwal Trough water supply area has indicated that the target aquifer is separated from a higher, superficial aquifer by an aquitard, limiting impacts on the superficial aquifer.	Monitor vegetation adjacent to the abstraction area. Monitor superficial aquifers to identify drawdown impacts. Ensure abstraction in undertaken in accordance with license and operational management plans.	E	3	M	No decline in surface ecosystems as a result of water abstraction.
		Disturbance of subterranean groundwater dependent ecosystems due to inappropriate groundwater abstraction at the Operational Area or Minigwal Trough water supply area causes damage to populations of subterranean fauna	C	4	E	Surveys and desktop assessments for subterranean fauna have been undertaken for the Operational Area and the Minigwal Trough water supply area. To date, no subterranean fauna species has been identified that will be negatively impacted by the proposed borefield at the Minigwal Trough or dewatering program at the Operational Area.	Design borefield layout and extraction rate for sustainable use of the aquifer. Ensure abstraction in undertaken in accordance with license and operational management plans.	E	3	M	No subterranean groundwater dependent ecosystems.

Environmental Aspect	Specific Factor	Potential Negative Outcomes	Likelihood	Consequence	Inherent risk	Assessment/ Survey Results	Management Response	Likelihood	Consequence	Residual risk	Success Criteria
		Aquifer is damaged due to unsustainable abstraction	B	3	H	Assessment of the target aquifer at the Minigwal Trough has demonstrated that an appropriate abstraction regime can be designed to avoid unsustainable abstraction.	As above.	E	3	M	Aquifer recovers after operations cease.
		Discharge of water from pit dewatering causes damage to substrate, surface water and/ or groundwater	B	3	H	Groundwater sampling has indicated that mine dewater will be saline. Water generated from pit dewatering will be directed to the processing plant for use.	Utilise all water generated during dewatering activities onsite in processing or for dust suppression.	E	2	L	Groundwater aquifers connected to the pit void return to original state after operations cease.
		Surface sheet flow disrupted by road embankment disturbing vegetation	B	3	H	Assessment of surface drainage along the infrastructure corridor completed.	Incorporate management recommendations identified in infrastructure corridor assessment into Access Road design. Design to minimise water pooling and changes to sheet flow along access road. Monitor vegetation adjacent to road corridor to assess effectiveness of management measures adopted into the design.	D	2	L	Roadside vegetation health does not decline.