8. Environmental Impact Assessment and Management Strategies

8.1 Environmental and Social Factors

The environmental and social factors relevant to the project were identified using EPA assessment guidelines and information from stakeholder consultation. These factors were outlined in the Environmental Scoping Document (Moly Mines, 2007) and are assessed in this PER document. The environmental and social factors are:

- biophysical factors
  - soils and landforms;
  - geoheritage;
  - groundwater;
  - surface water and drainage;
  - terrestrial flora and vegetation;
  - terrestrial fauna and faunal assemblages;
  - aquatic fauna;
  - subterranean fauna;
  - wetlands and rivers;
  - conservation areas;
- pollution management
  - air quality;
  - greenhouse gases;
  - noise, blasting and vibration;
  - solid and liquid waste disposal;
  - dangerous goods management;
- social surrounds
  - mine closure and decommissioning;
  - local community (social and economic);
  - land use;
  - Aboriginal heritage
  - non-Aboriginal heritage;
  - public safety – traffic and ore transport
  - product handling and management; and
  - visual amenity.

Sections 8, 9 and 10 assess each of these factors by identifying the potential impacts and recommending appropriate management and monitoring strategies required to mitigate impacts for the construction, commissioning and operation of the project. A management objective is specified for each factor that provides a specific target for the nominated management and monitoring strategies.

8.2 Landforms and Soils

General impacts on landforms and soils relate to the physical and chemical alteration of landforms and regolith profiles as a result of mining activities and associated earthworks, plus the excavation or exposure of potentially problematic materials and their mobilisation into the surrounding environment.

Issues directly associated with the waste landforms, tailings storage facility and visual amenity are addressed in **Sections 8.12.1**, **8.12.2** and **8.12.3**, respectively.

8.2.1 Project Area

8.2.1.1 Management Objectives, Standards and Guidelines

The objectives of the management strategies pertaining to soils and landforms within the project area are to maintain the integrity, ecological functions and environmental values of the soils and landforms within the area. Of particular relevance are the management of issues relating to:

- Minimisation of on-site and off-site impacts from soil excavation and handling activities (e.g. dust, erosion and sedimentation of drainage lines); and
- Management of soil resources in ways as to maximise the potential for successful rehabilitation (appropriate topsoil handling, landform and soil profile reconstruction).

8.2.1.2 Potential Impacts

Potential impacts relating to soils and landforms within the project area include:

- *Physical alterations to existing landforms and topography;* Alterations to existing landforms and topography would primarily be in the vicinity of the open pit and as a result of cut and fill works associated with the construction of mining infrastructure.
- *Alteration of soil profile characteristics;* Soil stripping and earthworks activities have the potential to alter soil chemical and physical properties at the surface. Parameters such as soil pH and electrical conductivity, water holding capacity, infiltration and drainage characteristics may be altered as a result of soil disturbance, profile redistribution and vehicle compaction.
- *Soil erosion*; Potential erosion of disturbed areas and constructed landforms by wind and water, and associated impacts on surrounding vegetation and sedimentation of drainage lines. Erosion may also have a negative impact on the rehabilitation capacity of the altered / reconstructed land surface.
- *Dust*; Increased dust generation from mining activities, earthworks, roads and exposed landforms (**Section 8.9**).
- *Metals*; Excavation or exposure of regolith materials with high concentrations of metals, and resulting mobilisation of metals into surrounding environment.
- *Acid forming materials;* Excavation and / or exposure of potentially acid forming regolith and waste materials (**Section 8.12.1**).

- *Soil contamination;* The contamination of surface soils with external pollutants such as hydrocarbons.

8.2.1.3 Management of Impacts

Management strategies to minimise impacts pertaining to soils and landforms in the project area will include:

- Minimise disturbance area and operate within a well defined footprint;
- Collection, stockpiling and management of soil resources in ways as to maximise rehabilitation potential and minimise erosion potential;
- Development, implementation and ongoing review of rehabilitation plans incorporating applicable design criteria for the reconstruction and rehabilitation of surface soil profiles;
- Progressive rehabilitation of disturbed areas as they become available for rehabilitation;
- Construction of landforms that blend in with existing landforms, are suitable for closure and are stable and resistant to erosion **(Section 8.12)**;
- Ongoing assessment of mine-waste components to identify potentially problematic materials (e.g. PAF materials), particularly in relation to waste landform construction (**Section 8.12.1**);
- Ongoing monitoring of rehabilitated areas to identify problematic soil characteristics;
- Management of potential dust generation sources and activities as outlined in **Section 8.9**;
- Decommissioning, re-contouring and rehabilitation of infrastructure areas to blend into the surrounding topography and minimise disturbance to surrounding landforms **(Section 9)**;
- Protocols to minimise the contamination of surface soils with external pollutants (e.g. hydrocarbons) as outlined in **Section 8.13**; and
- Management of waste rock and process tailings as outlined in **Sections 8.12.1**, and **8.12.2** respectively.

8.2.2 Creek Diversion and Coppin Gap

8.2.2.1 Management Objectives

The objectives of the management strategies pertaining to soils and landforms within the creek diversion and Coppin Gap are to maintain the integrity, ecological functions and environmental values of the drainage lines and surface water in the project area.

The proposed creek diversion is designed to function in a similar manner to the existing creek. An important component of the creek diversion is therefore the soil profiles of the proposed diversion path. The nature of the soil profile, in terms of its morphology and the soil's physical and chemical properties, will strongly influence the establishment and growth of vegetation, resistance to erosion and downstream sedimentation.

8.2.2.2 Potential Impacts

Potential impacts relating to soil and landforms within the creek diversion and Coppin Gap include:

- alteration of aesthetic value of landforms (**Section 10**);

- erosion within the diversion channel;
- downstream sedimentation; and
- excavation or exposure of potentially problematic regolith materials.

8.2.2.3 Management of Impacts

Baseline soil investigations have indicated that the soil profiles within the existing drainage lines of the proposed diversion path have physical and chemical characteristics similar to those within the existing creek (OES, 2006b; OES, 2006c).

The proposed creek diversion follows existing drainage lines, where practicable (**Figure 3-1**). Where excavations are required, the channel is designed to minimise the potential for erosion and downstream sedimentation. The majority of the channel will be cut into competent rock material with a low potential for additional sediment generation. Of particular importance to the construction of a creek diversion channel is the creation of a suitable creek bed and creek bank surfaces with low potential erodibility. This is particularly important for the early stages following construction, prior to the establishment of vegetation.

A Coppin Gap Management Plan has been developed, incorporating strategies and design criteria to minimise erosion and downstream sedimentation, and maximise potential for appropriate vegetation establishment on the creek diversion path.

Channel design has been undertaken with consideration to mimicking the natural creek channel and adjacent floodplain. The creek channel profile incorporates a constructed floodplain that will allow for vegetation establishment in the area adjacent to the main channel flow. Rehabilitation of this area using material from the creek that overlies the pit will enhance the likelihood of the diversion channel achieving ecological function similar to that of the existing creek.

8.2.3 Borefields and Service Corridors

8.2.3.1 Management Objectives

The objectives of the management strategies pertaining to soils and landforms within the borefields and service corridors is to maintain the integrity, ecological functions and environmental values of the soils and landforms within theses areas.

8.2.3.2 Potential Impacts

Potential impacts relating to soil and landforms within the water supply areas and associated corridors include:

- alteration of aesthetic value of landforms (**Section 10**);
- erosion of disturbed surfaces;
- potential to introduce or facilitate the establishment of weeds and exotic species;
- excavation of potentially problematic soil and regolith materials; and
- establishment of the gas pipeline corridor.

8.2.3.3 Management of Impacts

Moly Mines will implement the following management prescriptions:

- pipelines will follow existing roads and tracks, low in the landscape, wherever possible;
- significant landforms will be avoided;
- permanent pipelines will be buried;
- pipeline trench will be open for the minimum time required to safely install the pipeline and will be progressively rehabilitated;
- collection, stockpiling and management of soil resources in ways as to maximise rehabilitation potential and minimise erosion potential;
- monitoring of rehabilitated areas to identify any problematic areas with remedial actions implemented if required;
- construct the pipeline in the existing degraded road reserve along the Marble Bar to Woodie Woodie road which will minimise impacts to the adjacent vegetation, including weed spread and introduction;
- construct and maintain the pipeline utilising existing infrastructure (eg. roads and tracks) where possible to minimise impacts to the vegetation from vehicle use, including weed spread and introduction; and
- implement weed management procedures that address vehicle and equipment clean down.

8.2.4 Predicted Outcome

Based on the management approach and strategies identified above, the Spinifex Ridge Project is considered to meet the EPA objectives for landforms and soils.

8.3 Groundwater

8.3.1 Mine Site

8.3.1.1 Management Objectives, Standards and Guidelines

The management objectives necessary to mitigate the possible groundwater response to development of the Spinifex Ridge Mine are:

- Preserve the existing surface water expressions at Coppin Gap to within natural variation.
- Maintain the seasonal surface and groundwater flow through Coppin Gap to within natural variation.
- Ensure the groundwater quality surrounding the mine and tailings storage facility is maintained to ensure the currently identified beneficial uses are preserved.
- Continuously improve the understanding of surface and groundwater systems to ensure timely management and remediation of any deleterious impact.
- DoW is responsible for licensing and regulation of bore installation and abstraction. They are currently undertaking a review of water usage for mining across the Pilbara.

8.3.1.2 Potential Impacts

Definition of Groundwater Impacts

Impact on the groundwater system, due to the mining activity at Spinifex Ridge, is defined as any change to the current natural system. To determine if the groundwater impact is acceptable, consideration needs to be given to the current or future use of the groundwater, with respect to social, environmental or commercial aspects.

The potential impact of open-cut dewatering and tailings disposal on the groundwater system at Spinifex Ridge is primarily defined as a change that exceeds the natural range of groundwater flow rates, water levels and/or chemical composition.

The criteria for assessing the acceptability of any potential impact needs have been defined in terms of a beneficial use. **Table 8-1** below summarises the identified beneficial uses and the potential criteria that will be monitored to assess effects from the mining activities.

Table 8-1 Summary Of Impact and Assessment Criteria

Use Group	Beneficial Use	Location	Current Status of the Beneficial Use	Criteria for assessment
Social	Recreation	Coppin Gap Pool Riparian Fringe	Acceptable	Water Level Water Quality[1]
	Aesthetic appearance	Coppin Gap Pool Riparian Fringe	Acceptable	Water Level
	Water Supply	Coppin Gap Pool	Unacceptable	Water Quality[2]
Environmental	Aquatic Fauna	Coppin Gap Pool	Acceptable	Water Level Water Quality[3]
	Phreatophytic Vegetation	Coppin Gap Pool Riparian Fringe	Acceptable	Water Level Water Quality[3]
	Subterranean invertebrates	All aquifers	Acceptable	Water Level Water Quality[3]
Commercial	Stock Water Supply	Fractured Rock Aquifers (northern)	Acceptable	Water Quality[4]
	Stock Water Supply	Fractured Rock and Alluvial Aquifers (Southern)	Unacceptable (Due to existing Mo Levels)	Water Quality[4]

[1] The acceptable water quality due to exposure as infrequent swimming (twice per year).

[2] Unacceptable due to levels of As and Mo exceeding Drinking Water Guidelines (NHMRC, 2004).

[3] A change in water quality that exceeds relevant guidelines.

[4] ANZECC Guidelines for stock water (ANZECC/ARMCANZ, 2000). With water trigger value of 0.15mg/L for Mo.

The extent of the potential groundwater impact on Coppin Gap due to mining is presented in **Section 8.3.1**. The extent of impact on riparian vegetation and subterranean fauna is presented in **Sections 8.5** and **8.8**. The impact due to potential seepage from the TSF into the groundwater beneath the site is described in **Section 8.12.2**.

Potential Impacts Identified

The mining activities that are proposed to occur on either side of the Talga Range are treated as mutually exclusive for the purposes of groundwater interaction. This is due to the groundwater system being essentially bounded by the low permeability units that form the Talga Range, which effectively separates the north and southern sides of the Spinifex Ridge site.

To successfully mine the proposed open-cut development at Spinifex Ridge, water that enters the pit will be pumped out and incorporated into the mine water circuit. This will induce groundwater flow into the excavation from the rock mass surrounding the open-cut mine. The environmental response to the dewatering effort may result in:

- The localised change to the direction of groundwater flow and lowering of groundwater levels directly surrounding the mine;
- The potential lowering of water levels at Coppin Gap below natural variation; and
- The potential change in groundwater water quality at Coppin Gap by removing a source of molybdenum and arsenic that currently exists.

Flows at Coppin Gap

Predicted groundwater flows at Coppin Gap were modelled (Aquaterra, 2007) for a 12 year mining case. The results from the modelling case are more conservative than the current 10 year mine plan with a longer dewatering period applied (**Appendix I**). Groundwater flows are dwarfed by surface water contribution to flows into Coppin Gap (**Figure 4-12**). For the case where average recharge conditions are assumed, the model predicts a decrease in groundwater flows at Coppin Gap from around 110 kL/d to around 95 kL/d over the life of the mine. For a situation where there are a series of years with drought, predicted inflows at Coppin Gap, assuming no dewatering, are predicted to decrease from around 90 kL/d by the end of the first drought year and decrease further to 50 kL/d by the end of 2019. When mine dewatering is included, a more rapid decrease in flows to Coppin Gap is predicted, decreasing to zero by the end of 2016. For the climatic scenario with a series of wet years, a smaller decrease in flows to Coppin Gap is also predicted, down from 120 kL/d to 115 kL/d.

Predicted Drawdown

Predicted drawdowns at Coppin Gap throughout the life of the mine, assuming base case recharge, are presented in **Figure 4-14**. The model indicates that there is a minor change in water levels toward the end of mining, but that these levels are within the range of the modelled water level variation under a range of different climatic conditions (Aquaterra, 2007).

Other Predicted Water Level Changes

Maximum drawdown is predicted in the vicinity of the proposed pit, corresponding to the depth of the pit at 430m. There will be a steep cone of depression around the pit, give the nature of the surrounding rock.

Predicted water levels in the aquifer immediately underlying Coppin Gap for the base case recharge scenario have been modelled. The base case recharge scenario assumes that each year there is wet season of three month duration that recharges the aquifer feeding the Coppin Gap pool. Over the life of the mine there is a small predicted decrease in water level in the aquifer due to mine dewatering.

The results suggest that the maximum impact of the order of less than one metre will occur at the end of the dry season. This does not reflect a change in the pool level of this magnitude (see preceding section for Coppin Gap Pool drawdown).

When drought conditions are considered, predicted water levels in the Coppin Gap area are predicted to decrease after several consecutive dry years. The extent of this decrease is greater than the predicted decrease attributable to mining in the base case. When the mine development is included in the drought conditions case the greatest impact is predicted to be in the order of less than 0.5 metres in the underlying aquifer (not the Coppin Gap pool).

The deposition of tailings will occur within a circular impoundment that will not be artificially isolated from the groundwater environment. While it is expected that the tailings are essentially benign and the subsurface beneath the TSF is primarily comprised of a low permeability granitoid, potential exists for migration of tailings leachate to enter and migrate from the impoundment via the groundwater system. All other activities associated with the processing plant that could alter groundwater composition have been designed to be internally contained and therefore eliminate the possibility of their interaction with the groundwater system. Specifically potential impacts to groundwater from the tailings facility include:

- Migration of leachate from the TSF into the groundwater system directly beneath the impoundment. Although essentially benign the leachate may contain elevated levels of molybdenum of up to 1mg/L (Campbell, 2007).
- Groundwater levels in the vicinity of the TSF may be periodically elevated during periods of high rainfall.

8.3.1.3 Management of Impacts

Measures will be introduced to manage any impacts to the groundwater system (both north and south of the ridge), these include:

- Development and implementation of a Groundwater Management Plan;
- Ongoing monitoring and prediction of the groundwater response to mining activities both within and surrounding the mine;
- Incorporate water from the pit into the mine water circuit;
- Establish a groundwater monitoring system around the TSF. If monitoring indicates significantly elevated contaminant levels, the bores will be used to recover groundwater and returned to the water circuit;
- Monitor the water level within Coppin Gap and, if this drops below the natural variation range due to mining, supplement the water level with appropriate quality water;
- If further monitoring and modelling indicate the likelihood of long term impacts on water levels in Coppin Gap, implementation of engineering controls will be undertaken. The practise of grouting of aquifer is routinely undertaken in civil engineering projects and is a widely accepted practise. Installation of an aquifer grouting system to prevent drawdown from Coppin Gap Pool has been investigated (Coffey Geotechnics, 2007) and would be undertaken in consultation with DoW.

- Artificial management of groundwater levels will occur if a trend of 3 months excessive (50% greater than predicted fluctuation) drawdown is observed. Review of trigger water levels will occur biannually with continued improvement of the groundwater model.

Table 8-2 below summarises the potential groundwater impact and the proposed measures and monitoring systems to manage them.

- **Table 8-2 Summary of Impacts and Remedial Measures**

Potential Impacts	Measures to reduce Impacts	Monitoring of Impacts
TSF impact on water levels	Internal water reclaim systems and, if required, external groundwater recovery systems.	Downstream monitoring bores installed
TSF impact on water quality	If monitoring indicates significantly elevated contaminant levels, bores will be used to recover groundwater and returned to the water circuit.	Downstream monitoring bores installed
Lowering of water levels in Coppin Gap	If excessive drawdown (greater than natural variation) within the upper alluvial or calcrete aquifers is identified during mining resulting in impact on the water level in the Coppin Gap pool, artificial recharge of the pool with water of equivalent quality will be initiated. Given that the water volumes required for dewatering are expected to be modest (5 to 20 L/s) it follows that the rates required to manage water levels within a required range, will not be excessive and well within the surplus capacity of the mine water supply. The mode of discharge should be directly into an existing drainage line at a point that maximises infiltration and does not create an area of accelerated vegetative growth or change in the type of vegetation preferentially supported. Ongoing monitoring and investigations will determine whether aquifer grouting will be required to ensure the maintenance of the Coppin Gap pool post-mining. Aquifer grouting is a widely practised engineering process in civil engineering.	Groundwater monitoring bores installed in all aquifers. Groundwater volume monitoring of both recharge and dewatering. Continuous calibration of the groundwater model with the monitoring data collected. Monitoring of climatic data (rainfall, temperature, evaporation).
Lowering of water levels in creek systems between the mine and Coppin Gap	Water levels within the creek system between the mine and Coppin Gap are expected to lower within the basement rocks and to some extent within the alluvial and calcrete aquifers. In the immediate vicinity of the open-cut, between the creek diversion bund and the open-cut, maintenance of water levels will not be sustainable. Establishment of local native vegetation over areas where riparian vegetation is not sustainable and establishment of riparian vegetation along the diversion channel.	Groundwater monitoring of water levels. Groundwater monitoring of recharge rates. Monitoring of vegetation response to water level changes.
Change in groundwater chemistry between the mine and Coppin Gap	There is currently no anticipated deleterious impact to down gradient groundwater due to development of the open-cut mine. Presently the ore deposit is a suspected source of As and Mo which may be the source of elevated levels of As and Mo observed in groundwater monitoring performed between the deposit and Coppin Gap.	Groundwater monitoring bores installed in all aquifers.

8.3.1.4 Monitoring Plan

Effective management of the groundwater system relies upon the ability to assess the predicted outcomes against actual performance in a timely way that enables corrective measures to be planned and implemented. To monitor the effectiveness of mine dewatering and the groundwater response of the surrounding environment, a monitoring programme consisting of groundwater levels and pressures, abstraction and chemistry has been proposed and is discussed below and in **Table 8-3 –**

Table 8-5. The monitoring programme is designed to incorporate collection of the required data for ongoing revision of the closure plan.

Groundwater Levels and Pressures

Monitoring groundwater level and pressures is necessary to:

- Assess the performance of the dewatering effort, a key performance indicator for the development of each mining bench.
- Assess the depressurisation of pit slopes in areas where the slope design is sensitive to pore pressures.
- Assess the influence of dewatering on water levels in the natural system, including:
  - Coppin Gap surface water features, and
  - groundwater dependent ecosystems.
- Assess the influence of dewatering on the regional water system.

These objectives and the proposed monitoring programme are captured in **Table 8-3** with monitoring locations shown in **Figure 8-1**.

Groundwater Abstraction

To accurately calibrate the groundwater model, the mine water balance will need to be assessed and measured. During mining, water is abstracted from the groundwater system by:

- abstraction of “free” water via the mine dewatering system;
- evaporation from the pit walls and floor;
- vaporisation during blasting of the in-situ rockmass; and,
- added moisture for dust suppression management.

Of these, dewatering abstraction is the easiest to measure and the highest contributor to the overall abstraction. However, the majority of the rockmass at Spinifex Ridge is anticipated to be of low permeability with low inflow rates. It can be expected therefore that a high groundwater table will be maintained, with evaporative losses via the pit wall surface(s) contributing to a significant proportion of the mine dewatering effort.

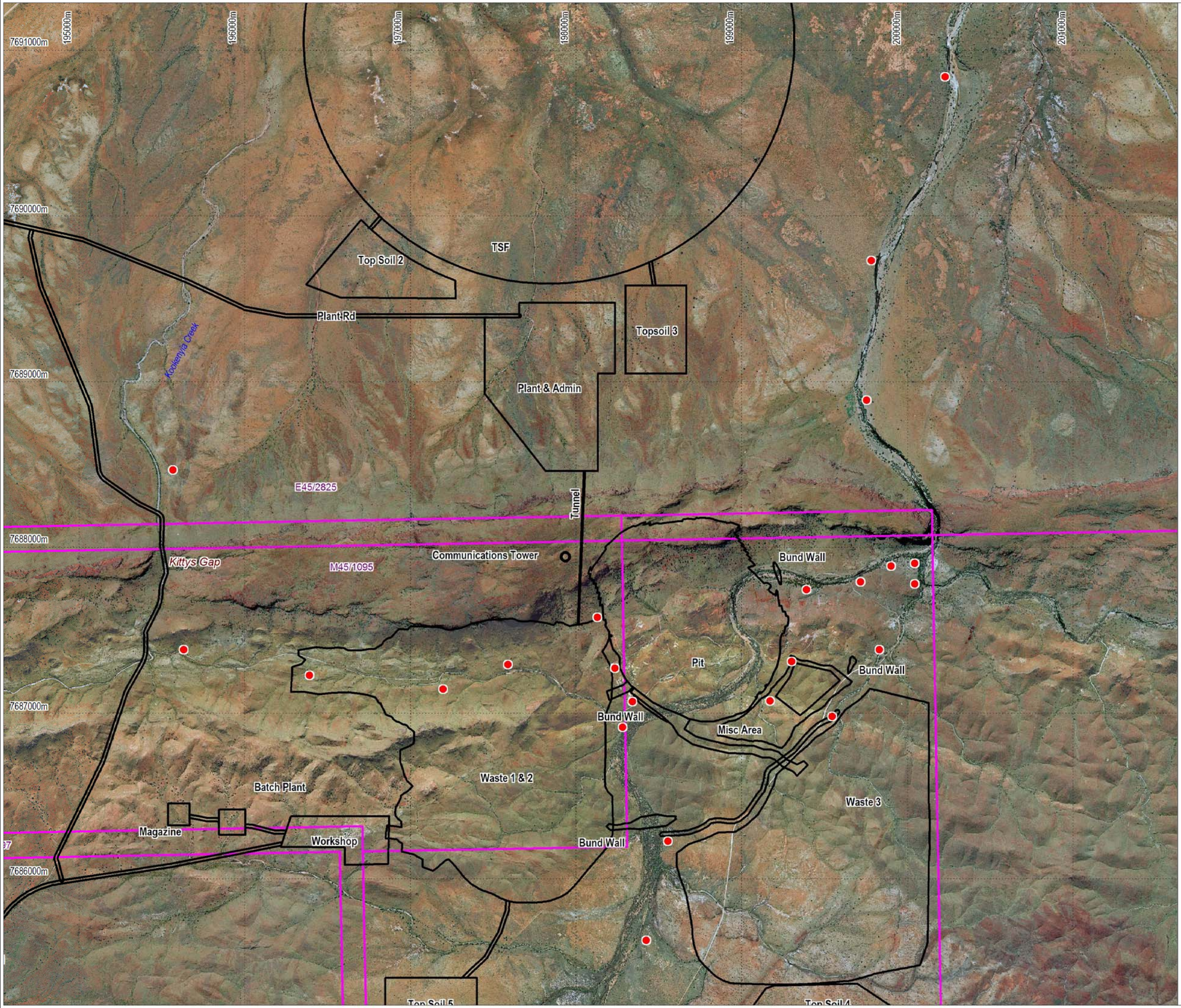
To measure the net abstraction from the pit, the following monitoring programme is outlined in **Table 8-4**.

It is expected that evaporative loss will form a large component of any total groundwater loss from the mining system and as such will need to be quantified with on-site data monitoring with an integrated meteorological monitoring station that includes the ability to measure daily evaporation.

Table 8-3 Water Level Monitoring Programme

Area	Monitoring Installation Type		Target Aquifer / Aquitard	Monitoring Frequency (operational)[1]	Installation Status (commenced)	Management Trigger Tool	Possible Action to Correct Impact[2]	Comments
	Water Level	Pressure Profile						
Spinifex Ridge Regional	X		Fractured rock (fresh and weathered)	Monthly	Yet to commence	Groundwater model	Make good any decrease in water supply to pastoral bores.	Monitoring of pastoral bores and additional bores to be installed.
Coppin Gap	X		Fractured rock	Monthly	Current (Dec 2006)	Groundwater model	Artificially manage water levels within natural variation, develop and demonstrate closure solutions while operating.	A detailed understanding of the hydrogeological interaction of the mine and Coppin Gap is to be developed during operation of the mine and a closure plan demonstrated within 5 years of operation.
Coppin Gap North	X		Alluvial and fractured rock (weathered)	Monthly	Yet to commence	Groundwater model	Make good any decrease in water supply to pastoral bores.	Monitoring of pastoral bores and additional bores to be installed.
Mine East	X	X	Alluvial, calcrete, fractured rock (weathered & fresh)	Bimonthly	Current (Dec 2006)	Groundwater model	Artificially manage water levels to sustain GDE's while operating.	A detailed understanding of the Hydrogeological interaction of the mine and area to the east of the mine is to be developed during operation of the mine and a closure plan demonstrated within 5 years of operation.
Mine West	X		Fractured rock (weathered & fresh)	Bimonthly	Current (Dec 2005)	Groundwater model	N/A	The hydrology and hydrogeology will be altered by the mine infrastructure.
Mine Walls		X	Fractured rock (fresh)	Bimonthly	Current (Dec 2005)	Slope design	Horizontal drainholes.	The requirement to install horizontal drainholes may increase the area of influence the mine void has on the surrounding environment. This increase is not expected to significantly alter dewatering predictions.
Open Cut Pit	X		Fractured rock (fresh)	Monthly	Current (Dec 2005)	Mining schedule	Increased dewatering	A change (increase) in the mining rate may increase the vertical advance and therefore dewatering rate. This is not expected to significantly alter the groundwater profile.
Tailings Storage Facility	X		Fractured rock (weathered and fresh)	Monthly	Preliminary	Unexplained change in level	Installation of recovery bores	An unexplained change is a variation to groundwater level that cannot be readily explained by natural events (eg. rainfall). Interpretation of groundwater monitoring must be performed by a suitability experienced professional in tailings management.

1. Recommended monitoring frequency for reporting. Higher frequencies may be required for operational management.
2. Suggested remedial measures to possible outcomes. The remedial measures are not limited to these suggestions.



MOLY MINES LIMITED

Spinifex Ridge Project
Western Australia

Figure 8-1

Groundwater Monitoring Bore Locations

0 1200m

Map Projection: MGA Zone 51 (GDA 94)

File: j:\3100 spinifex ridge mo\14 gis\user working data\per\per_figure_8.1 - a3.wor

Compiled: 4 / 7 / 2007
Updated : 4 / 7 / 2007
Plan No :

Compiled by:
Checked by :
Revision No : A

Location Diagram :

Legend

● Monitoring Bore Location

Groundwater Chemistry

The groundwater chemistry monitoring programme is designed to monitor the seasonal aquifer recharge and influence of the mining activity on the surrounding environment. The programme aims to achieve this by monitoring:

- the surrounding environment (regional bores), to establish a regional baseline;
- the influence of the tailings storage facility on the fractured rock aquifer beneath;
- the water abstracted via mine dewatering, to understand the influence of the mine on the groundwater system;
- the current receiving environment from the mine towards Coppin Gap, via bores within the system between Coppin Gap and the mine and the surface water expressions at Coppin Gap; and,
- The alluvial and fractured rock system north of Coppin Gap, to monitor the only identified ground and surface water discharge from the Spinifex Ridge mine to the receiving environment.

Table 8-4 Dewatering Volume Monitoring Programme

Abstractive Source	Measure	Method	Frequency
Direct abstraction (sumps or bores)	kL	Direct measurement	Weekly
Blasting (vaporisation)	Insitu storage estimate (m^3)	Calibrated measurement from test work	Monthly total of wet blasts
Evaporation	mm/day	Onsite measure of pan evaporation	Daily
In-pit dust suppression	kL	Direct measurement	Daily

Table 8-5 describes the monitoring frequency and constituents to be analysed to allow assessment of the aims of the programme.

Table 8-5 Groundwater Chemistry Monitoring Programme

Area	Sample Frequency	Analytes	Purpose
Coppin Gap	Monthly	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3 Al, As, Mn, Si, Pb, Cd, Mo, Cr(VI), NH_3, Sb, Ba, Br, Cu, Hg, Ni, Se, Ag, Zn	Influence of mining activities
Mine East	Quarterly	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3 Al, As, Mn, Si, Pb, Cd, Mo, Cr(VI), NH_3, Sb, Ba, Br, Cu, Hg, Ni, Se, Ag, Zn	Influence of mining activities
Regional Monitoring and Coppin Gap North	Biannually	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3	Influence of mine dewatering
Dewatering Abstraction	Monthly	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3 Al, As, Mn, Si, Pb, Cd, Mo, Cr(VI), NH_3, Sb, Ba, Br, Cu, Hg, Ni, Se, Ag, Zn	Influence of mining activities
Remedial Discharge/Injection	Monthly	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3 Al, As, Mn, Si, Pb, Cd, Mo, Cr(VI), NH_3, Sb, Ba, Br, Cu, Hg, Ni, Se, Ag, Zn	Influence of mining activities
Tailings Storage Facility	Biannually	pH, Ec, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3, CO_3 Al, As, Mn, Si, Pb, Cd, Mo, Cr(VI), NH_3, Sb, Ba, Br, Cu, Hg, Ni, Se, Ag, Zn	Influence of tailing deposition

8.3.1.5 Potential Impacts

The groundwater response to abstraction from the aquifer system is based on predictions performed with the aid of a numerical model (Aquaterra, 2006) with the following outcomes:

- Modelling of the surrounding aquifer system demonstrates that sustainable abstraction at 600 L/sec, with minor change in aquifer condition, is possible from a single location (single evenly space borefield) for a period of at least 10 years.
- At the end of 10 yrs of pumping from the proposed borefield, additional drawdown at the Shay Gap Borefield is expected to be between 5 and 7 m. This is not expected to impact on the viability of the Shay Gap borefield.
- Pressures heads within artesian bores drilled at coastal areas could drop by up to 5m at the end of 10 yrs. It is however, expected that artesian bores will remain artesian.
- Optimisation of the borefield configuration will be required during the construction phase to determine the northern extent of the borefield, number of bores (based on actual yields) and optimal bore spacing.
- No change to water levels in the Broome Sandstone Aquifer is expected, and therefore no impact to currently drilled livestock wells or bores is expected.
- The Canning borefield will be managed to maintain saturated conditions within the aquifer. It is expected there will be no loss of habitat for any subterranean fauna that may populate the aquifer.

The extent of recharge to the Wallal Aquifer in the southern margin of the basin is unknown and has not been included in modelled predictions. If there is recharge to the Wallal aquifer, the water level drawdowns predicted will be less.

8.3.1.6 Management of Impacts

The following specific strategies have been recommended to ensure that impacts are managed;

The Wallal Sandstone is likely unconfined in the southern extent of the proposed wellfield and potentially confined in the northern extent. As such there is flexibility to manage aquifer drawdown to limit either the lateral drawdown response or the magnitude of vertical drawdown.

Extensive monitoring of existing wells, bores and springs for water level and water chemistry needs to be undertaken. This monitoring will be used to refine the groundwater model and anticipate any future impacts.

Should any drawdown impacts be anticipated, there is significant scope to modify the borefield operation and/or layout to limit either the vertical draw or spatial impact of the drawdown. Due to the size of the resource the Canning Basin offers it is expected that in the event any unpredicted groundwater response, significant lead time exists to enable a considered and well planned response.

8.3.1.7 Monitoring Plan

A program will be designed to monitor the impacts of borefield operation on local groundwater levels, groundwater quality and the possible impacts on groundwater dependent springs. The monitoring results, and the interpretation of results, will be reported to the DoW annually in the Aquifer Review process.

A proposed monitoring programme is summarised in **Table 8-6**.

Monitoring data should be recorded in a site database and reviewed quarterly to ensure compliance with the mine's Groundwater Operating Strategy. The data will be presented in tables and on graphs in the annual and triennial GWL reports.

- **Table 8-6 Proposed Canning Monitoring Schedule**

Parameter	Monitoring / Sampling Site	Frequency
Water Quantity		
Water Supply Abstraction	Flow meter at each water supply bore	Monthly
Water Use	Mine site potable	Monthly
	Mine process	Monthly
Water Levels		
Water Levels - Operational	Water supply	Monthly
Water Levels - Regional	Monitoring bores[1]	Monthly
Water Quality		
Salinity (EC) and pH	Water supply bores	Monthly
Water Supply - Hydrochemistry	Water supply bores	Quarterly
Salinity (EC) and pH	Dewatering bores	Monthly
Dewatering - Hydrochemistry	Dewatering bores	Annually

[1] Monitoring sites to be established

Other groundwater related monitoring maybe stipulated when the Project's DoW operating licence is issued.

8.3.2 Woodie Woodie

Moly Mines requires a maximum water draw of 600L/sec of water for processing of molybdenum ore from the Spinifex Ridge Project. One of the options that Moly Mines would like to investigate is the feasibility of using the aquifer around the Woodie Woodie area to supply this water for a period of 10 years. A model was developed to simulate groundwater abstraction from the Woodie Woodie minesite and adjacent affected areas and to assist with the assessment of the impacts on the groundwater system (GRM, 2006).

8.3.2.1 Management Objectives, Standards and Guidelines

The management objective for use of the Woodie Woodie water source, is to manage abstraction so that abstraction does not adversely affect groundwater or surface water quality and quantity.

Applicable guidelines and standards include:

- Licences to take water issued under Section 5C of the RIWI Act;
- Licences to construct or modify a bore issued under Section 26D of the RIWI Act.

8.3.2.2 Potential Impacts

Groundwater abstraction impacts within the aquifer system (based on simulation results of the Woodie Woodie Aquifer Abstraction Modelling prepared by GRM (2006)) are as follows:

- It is possible to pump an additional 600L/sec of additional groundwater from a single source location (Cracker Pit) for a period of 10 years, without causing significant additional change to the system.
- The extent of the 5m drawdown contour due to existing dewatering in the Woodie Woodie area may increase by 600m lateral distance, but should be constrained to areas of high permeability.
- The simulated change in groundwater drawdown is less than 0.5m at the closest point along the Oakover River to the extraction point at Cracker Pit.
- The decrease in groundwater discharge flow rate to the Oakover River is simulated to be about 2,000m^3/day. However this modelled decrease does not take into account flood recharge which would take place due to cyclones or rain bearing low depression systems. Historical monitoring data indicates that the Woodie Woodie aquifer may recharge up to 1 to 2m following these events. Therefore, some of the simulated impacts may be counteracted by the onset of cyclones or severe rain-bearing low depression systems.
- The increase in the simulated time for the groundwater system to recover following cessation of pumping for this extra abstraction compared to the current mine abstraction, is about 13 years (increases from 40 to 53 years).

8.3.2.3 Management of Impacts

The following specific strategies have been recommended to ensure that impacts are managed:

- Monitoring bores should be constructed to measure groundwater drawdown in the Woodie Woodie area once the additional 600L/sec is abstracted. Information collected from the monitoring should be used to refine the groundwater model to anticipate any future impacts.
- Monitoring bores near the Oakover River should monitor the drawdowns near the Oakover River to confirm the modelling results.
- The Woodie Woodie groundwater flow model does not simulate the potential for rapid recharge of the aquifer following a cyclonic event or a severe rain-bearing low depression system. These events should be monitored and their effects on the groundwater levels measured and quantified.
- As more regional monitoring information is gathered, the data should be used to refine the groundwater model.
- Assuming the impact of pumping from Woodie Woodie (Cracker Pit) was found to have too large a stress on the Woodie Woodie aquifer, two other options could be implemented to manage the impact:
    1. Ongoing groundwater abstraction from current and future mining areas at Woodie Woodie could be pumped to Cracker Pit, thereby providing a significant part of the water pumped to Spinifex Ridge. This would reduce the amount of groundwater pumped from the Woodie Woodie aquifer as an additional 600L/sec would not be required, only the make-up quantity.
    2. A number of extraction points could be established, and a lower quantity of water from each single point pumped to deliver the required quantity of groundwater. This would reduce the stress placed on the Woodie Woodie aquifer due to a single source extraction point.

8.3.2.4 Monitoring Plan

A program will be designed to monitor the impacts of borefield operation on local groundwater levels, groundwater quality, the possible impacts on groundwater dependent vegetation close to production bores and reduction in stream flow. The monitoring results, and the interpretation of results, will be reported to the DoW annually in the Aquifer Review process.

A proposed monitoring programme is summarised in **Table 8-7**.

Monitoring data should be recorded in a site database and reviewed quarterly to ensure compliance with the project's Groundwater Operating Strategy. The data will be presented in tables and on graphs in the annual and triennial GWL reports.

- **Table 8-7 Proposed Woodie Woodie Monitoring Schedule**

Parameter	Monitoring / Sampling Site	Frequency
Water Quantity		
Water Supply Abstraction	Flow meter at each water supply bore	Monthly
Dewatering	Flow meter on each dewatering bore	Monthly
Water Use	Mine site potable	Monthly
	Mine process	Monthly
Discharge	Dewatering outfall	Monthly
Water Levels		
Water Levels - Operational	Water supply & dewatering bores	Monthly
Water Levels - Regional	Monitoring bores[1]	Monthly
Water Quality		
Salinity (EC) and pH	Water supply bores	Monthly
Water Supply - Hydrochemistry	Water supply bores	Quarterly
Salinity (EC) and pH	Dewatering bores	Monthly
Dewatering - Hydrochemistry	Dewatering bores	Annually

[1] Monitoring sites to be established.

Other groundwater related monitoring maybe stipulated when the project's DoW operating licence is issued.

8.3.3 De Grey River

The Spinifex Ridge Project has a nominal mine life of 10 years with plans to produce and process 20 Mtpa of ore. The mine has an estimated average water supply demand of 15GL/annum. To part supply the project's water requirements, a borefield linked to the De Grey River palaeochannel aquifers is planned in conjunction with the Canning supply. The De Grey borefield will supply water at a rate of between 4 – 8 GL/annum for use in construction of the ore treatment plant and to supply the peak water demand. Initially, when the mine is starting up, the wellfield is planned to deliver 8GL, but this will drop to 4 GL once the mine is fully operational and once the Canning borefield is operational.

8.3.3.1 Management Objectives, Standards and Guidelines

The management objective for De Grey water source management is to manage abstraction to ensure that abstraction does not adversely affect groundwater or surface water quality and quantity.

Applicable guidelines and standards include:

- Licences to take water issued under Section 5C of the RIWI Act;
- Licences to construct or modify a bore issued under Section 26D of the RIWI Act.

8.3.3.2 Potential Impacts

Impacts related to abstraction of groundwater from the De Grey Borefield are discussed below.

The predicted groundwater response to 10 years pumping for the 4GL/annum scenario is shown in **Figure 8-2** to **Figure 8-4**. The figures graphically show the groundwater drawdown response within the three layers of the model with the pertinent outcomes summarised as:

- The upper alluvial system associated with the De Grey River, is maintained by the limited recharge applied in the model, without taking into account the annual flood events that would further recharge the upper system during each wet season (**Figure 8-2**);
- In those areas where low permeability material overlies the palaeochannel (i.e. away from the current river channel) groundwater levels will drop. Stock bores and wells located within these areas may suffer a reduction in water level (**Figure 8-2**), and;
- Drawdown of between 10 and 40m is predicted within the confining layer and palaeochannel aquifer, however the palaeochannel aquifer is maintained as a saturated confined aquifer over the 10 year abstraction period (**Figure 8-3** and **Figure 8-4**).

8.3.3.3 Management of Impacts

The De Grey Borefield is designed to draw water from a semi-confined palaeochannel aquifer. It relies on leakage from an overlying semi-confining layer and to a limited extent, recharge via direct infiltration from rainfall. To manage water level drawdown across the borefield, cycling of production and standby bores will be required to ensure an even drawdown cone across the borefield.

The groundwater modelling performed to date did not allow for direct recharge to the palaeochannel from the annual flood events down the De Grey River. By drawing down water levels in the palaeochannel there is potential that some of the flood waters may recharge the palaeochannel where it crosses the De Grey River. While the recharge volumes would be a minor percentage of the total seasonal flows down the De Grey (600GL/annum, WRC, 1996), they would further enhance the capacity of the borefield and reduce drawdown impacts. This connectivity can only be practically determined once the operating borefield is commissioned.

There are primarily three requirements to the successful management of groundwater levels associated with the De Grey Borefield:

1) Minimise the drawdown within the upper alluvial aquifer associated with the De Grey River.
2) Maintain confined conditions within the palaeochannel.
3) Minimise the interference effects between bores to ensure efficient operation.

Of these three considerations, items 2 and 3 are concerned with pumping bore hydraulics and will be modelled upon completion of the borefield using actual pump test data. Groundwater modelling has demonstrated that these items are achievable with conservative hydraulic parameters.

Item 1 aims to protect the ecosystem that relies on the upper alluvial aquifer associated with the De Grey River. The impact the borefield can have on this aquifer is considered low, due to annual flooding of the De Grey River each year, which effectively recharges the upper aquifer.

In the event that drawdown within the upper aquifer is observed to be excessive and the two aquifers are in direct connection, a seasonal pumping strategy can be implemented to:

- replenish the palaeochannel during times of flood, and
- reduce pumping from those bores close to the river during the drier months.

8.3.3.4 Monitoring Plan

A program will be designed to monitor the impacts of borefield operation on local groundwater levels, groundwater quality, the possible impacts on groundwater dependent vegetation close to production bores and reduction in stream flow. The monitoring results, and the interpretation of results, will be reported to the DoW in the Annual Aquifer Review process.

A proposed monitoring programme is summarised in **Table 8-8**.

Monitoring data will be recorded in a site database and reviewed quarterly to ensure compliance with the mine's Groundwater Operating Strategy. The data will be presented in tables and on graphs in the annual and triennial GWL reports.

8.3.4 Predicted Outcome

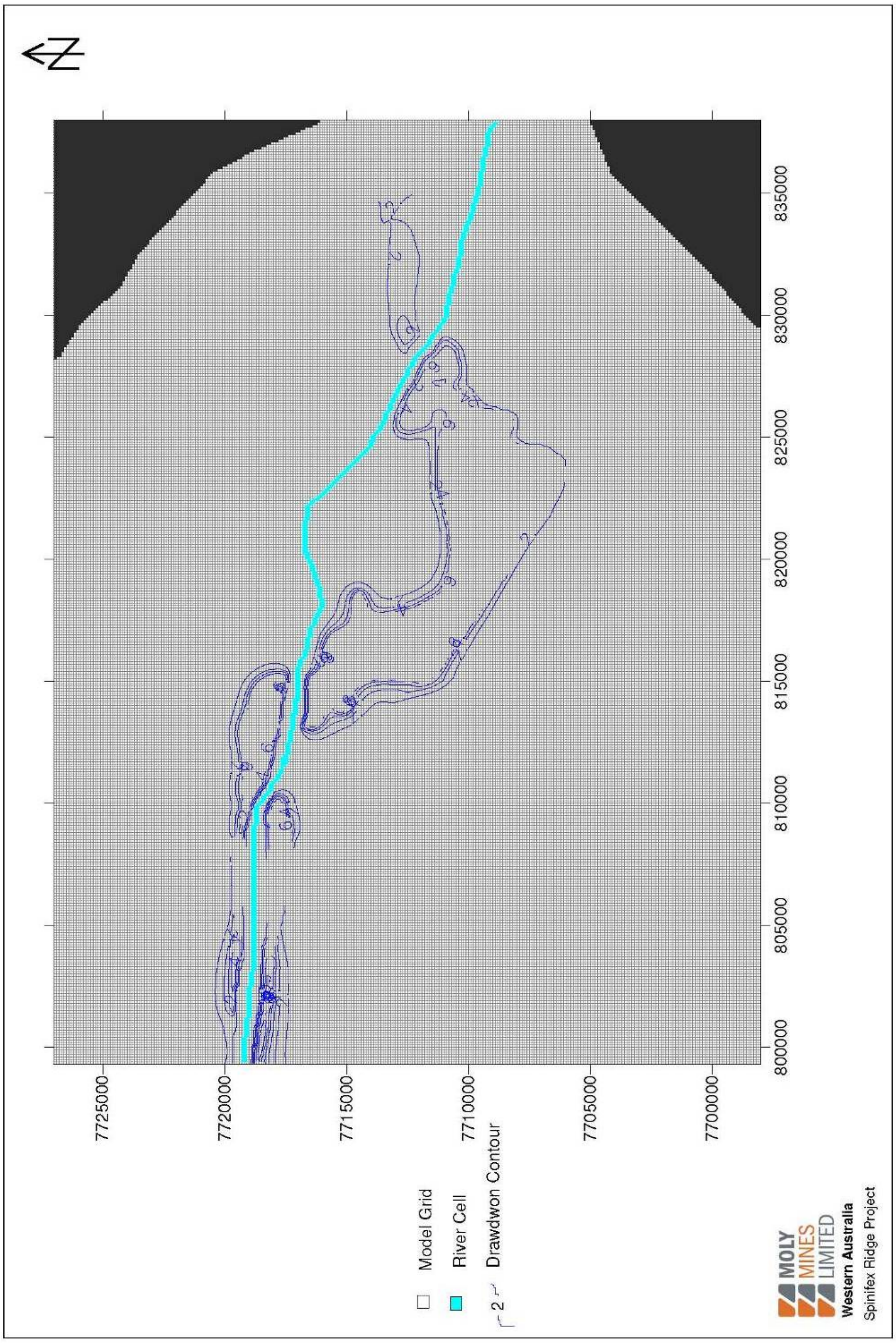
Based on the management approach and strategies identified above, the Spinifex Ridge Project is considered to meet the EPA objectives for groundwater.

Table 8-8 Proposed De Grey River Monitoring Schedule

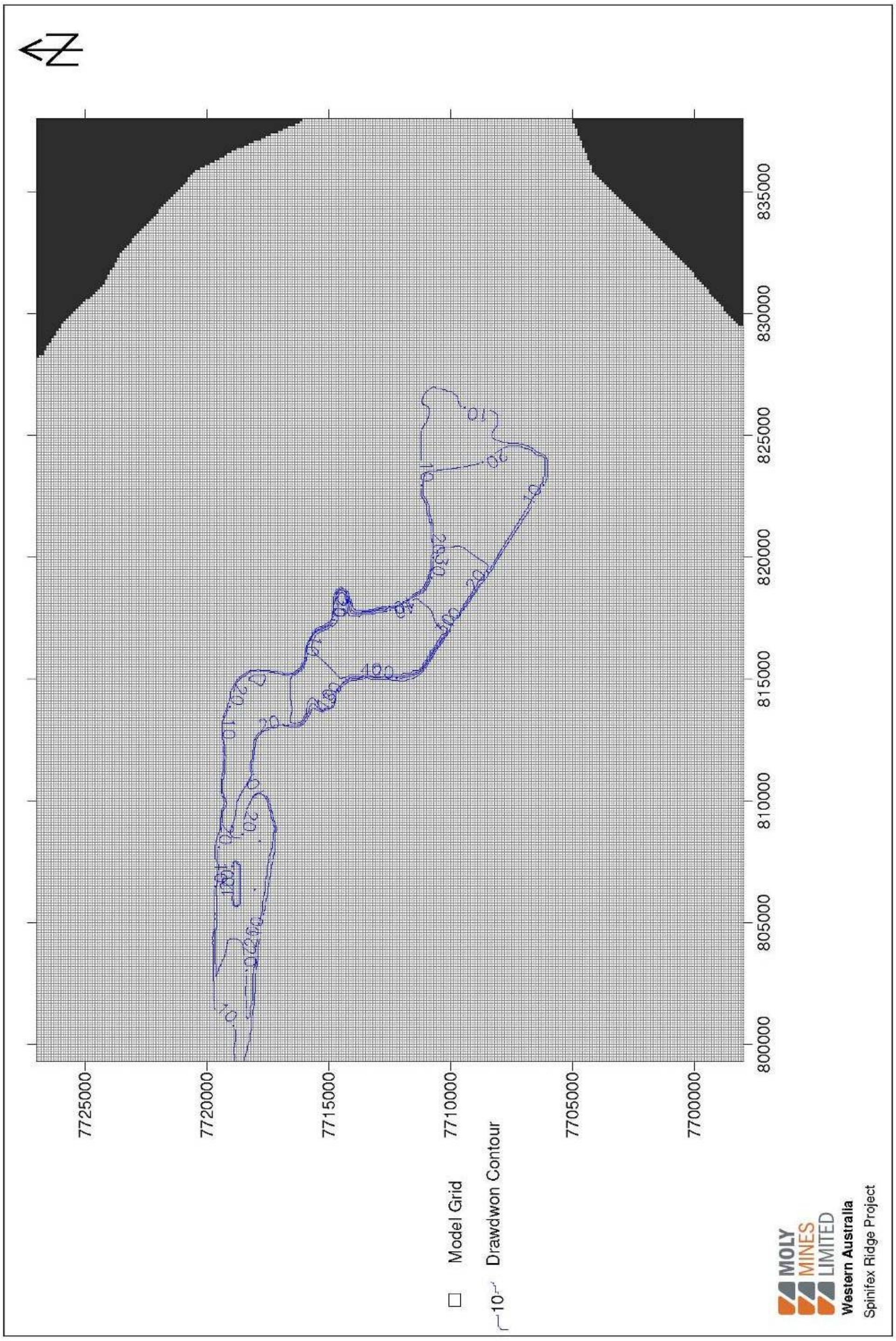
Parameter	Monitoring / Sampling Site	Frequency
Water Quantity		
Water Supply Abstraction	Flow meter at each water supply bore	Monthly
Water Use	Mine site potable	Monthly
	Mine process	Monthly
Water Levels		
Water Levels - Operational	Water supply bores	Monthly
Water Levels - Regional	monitoring bores[1]	Monthly
Water Quality		
Salinity (EC) and pH	Water supply bores	Monthly
Water Supply - Hydrochemistry	Water supply bores	Quarterly

[1] Monitoring sites to be established including in the shallow aquifer

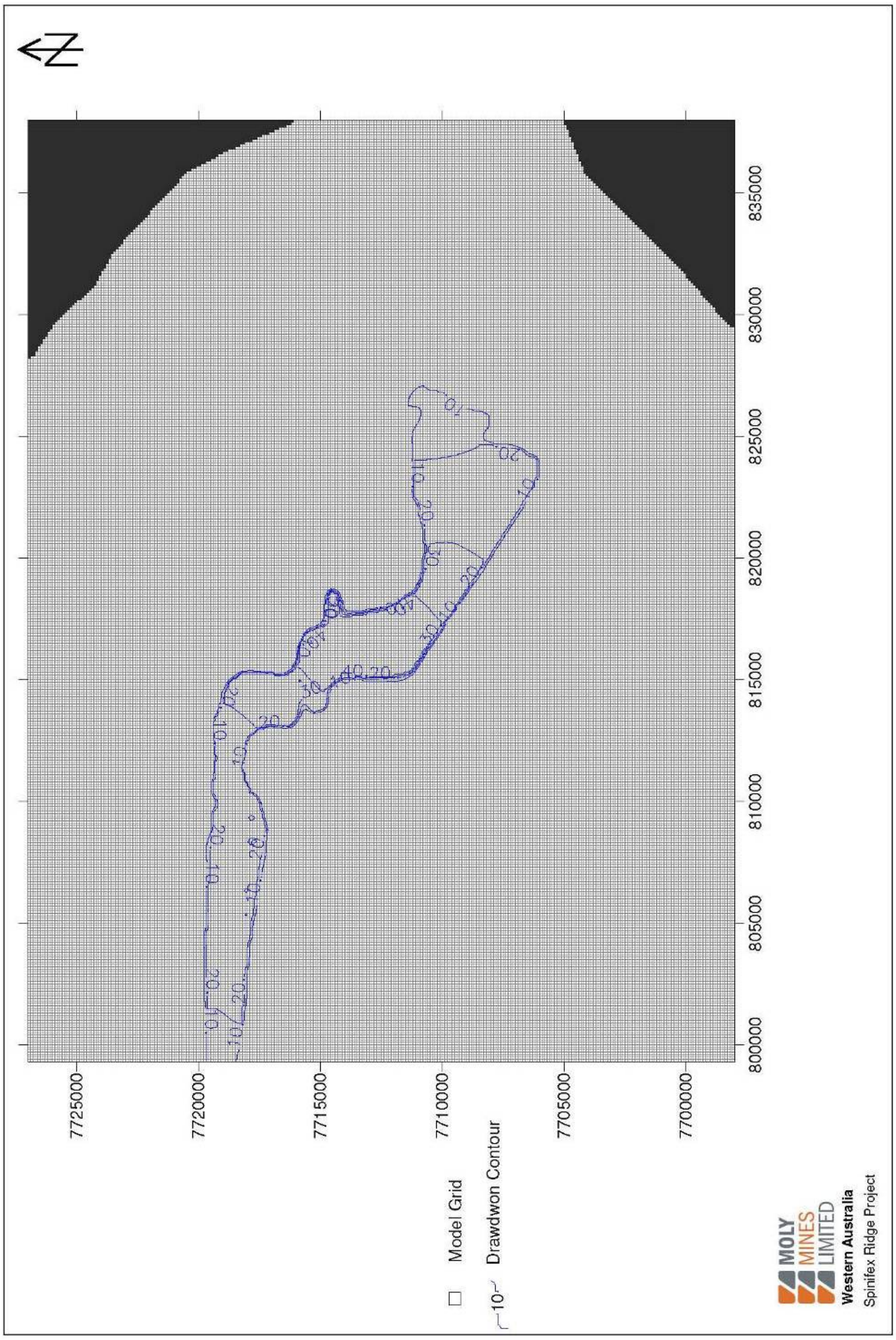
[2] Other groundwater related monitoring maybe stipulated when the project's DoW operating licence is issued.



- **Figure 8-2 Scenario 1 Predicted Drawdown Contours After 10 yrs Pumping Layer 1**



■ **Figure 8-3 Scenario 1 Predicted Drawdown Contours After 10 yrs Pumping Layer 2**



- **Figure 8-4 Scenario 1 Predicted Drawdown Contours After 10 yrs Pumping Layer 3**

8.4 Surface Water and Drainage

8.4.1 Management Objectives, Standards and Guidelines

Stormwater management, surface water discharges and activities that discharge to the environment are regulated under the EP Act..

EPA Objectives

The EPA normally applies the following objectives in its assessment of proposals that may affect surface water and water quality. These objectives are considered relevant to this proposal.

- The EPA objective for the management of watercourses is to maintain the integrity, ecological functions and environmental values of watercourses and sheet flow.
- The EPA objective for surface water quality is to ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

Standards and Guidelines

Applicable guidelines and standards include:

- ANZECC/ARMCANZ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCAZ, 2000).
- *Water Quality Protection Guidelines* (No. 1-11) (DoW & DoIR, 2000).
- *State Water Quality Management Strategy* (ANZECC and ARMCANZ, 2001).

ANZECC/ARMCANZ Guidelines

In 1996 the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) developed the National Principles for the Provision of Water for Ecosystems (1996). These national principles aimed to improve the approach to water resource allocation and management, and to incorporate the needs of the environment in the water allocation process. The overriding goal of the principles is to provide water for the environment to sustain, and where necessary restore, ecological processes and biodiversity of water dependent ecosystems.

ANZECC and ARMCANZ have also released a set of water quality guidelines for the protection of marine and freshwater ecosystems (ANZECC/ARMCANZ, 2000). The ANZECC/ARMCANZ guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, broken down into five geographical regions across Australia and New Zealand.

Water Quality Protection Guidelines (No.1-11)

In 2000 the Water and Rivers Commission (WRC, now DoW) and Department of Minerals and Energy (DME, now DoIR) developed a series of Water Quality Protection Guidelines for mining and mineral processing. These guidelines address a range of issues including installation of minesite groundwater monitoring wells, minesite water quality monitoring and minesite stormwater.

State Water Quality Management Strategy

The Government of Western Australia developed the State Water Quality Management Strategy with the objective to achieve sustainable use of the State's water resource by protecting and enhancing their quality while maintaining economic and social development.

8.4.2 Potential Impacts

Pit

The main impact of the proposed pit will be the alteration of natural surface water drainage lines. The pit footprint will intersect Coppin Creek just upstream of Coppin Gap, and minor tributaries that flow into Coppin Creek. To provide flood protection to the pit area, a diversion channel will redirect flows from Coppin Creek around the pit to rejoin the creek downstream of the pit and upstream of Coppin Gap. As a result of this diversion, a portion of the pre-mining catchment will no longer drain to Coppin Creek.

Flood protection bunding will be required upstream and downstream of the proposed pit. Upstream of the pit, earth embankments will prevent water from Coppin Creek entering the pit area and will assist in redirecting water to the diversion channel. Downstream of the pit, bunding will prevent backwater from Coppin Gap entering the pit area. However, the construction of these bunds may potentially impact adjacent flood levels.

Diversion Channel

The purpose of the diversion channel will be to redirect surface water from Coppin Creek around the pit area (**Figure 8-5**). Flow diversions may result in a loss of flow volume and peak discharge for a certain distance downstream in the natural channel as a portion of the catchment is bypassed. Immediately upstream of Coppin Gap, flow volumes and peak discharges will potential decrease due to a smaller contributing catchment area. However, the diversion channel route is approximately 900m shorter than the existing Coppin Creek route through the pit area. As such, the mainstream length of the Coppin Gap catchment is reduced by around 5% which will reduce catchment response time and potentially increase peak discharges. To some degree, the potential for increased peak discharge as a result of reduced catchment response time will be somewhat offset by the potential for reduced peak discharge as a result of reduced catchment area.

MOLY MINES LIMITED

Spinifex Ridge Project
Western Australia

Figure 8-5
Creek Diversion Channel

0 400m

Map Projection: MGA Zone 51 (GDA 94)
Contour Interval: 2m

File: j:\3100 spinifex ridge mo\14 gis\user working data\per\per_figure_8.2 - a3.wor

Compiled: 12 / 7 / 2007
Updated : 12 / 7 / 2007
Plan No :

Compiled by:
Checked by :
Revision No : A

Location Diagram :

- Tenement boundary
- Site Layout Areas
- Creek Diversion Channel
- Contour Line (2m interval)
- Index Contour Line (10m interval)

The diversion channel has the potential to experience high flow velocities. These high velocities together with the disturbance of soil and removal of vegetation are likely to result in erosion occurring within the diversion channel. Erosion of the excavated faces is likely to be the principle source of eroded materials while the base of the channel is expected to have a lower potential for erosion as a result of the base being mostly rock. Deposition in the channel bed would likely occur during low/reducing flow events. It is likely that erosion would not be extensive, as the diversion channel and the downstream tributary are located in a typically rocky area, which would be resistant to erosive forces.

Erosion along the diversion route is also likely to increase at locations outside the excavation zone due to the increased flood discharges and velocities. The tributary that the diversion channel is proposed to discharge into has a relatively small pre-mining catchment area of 2.2km^2. After construction of the diversion channel, this catchment increases to 50km^2. As such, there will be a substantial increase in peak discharges and velocities downstream of the diversion channel, with a resultant increase in the potential for erosion in this tributary.

Impact on flow volumes and peak discharges upstream of the diversion channel are not expected to be significant.

Coppin Gap

Eroded material from the diversion channel route is likely to be transported and deposited just upstream or just downstream of Coppin Gap. Modelling of Coppin Creek before and after the construction of the diversion drain showed that the flood depths do not change for the 2-year ARI flood event and decline by 0.03m (less than 0.5%) during the 100-year ARI flood event. Hence flood levels and flow velocities through Coppin Gap are expected to be effectively unchanged after the construction of the diversion drain. As sediment levels in Coppin Gap are governed by the flow regimes, long term sediment levels in Coppin Gap are not expected to be different from current levels.

The flow velocities upstream of Coppin gap and immediately entering and leaving Coppin Gap with the diversion channel in place are shown in **Table 8-9**. As can be seen from this table, for both the 2 year ARI and 100 year event, flow velocities through Coppin Gap are significantly higher than upstream of the Gap. Consequently, even during relatively minor flow events, the flow regime will act to deposit sediment upstream of the gap and scour any sediment located in the Gap.

- **Table 8-9 Coppin Gap Flow Velocities**

Location	2 Year ARI Channel Velocity (m/s)	100 Year ARI Channel Velocitiy (m/s)
Upstream of Coppin Gap	1.2	1.8
Entering Coppin Gap	2.9	8.7
Exiting Coppin Gap	1.4	6.5

Waste landforms

The waste landforms have been positioned such that they are located outside the floodway of major waterways. However, they will intersect minor creeks. This can potentially result in water ponding on the upstream side of the waste landforms, creating a safety hazard and potentially causing inundation and loss of vegetation.

Waste landforms can also be a large source of sediments. Rainfall and surface water runoff around the waste landforms have the potential to distribute sediment laden water to the environment. Additionally, any diversion channels or flood bunds placed around the waste landforms may concentrate sheet flow and potentially increase local flow velocities and soil erosion.

Waste landforms 1 and 2 will contain PAF material which has a potential to produce acidic runoff or runoff that may contain elevated concentrations of metals. This issue is discussed in **Section 8.12.1**.

Tailings Storage Facility

The TSF will be located downstream of Spinifex Ridge, between Coppin Creek and Kookenyia Creek. The TSF will be positioned outside the main Coppin Creek floodway but will intersect smaller tributaries to the creek. This may potentially result in minor upstream ponding against the tailings but should not have a significant impact on water levels during a 100 year ARI event.

However, the TSF has the potential to impact the Kookenyia Creek floodway. The topography downstream of Kitty's Gap is relatively flat, and during major rainfall events, Kookenyia Creek will likely have large flood fringe areas as water from the main floodway spreads out and overspills into adjacent creeks. The proposed footprint of the TSF is currently located on several of these adjacent creeks and a small section of the TSF protrudes into the Kookenyia Creek floodway. This may potentially impact flow volumes and peak discharges in Kookenyia Creek.

Modeling of a 100 year ARI event through Kitty's Gap before construction of the TSF shows that floodwaters will overtop the ridges confining the main channel and overflow into adjacent creeks. Thus the peak discharge flowing through Kookenyia Creek may progressively reduce as water overspills into these adjacent creeks. However, the proposed position of the TSF will intercept many of these adjacent creeks and prevent water from Kookenyia Creek from overflowing into them. This may result in increased volumes and peak flows through Kookenyia Creek after the construction of the TSF.

Increased peak flows through the creek have the potential to increase velocities and erosion. However, the velocities through Kookenyia Creek are relatively low (<1.5m/s) and minor increases in velocity after construction of the TSF (0.1-0.3m/s in the 100 year ARI event) are not expected to significantly increase erosion around the TSF.

Increased peak flows and volumes also have the potential to increase flood levels in Kookenyia Creek. Modelling shows that a 100 year 72 hour event will cause water levels in Kookenyia Creek to rise by an average of 0.12m for the length of the creek constricted by the tailings facility. The maximum increase in water levels occurs where the tailings footprint intrudes the greatest into the Kookenyia Creek floodplain. In this area, the model predicts water levels to rise by 0.15m.

Ponding around the TSF could potentially occur. The TSF will receive water from minor catchments on Spinifex Ridge which drain northwards and likely pond along the southern edge of the tailings facility. The TSF will also increase the risk of surface water contamination as it has the potential to discharge various chemicals, reagents and unrecovered metals to the environment.

The TSF has the potential to impact on water quality through the inclusion of PAF material or process chemicals. This issue is discussed in **Section 8.12.2**.

Camp Site, Plant Site and Air Strip

The camp site, plant site and air strip are also located downstream of Spinifex Ridge and outside of major floodways. Chemicals generated by these sites have the potential to be distributed to the environment by smaller creeks flowing through these areas. To redirect minor flow paths and to prevent flooding of the infrastructure, diversion channels, flood bunds and raised pads will be used. However, these structures may potentially increase local flow velocities and hence soil erosion around the infrastructure.

8.4.3 Management of Impacts

The potential impacts of minesite infrastructure on surface water and drainage will be addressed by the following management actions:

- Use diversion structures around the pit to direct surface water downstream.
- Design the diversion channel to incorporate water management features that replicate natural conditions prior to minesite development.
- Design waste landforms to incorporate water management features to minimise design flow diversion and the potential for sediment-laden surface wafer runoff.
- Design diversion structures around mine infrastructure to minimise erosion and associated water quality impacts.
- Install sediment traps/basins, where appropriate, to reduce sediment loads from mining infrastructure.

Diversion Structures Around Pit

Diversion structures such as flood bunds and diversion channels will be used to prevent water from flowing into the pit. Inflows from the catchment that drain into the pit will be re-directed back into Coppin Creek. Diverting Coppin Creek around the pit area reduces the total catchment area upstream from Coppin Gap by around 7% after mining. This is not a significant reduction in area of the contributing catchment and, along with local diversion of minor pit inflows, downstream volumes of discharge will not be significantly reduced. Changes in flood levels adjacent to the pit bunds can be minimised in the diversion channel design.

Diversion Channel Design

To mitigate the potential impacts of the diversion channel on surface water drainage, the channel should be designed to replicate the natural conditions prior to minesite development.

A list of design criteria for the diversion channel has been developed and includes the following:

- Reproduce pre-development flood levels.
- Stable flow profile.
- Channel should "drain out".
- Limit the disturbance footprint.
- Floodplain zones.

The diversion channel will be designed to reproduce as close as possible pre-development flood levels on Coppin Creek at the upstream end of the diversion channel. In this way, the impact on upstream Coppin Creek water levels is reduced. Downstream water levels are also not expected to change. HEC-RAS modelling shows that flood levels downstream of the diversion channel (immediately upstream from Coppin Gap) will not be impacted after completion of the diversion channel as the total volume of water discharging to Coppin Gap does not significantly change.

Ensuring a stable flow profile will require that flow velocities through the diversion channel be less than 3 - 4m/s and preferably be similar to natural channel velocities, to give a similar sediment transfer capacity. The channel bed slopes will also match the existing bed slopes as best as possible.

The diversion channel will be designed such that all sections along the channel drain out. If sections of the channel are inundated for long periods after a flood event, the vegetation in these inundated zones will be at risk. A continuously falling gradient will reduce the occurrence of areas of inundation, which may otherwise persist after flow events.

To limit the area of flora loss and visual impact, design of the diversion channel will minimise the footprint of disturbance, whilst satisfying all other design constraints. The existing established vegetation will help control the amount of soil erosion during a flood. Disturbing this vegetation with construction of the diversion channel will increase the potential for erosion in the short term. Limiting the disturbance footprint will mitigate this potential for erosion.

The construction of a diversion channel with floodplain zones will provide areas where vegetation can re-populate. The presence of this vegetation will help reduce velocities along the floodplain and encourage sedimentation and reduce erosion. It is expected that erosion in the diversion channel will reduce with time as vegetation establishes and stabilises the disturbed surfaces. The system is expected to approach an equilibrium between sedimentation and erosion processes, as occurs with natural streams. It is anticipated that during construction of the channel, road base material will be placed at the base of the channel. To minimise the sediment load in the system, this material should be removed from the diversion channel upon completion of the channel.

Coppin Gap

As previously discussed, eroded material from the diversion channel route is likely to be transported and deposited just upstream or just downstream of Coppin Gap. As sediment levels in Coppin Gap are governed by the flow regimes, long term sediment levels in Coppin Gap are not expected to be different from current levels. Despite the expectation that flow events through Coppin Gap will act to scour the Gap of any sediment, a number of measures to control the production of sediment in the catchment will be implemented. The measures include:

- diversion channel design to include flood plain zones and produce flow velocities close to natural velocities;
- diversion channel design to include sediment trap at haul road crossing; and
- the use of containment bunding and sediment traps around potential sediment producing structures (e.g. Waste Landforms).

Waste Landform Flow and Sediment Control

As the waste landforms will be located on minor waterways, flow diversions and perimeter bunding have been designed around the waste landforms to manage local runoff. External surface water will collect against the waste area. For small upstream catchments ponded water will be allowed to dissipate by evaporation and seepage, avoiding the need for flow diversions.

For larger upstream catchments, diversion channels will direct flows around the waste landform and into the downstream catchment. The volume of flow and streamflow regime downstream will therefore not be affected. Channels will also be designed such that flow velocities will be similar to those under natural circumstances to prevent increased erosion. Where diversion of upstream surface water runoff around the bund perimeter is not feasible, for example due to topography, a flow path with a pervious infill can be constructed underneath the waste landform. This will allow the ponded water upstream of the waste landform to drain. For long-term closure conditions, riprap pads will be provided as appropriate at the exit from the waste areas to slow and redistribute runoff.

As waste landforms are also a large potential source of sediment, appropriately located and sized containment bunding, sediment traps and diversion bunding around the waste landforms will be required to manage the runoff. These protection works, comprising a combination of earth bunds and drainage channels, will prevent external surface water from entering the waste landform areas.

Within the waste landform areas, surface water runoff will be drained from the top surface and batters to the downslope sides and then directed through sediment basins, to reduce sediment loadings, prior to discharging to the downstream environment. Depending on the waste materials, the waste area top surface may be dished in the centre, to be internally draining and thus reducing runoff and the potential for erosion down the waste area faces. If constructed in this manner, the collected runoff water on the top surface would dissipate by evaporation and seepage.

Diversion Structures around Mine Infrastructure

Erosion protection structures will be required around mine infrastructure such as the TSF, camp site and plant site to divert local catchments, prevent flooding and manage downstream water quality. As mining infrastructure will be located outside the floodway of major watercourses, flow velocities in the main waterway are not expected to increase and there is a low risk of increased erosion. Local catchments, however, will need to be diverted. These catchments will be relatively small and the diversion channels designed such that flow velocities will be similar to those under natural circumstances, thus reducing the erosion potential.

Diversion structures will be particularly important around the TSF as a small section of the tailings protrudes into the Kookenyia Creek floodway. Appropriate structures will be required to prevent flooding, to contain potential contamination, and to redirect local floodwaters so that ponding is minimised around the TSF.

Earthen bunds will be constructed where appropriate to prevent local flooding and to divert sheet flow runoff around the minesite area. Similarly, with relatively small upstream catchments, flow velocities adjacent to the pad are not expected to be high and the potential for erosion will not be significant. Drainage lines that are crossed by access roads will use culverts to ensure that down-stream vegetation is not affected by watercourse diversion or obstruction.

All diversion structures will be stabilised to minimise erosion and associated water quality impacts. Bunding of hydrocarbon and chemical storage areas will minimise the potential risk of chemicals being released to the environment. All hydrocarbons and chemicals will be stored according to Australian Standards AS1940 to minimise contamination.

Install Sediment Traps and Basins

Sediment traps and basins can also be used to mitigate the potential impacts on downstream water quality. Sediment loading can be minimised by traps that slow down water velocity, allowing suspended solids to settle out. The diversion channel will have a road crossing connecting the waste landform to the open pit that will be nominally 1m above the base of the channel and act as a sediment trap. The trap will catch sediments during small flood events, however during large flood events the sediment trap will have very little impact. Therefore, sediments will be removed from the road sediment trap prior to the wet season, so that they are not remobilised during a large flood.

8.4.4 Predicted Outcome

No significant changes to surface water drainage or quality is expected. The management plan will ensure that potential impacts from the minesite are minimised. Reduction in surface water runoff volume will be minimal as most runoff will be redirected and distributed downstream. Minor changes in drainage flows associated with earthworks will not have a significant impact on the quality or quantity of water in the creeks. In most cases, changes in surface flow volume will be insignificant when compared with the overall catchment runoff. The potential for increases in surface water sediment loading will also be minimal due to appropriately designed diversion structures and sediment basin interceptors.

Therefore, consistent with the EPA objective for surface water, the alterations to surface runoff and drainage should not have an adverse impact on identified beneficial or environmental uses of the water. The general integrity, ecological functions and environmental values of the Coppin Creek system will be maintained through regular monitoring and management.

8.5 Terrestrial Flora and Vegetation

8.5.1 Management Objectives, Standards and Guidelines

The EPA's objectives for the management of terrestrial flora are to:

- Maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
- Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*.
- Protect flora listed under the EPBC Act.

Applicable guidelines include:

- EPA Guidance Statement No 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA, 2004a).
- EPA Position Statement No 2: *Environmental protection of native vegetation in Western Australia* (EPA, 2000).
- EPA Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA, 2002).
- EPA Guidance Statement No. 6 : Rehabilitation of Terrestrial ecosystems

The management of flora and vegetation over the project area, borefields and service corridors will abide by these objectives and be addressed in a specific Flora and Vegetation Management Plan. Moly Mines will implement a number of specific management measures to ensure that impacts are minimised.

8.5.2 Project Area

8.5.2.1 Current Impacts

Impacts currently affecting vegetation communities over the project area include altered fire regimes, grazing by introduced herbivores, and weed invasion. The project area is subject to frequent fire, with four fires recorded over the past nine years. Within the project area the majority of the riverine vegetation upstream of Coppin Gap was burnt during a bushfire in February 2005. Some sections of Coppin Creek, particularly those upstream of the proposed pit have been impacted by grazing, resulting in bank erosion.

Buffel Grass (*Cenchrus ciliaris*) is widespread within Coppin Creek. Seven other weed species have been recorded, the majority of which are restricted to Coppin Creek upstream of Coppin Gap. Vegetation occurring over the orebody has been cleared during ongoing drilling programmes within the last 24 years. Vehicle tracks are present over the project area, and are utilised by mining and station personnel, and also visiting tourists. Minor disturbance in discrete areas associated with visitation is evident, particularly adjacent to Coppin Gap where unauthorised camping occurs.

Cattle grazing occurs across the project area, most evidently in the drainage flats and creeklines where Buffel Grass is prevalent. The vegetation of the Capricorn, Rocklea and Talga land systems (which encompass the Talga Range and hills of the project area) are generally poorly accessible to livestock and support vegetation (*Triodia*) which is not preferred for grazing. Similarly, the mature spinifex on the plains of the Macroy land system is not preferred by grazing animals, but post-fire younger stands are palatable.

Overall vegetation condition over the project area was rated from ‘very good’ to ‘excellent’ using a standard condition scale, with some areas such as the upper slope of the Talga Range considered ‘pristine’.

8.5.2.2 Potential Impacts

Potential impacts of the proposal to flora and vegetation over the project area include:

- direct clearance or disturbance of vegetation and flora;
- impacts to riparian and phreatophytic vegetation associated with the diversion of Coppin Creek and potential changes to groundwater levels due to pit de-watering;
- effects of dust, including toxicity from metals;
- potential to introduce or facilitate the establishment of weeds and exotic species; and
- secondary impacts, such as off-road vehicles and changed fire regime.

Details of these potential impacts are provided below, with management prescriptions given in **Section 8.5.2.3**.

Direct clearance or disturbance of vegetation and flora

A primary impact to flora and vegetation of the project area will be direct clearing required for the project. The proposal will result in approximately 1,582 ha of vegetation clearing required to accommodate the infrastructure footprint. Indicative areas of the 24 vegetation associations identified within the project area that will be affected are given below in **Table 8-10**. Indicative areas of land systems affected are given in **Table 4-3**.

No known DRF, Priority Flora, TEC or flora listed under the EPBC Act will be affected by clearing as none have been identified within the project area. The undescribed *Tephrosia sp.* Bungaroo Creek (M.E. Trudgen 11601) was identified within two survey plots (14 and 15) located in the P1 vegetation association. Both plots were located to the north-west of Kitty’s Gap in an area that will remain undisturbed between the proposed camp site and Kitty’s Gap. This species occurs across a broad area extending from near the WA/NT border in the Kimberley region across the Pilbara to the northern Gascoyne and is not under threat from development of the Project Area.

Most clearing, including that for the tailings dam, plant site, camp, and majority of waste landforms will be of the relatively flat and extensive stony and sandy spinifex plains of the Macroy Land System (**Table 4-3**) which is widespread in the region.

A total of 13.17 ha of riverine vegetation supporting River Red Gums (Vegetation Associations D3 and D6) will be affected by direct clearing over the project area. At the local scale, this vegetation community is proportionately more affected by direct clearing over the project area than other vegetation types. While riverine vegetation is represented across a number of land systems within the Pilbara region and is represented in the conservation estate, it is recognized that the riverine community is a key fauna habitat type.

Impacts to riparian vegetation associated with the diversion of Coppin Creek and potential changes to groundwater levels due to pit de-watering.

Impacts associated with the diversion of Coppin Creek and potential changes to groundwater levels due to pit de-watering are covered in detail in **Section 8.6.3**.

Dust

The impact of dust during construction and operational phases has the potential to locally impact vegetation communities primarily by smothering of vegetation, but can be mitigated by using standard dust management practices (**Section 8.9**). Water to be used for dust suppression over the project area is classified as fresh and there is little potential for impacts on vegetation communities.

Dust generated from the processing of the mineralied ore has the potential for elevated levels of metals, particularly molybdenum and copper. Plant toxicity caused by elevated molybdenum levels has been recorded previously, but at concentrations sourced from fertilisers and well above those in the tailings (60 – 100ppm).

Potential to introduce or facilitate the establishment of weeds and exotic species

The potential to introduce, or exacerbate the effects of weeds species is likely to increase with an increased human presence and subsequent greater vehicle movements over the project area. Buffel Grass is abundant along Coppin Creek within the project area. This species is also well established within the Meentheena Conservation Park which borders the Yarrie pastoral station within which the project area is located.

Table 8-10 Impacted Vegetation Associations from Spinifex Ridge

Vegetation Association		Level of Conservation Significance	Area Mapped Over Project Area (ha)	Indicative Area to be Impacted (ha)	% of Total Mapped Area to be Impacted	Comments
Drainage Flats and Creeklines			**1060.2**	**96.37**	**9.1**	
D1	*Triodia longiceps* hummock grassland.	Low	51.4	4.52	8.8	Vegetation well represented outside of Project Area. Identified during service corridor surveys.
D2	*Eucalyptus camaldulensis* var*. obtusa* open woodland to open forest	Moderate	2.8	0	0.0	Vegetation of Coppin Gap and immediate upstream; Vegetation restricted to major creeklines.
D3	*Eucalyptus camaldulensis* var. *obtusa / E. vitrix* open woodland to woodland	Moderate	111.7	8.85	7.9	Vegetation of Coppin Creek; vegetation restricted to major creeklines.
D4	*Terminalia canescens* and *Corymbia hamersleyana* low woodland	Moderate	1	0.15	15.0	Vegetation of Kitty's Gap; habitat limited in area.
D5	*Corymbia hamersleyana* low open woodland	Low	20.7	7.30	35.3	Vegetation of minor drainage line. Displays similarity to vegetation of other project sites in regional analysis.
D6	*Eucalyptus camaldulensis* var. *obtusa* open woodland	Low	5.4	4.32	80.0	Vegetation of minor drainage line which has a limited distribution within Project Area, however displays similarity to vegetation of other project sites in regional analysis.
D7	*Acacia tumida* var. *pilbarensis* open scrub to high shrubland	Low	192.4	48.62	25.3	Common taxa widely distributed in region.
D8	*Corymbia flavescens* and *Bauhinia cunninghamii* low open woodland	Low	31.3	0.85	2.7	Limited distribution within Project Area but is similar to

Vegetation Association		Level of Conservation Significance	Area Mapped Over Project Area (ha)	Indicative Area to be Impacted (ha)	% of Total Mapped Area to be Impacted	Comments
						vegetation identified in service corridor surveys. Occurs in shallow drainage line infested with Buffel grass.
D9	*Corymbia flavescens* low open woodland	Low	96.4	19.99	20.7	Limited distribution within Project Area but is similar to vegetation identified in De Grey borefield and service corridor.
D10	*Acacia tumida* var. *pilbarensis* and *Crotalaria cunninghamii* high open shrubland	Moderate	545.4	1.77	0.3	Floristic composition apparently not widespread in region, however vegetation association well represented in Project Area and will be subject to minimal disturbance.
D11	*Acacia ampliceps* low closed woodland	Low	1.7	0	0.0	Monoculture of common *Acacia* species adjacent to creekline.
Stony Plains			**3110.3**	**487.72**	**15.7**	
P1	*Acacia inaequilatera* high shrubland to scattered shrubs over *Triodia epactia* hummock grassland	Low	1998.3	346.86	17.4	Vegetation well represented outside of the Project Area to the south, Displays similarity to vegetation of other project sites in regional analysis.
P2	*Acacia inaequilatera* high open shrubland to scattered shrubs over *Triodia wiseana* hummock grassland	Low	1112	140.86	12.7	Vegetation well represented outside of the Project Area, to the south. Displays similarity to vegetation of other project sites in

Vegetation Association		Level of Conservation Significance	Area Mapped Over Project Area (ha)	Indicative Area to be Impacted (ha)	% of Total Mapped Area to be Impacted	Comments
						regional analysis.
Sandy Plains			**4977.7**	**507.76**	**10.2**	
P3	*Acacia victoriae* open scrub to open shrubland	Low	18.2	0	0.0	Limited distribution within Project Area but taxa are common and identified during service corridor surveys.
P4	*Acacia tumida* var. *pilbarensis* and *Grevillia pyramidalis* ssp. *leucadendron* open shrubland to scattered tall shrubs	Low	445.2	28.22	6.3	Vegetation association well represented in Project Area and will be subject to minimal disturbance. Displays similarity to vegetation identified during service corridor surveys.
P5	*Pluchea tetranthera* low open shrubland over *Triodia epactia* open hummock grassland	Low	14.7	0	0.0	Limited distribution within Project Area but is present outside of Project Area in service corridor surveys.
P6	*Pluchea tetranthera* low open shrubland over *Triodia epactia* hummock grassland	Low	26	0	0.0	Limited distribution within Project Area but is present outside of Project Area in service corridor surveys.
P7	Mixed annual tussock grasses in scald area.	Low	30.1	0	0.0	Common taxa in apparently degraded area.
P8	*Acacia stellaticeps* low open heath over *Triodia epactia* hummock grassland	Low	3.7	0	0.0	Limited distribution within Project Area but is present outside of Project Area in service corridor surveys.
P9	Mixed *Grevillea* and *Acacia* scattered tall shrubs over *Triodia epactia* hummock grassland.	Low	4439.8	479.54	10.8	Vegetation association well represented outside of the Project Area, widespread to the north and west.

Vegetation Association		Level of Conservation Significance	Area Mapped Over Project Area (ha)	Indicative Area to be Impacted (ha)	% of Total Mapped Area to be Impacted	Comments
Stony Hills / Ridgeline			**1397.1**	**422.85**	**30.3**	
H1	*Acacia inaequilatera* scattered tall shrubs to high open shrubland	Low	1154.2	377.18	32.7	Vegetation association is well represented outside of the Project Area along the hills to the east and west of the site. Displays similarity to vegetation of other project sites in regional analysis.
H2	*Eucalyptus leucophloia* ssp. *leucophloia* scattered low trees to low open woodland with occasional *Corymbia hamersleyana*	Low	173	9.41	5.4	Limited distribution within Project Area but is present outside of Project Area. Displays similarity to vegetation of other project sites in regional analysis.
H3	*Ficus brachypoda/ Atalaya hemiglauca* low open woodland	Moderate	23.7	5.62	23.7	Vegetation of the mesic area of the BIF ridgeline; habitat is likely to have a relatively limited distribution in the area.
H4	*Eucalyptus leucophloia* ssp. *leucophloia* low woodland over *Acacia inaequilatera* scattered shrubs	Low	46.2	30.64	66.3	Limited distribution within Project Area but is present outside of Project Area. Displays similarity to vegetation of other project sites in regional analysis.

Seven other weed species have been recorded from the project area, the majority of which are restricted to Coppin Creek upstream of Coppin Gap. An increased road network and importing of earthmoving machinery onto site during construction and operation have the potential to introduce new weed species, and/or facilitate the spread of those already present, into new areas of the project area. Ruby Dock (*Acetosa vesicaria*) and Kapok Bush (*Aerva javanica*) are common weed species in the Pilbara that often invade disturbed areas. The latter is present along the creekline south of Coppin Gap and around the current exploration camp while Ruby Dock is currently absent. At present there appear to be no introduced aquatic weeds in the system (**Appendix D**). The potential impact and management of weeds and exotic species within the service corridors is discussed in **Section 8.5**.

Secondary impacts

An increased human presence over the project area has the potential to lead to secondary impacts such as off-road vehicle use and changes to the fire regime. Spinifex communities are particularly susceptible to vehicle damage and may take many years to recover while frequent fire has the propensity to further modify botanical composition and vegetation structure across the site.

8.5.2.3 Management of Impacts

The overall management of vegetation and flora will be addressed by Moly Mines in a specific Vegetation and Flora Management Plan (**Appendix F**). A management plan for Coppin Gap that will incorporate flora management will also be developed by Moly Mines in close consultation with the Shire of East Pilbara and DEC. The Environmental Management Plans (EMPs) will specify management measures to ensure that impacts to vegetation and flora are minimised over the project area. These measures are described below.

Direct clearance or disturbance of vegetation and flora

- Clearing of vegetation will be kept to a minimum necessary for safe construction and operation of the project.
- The discrete positioning of waste landforms will enable vegetation communities surrounding Coppin Gap to be avoided completely, and the impacts on H3 Vegetation Association of the more mesic areas of the southern flank of the Talga Range (supporting *Ficus brachypoda)* to be minimised (**Section 4.7.3.2**).
- Riparian vegetation will be avoided wherever possible. Design criteria will position waste landforms and the TSF at least 750 m from riverine sections of the project area (that is, Vegetation Associations D2, D3, and D6). Where disturbance is unavoidable to minor drainage lines, other than that impacted by direct clearing, sufficient culverting will be installed to maintain surface water flows.

Topsoil management and rehabilitation will be included in the Conceptual Closure Management Plan. Progressive rehabilitation of disturbed areas will be implemented with the aim of reflecting the pre-disturbance state as closely as possible (**Section 9**).

Impacts to riparian vegetation associated with the diversion of Coppin Creek and potential changes to groundwater levels due to pit de-watering.

Potential impacts and management strategies associated with the diversion of Coppin Creek and potential changes to groundwater levels due to pit de-watering are covered in detail in **Sections 8.5.3.1** and **8.5.3.2**.

Dust

Impacts of dust will be managed by implementing the strategies listed in **Section 8.9**.

Molybdenum and copper concentrate products will be stored and loaded in enclosed sheds to prevent loss of product and prevent spread of higher concentration dust, thereby reducing the likelihhood of toxicity issues. Concentrations of metals in the tailings are low, and are consistent with the concentrations from the natural mineralisation of the orebody (without some of the molybdenum and copper). Molybdenum concentrations in the tailings will be in the order of 60 – 100 ppm Mo, a level considered unlikley to pose a significant environmental risk.

Potential to introduce or facilitate the establishment of weeds and exotic species

Moly Mines aims to control the spread of existing weeds, and prevent the introduction of new weed species over the project area. Weed hygiene measures will include:

- Minimising the creation of disturbed areas and progressively rehabilitating areas of disturbance to avoid colonisation by weed species;
- Implementation of vehicle hygiene procedures for vehicles arriving and/or departing the project area;
- Off-road vehicle use will be strictly controlled over the project area with no driving permitted off designated routes;
- Topsoil and mulch sourced from areas of weed infestation will be stored and utilised separately;
- The use of provenanced seed in the rehabilitation programme, preferably sourced from the immediate area; and
- An induction and ongoing education program for Moly Mines staff will reinforce awareness of procedures to prevent and control the spread of weeds.

Secondary Impacts

Secondary impacts to vegetation associated with an increased human presence over the project area will be regulated through the implementation of the Vegetation and Flora Management Plan, the Coppin Gap Management Plan and education of site personnel through the induction process.

- Off-road vehicle use will be strictly controlled over the project area with no driving permitted off designated routes;
- Areas containing vegetation or flora of local significance will be identified within the Vegetation and Flora Management Plan and access to these areas will be regulated;

- Fire management will be based upon fire exclusion within the project area. A regional approach will be adopted to fire management and suppression in liaison with neighbours, including the local pastoralist, DEC, and FESA. The firefighting capability of the operation has the potential to significantly reduce the impact of fire in the area.

8.5.3 Creekline Diversion, Pit Dewatering and Coppin Gap

8.5.3.1 Potential Impacts

Potential impacts to vegetation and flora of Coppin Creek and Coppin Gap include:

- Direct loss of riparian vegetation due to clearing required to access the ore body.
- Potential degradation of riparian vegetation downstream of the creek diversion due to altered water levels or hydrological regimes affecting erosion and sedimentation
- Potential impacts to phreatophytic vegetation due to changes in groundwater as a consequence of pit de-watering.

Direct loss of riparian vegetation due to clearing required to access the ore body

A portion (approximately 8.85 ha, **Section 8.5.3**) of the D3 riverine vegetation association along Coppin Creek will require clearing to access the orebody. The vegetation is that of a River Red Gum (*Eucalyptus camaldulensis* var. *obtusa*) and Coolibah (*E. vitrix*) open woodland to woodland over *Melaleuca glomerata* and *Acacia* spp. low open woodland to woodland over *Cyperus vaginatus* very open sedges over *Triodia longiceps* hummock grassland (in patches). In addition, 4.32 ha of the D6 vegetation association which is associated with the drainage line running east-west within the valley will require clearing. This association is that of River Red Gum (*Eucalyptus camaldulensis* var. *obtusa*) open woodland over *Corymbia hamersleyana* low open woodland over *Tephrosia rosea* var. *clementii* shrubland over *Stemodia viscosa* open herbs over *Triodia epactia* open hummock grassland.

No Declared Rare or Priority Flora have been identified within either of these (or any other) vegetation association within the project area. The riparian vegetation to be cleared to access the ore body appears to be well represented across a number of land systems within the Pilbara region and is represented in the conservation estate.

Potential degradation of riparian vegetation downstream of the creek diversion due to altered water levels or hydrological regimes affecting erosion and sedimentation

The Coppin Creek diversion has the potential to impact downstream riparian vegetation (D2 and D3 vegetation associations) as a result of altered water levels or hydrological regimes and increased erosion and sedimentation. The latter has the potential to adversely impact on macrophytic vegetation, such as *Typha* and *Schoenoplectus*, immediately upstream and downstream of Coppin Gap as these have been highlighted as likely deposition areas of eroded material from the diversion channel (Aquaterra, 2006). While both species are common immediately upstream of Coppin Gap, the vegetation immediately downstream of Coppin Gap is dominated by River Red Gums and Coolibah, predominantly over Buffel Grass on the banks of the creek, and there is limited macrophytic vegetation.

The death of shallow-rooted riparian vegetation including macrophytic vegetation may occur within the section of Coppin Creek from which water will be diverted away from (between the mine void and the beginning of the creekline diversion), as a result of the altered hydrological regime. Deeper rooted phreatophytic vegetation within this same section may be at least partly dependent upon groundwater and therefore not totally reliant upon surface water flows. However, groundwater drawdown as a result of pit dewatering may impact this vegetation.

Potential impacts to phreatophytic vegetation due to changes in groundwater as a consequence of pit de-watering.

The regional groundwater response to dewatering is predicted to be relatively localised with the development of a steep hydraulic gradient surrounding the mine void due to the low permeability of the surrounding fresh rock mass. However, there is the potential for groundwater drawdown in excess of natural variation to occur within the calcrete and alluvial aquifers adjacent to the pit, particularly in the vicinity of drainage lines between the mine and Coppin Gap (Aquaterra, 2007). The vegetation of this area is that of the D2 and D3 associations (**Section 4.7.3.2**).

Within the localised cone of depression, phreatophytic and vadophytic species along Coppin Creek may be impacted as a result of the drawdown. The occurrence of *Melaleuca argentea* along areas of Coppin Creek indicates that, in its natural state, the depth to groundwater is unlikely to exceed 2 to 3m. This species is likely to be impacted within the cone of depression due to its relatively shallow root system.

Eucalyptus camaldulensis var *obtusa* (River Red Gum) and *E. victrix* (Coolibah) are dominant along Coppin Creek. The latter species is considered vadophytic and relatively drought tolerant, however, it may exhibit signs of stress in correlation to decreased access to groundwater (Maunsell, 2006). River Red Gum is also classified as a vadophyte or a facultative phreatophyte. It is thought that River Red Gums occurring along inland rivers may be dependent on shallow groundwater for survival (Hatton and Evans, 1988) although the root system of *E. camaldulensis* may penetrate deeper than 10m (Bacon *et al*., 1993).

Studies in the Pilbara indicate River Red Gums present within creek lines have access to groundwater up to 21m below the surface (Landman, 2001). It is suggested by BHP (1997) (as cited in Maunsell, 2006) that River Red Gums may be adversely affected by a fall in groundwater levels in excess of 8m, but that reductions of up to 8m at a rate of up to 4m/year may be tolerated. Where groundwater has fallen 17m over four years, with a drop of 10m in the first two years, River Red Gums have displayed evidence of stress.

8.5.3.2 Management of Impacts

The Vegetation and Flora Management Plan and the Coppin Gap Management Plan will specify management measures to ensure that impacts to the vegetation and flora of Coppin Creek and Coppin Gap are minimised over the project area. These measures are described below.

Direct loss of riparian vegetation due to clearing required to access the ore body

- Clearing of riparian vegetation will be minimised to that which is essential for access to the orebody.
- The waste landforms and the TSF are to be positioned at least 750 m from riverine sections of the project area (that is, Vegetation Associations D2, D3, and D6).
- Where disturbance is unavoidable to minor drainage lines, other than that impacted by direct clearing, sufficient culverting will be installed to maintain surface water flows.
- Appropriate topsoil and propagules sourced from the clearing required along Coppin Creek will be stored and utilised as the basis for establishing similar vegetation along the newly created diversion channel.

Potential degradation of riparian vegetation downstream of the creek diversion due to altered water levels or hydrological regimes affecting erosion and sedimentation

Hydrological modelling shows that flood levels and flow velocities, and subsequently sediment levels, will be relatively unchanged in Coppin Gap, following construction of the creek diversion (**Section 8.4**).

Moly Mines will prepare a Coppin Gap Management Plan that will include all mitigation strategies pertaining to the diversion of Coppin Creek.

- The key aspect of the management plan will focus on maintaining the sediment loading and hydrological function of Coppin Gap within the limits of natural variation.
- As part of the Coppin Gap Management Plan, a comprehensive bi-annual ecological monitoring program will be implemented to assess the health of riparian vegetation downstream of the diversion channel. This program will include strategies to differentiate between impacts attributable to the proposal and those associated with natural variations.
- If negative impacts attributed to the Coppin Creek diversion are detected then design elements of the diversion will be re-assessed and mitigation strategies implemented.
- Opportunity exists for research to gain a better understanding on the reliance of riparian vegetation on groundwater.

Potential impacts to phreatophytic vegetation due to changes in groundwater as a consequence of pit de-watering.

It is expected that phreatophytic and vadophytic vegetation (D2 and D3 associations) within the immediate vicinity of the mine void and between the void and Coppin Gap may be impacted by groundwater drawdown during extended periods of dry climactic conditions. The following management prescriptions will be implemented by Moly Mines:

- Overall management of vegetation and flora will be addressed by Moly Mines in a specific Vegetation and Flora Management Plan. A management plan for Coppin Gap, that will incorporate flora management, will also be developed.

- Continuation and refining of the groundwater monitoring programme which commenced at Spinifex Ridge in December 2005 to assist in confirming predicted regional drawdown and to identify changes to groundwater quality as a result of dewatering activities.
- Implementation of a phreatophytic vegetation monitoring programme that will facilitate the detection and minimisation of deleterious impacts associated with dewatering operations.
- If monitoring reveals that water levels at Coppin Gap are affected by the de-watering of the pit or that riparian vegetation is being impacted appropriate strategies to minimise the impacts of drawdown will be considered, such as:
  - implementation of an artificial aquifer recharge system designed to supplement the system at volumes similar to those abstracted during dewatering. Re-injection will be at a point where recirculation is minimised and environmental flow is maximised;
  - artificially maintaining the water levels at the Coppin Gap by the addition of appropriate, high-quality water; and
  - an engineering solution that confines or separates the aquifer around the vicinity of the pit from Coppin Gap so that drawdown does not occur.

8.5.4 Water Supply Areas and Pipelines

8.5.4.1 Current Impacts

Canning Borefield and the water pipeline service corridor

The water supply pipeline corridor for the Canning borefield will run adjacent to and parallel with the existing Borefield Road and Muccan-Shay Gap Road. The pipeline will be buried for its entire length.

A vegetation assessment of the borefield and service corridor (G & G Environmental, 2007b) rated vegetation condition of the borefield as ‘excellent’ while that of the corridor was from ‘excellent’ to ‘degraded’. Three areas along the corridor were regarded as ‘completely degraded’. These included:

- a corridor running parallel to the Muccan Shay Gap road recently excavated by Telstra laying subterranean fibre optic cables;
- a section of the road reserve in the vicinity of the De Grey river vegetated by a virtual monoculture of the weed species *Cenchrus ciliaris*; and
- a borrow pit.

Seven weed species were identified within the survey, none of which were declared plant species. *Cenchrus ciliaris* (Buffel grass) was recorded in many of the vegetation associations mapped in woodlands and shrublands on the hills and on the plains and was a dominant component of the grass cover in many drainage areas, creeklines and river banks of the service corridor.

De Grey Borefield and the water pipeline service corridor

The route of the water supply pipeline corridor from the project area to the proposed De Grey borefield is to follow the unsealed Muccan Shay Gap Road (**Figure 1-1**). The pipeline will be placed within the road reserve and will be buried for its entire length.

A recent vegetation assessment of the proposed service corridor and the De Grey Borefield (G&G Environmental, 2007a) rated vegetation condition from 'excellent' to 'degraded'. Cattle grazing occurs along the length of the corridor and across the borefield. Eight weed species have been identified within the vegetation. Of these, Buffel Grass (*Cenchrus ciliaris*) was the most widespread, and was a dominant component of the drainage areas, creeklines and river banks. *Parkinsonia aculeata* (Parkinsonia), a Declared Plant species, was recorded at two locations on the banks of the De Grey River. Five areas were classified as 'completely degraded'. These included:

- The site of the Muccan homestead that was demolished in January 2007.
- The airstrip for Muccan station.
- A corridor running parallel to the Muccan Shay Gap road recently excavated by Telstra.
- Borrow pits adjacent to the Muccan Shay Gap road.
- A track between Muccan and Yarrie stations heavily infested with Buffel Grass.

Water pipeline service corridor to Woodie Woodie Mine site

A proposed source of process water is the Cracker Pit located at Woodie Woodie mine site. The route of the water supply pipeline corridor follows an existing unsealed road for a length of 180 km. The pipeline will be buried for its entire length.

The vegetation along the proposed service corridor is subject to cattle grazing and eight weed species have been identified within the corridor. A recent vegetation assessment of the service corridor (G&G Environmental, 2006) rated vegetation condition generally from 'good' to 'excellent'. Buffel Grass *(Cenchrus ciliaris)* is particularly widespread in drainage areas which are considered degraded. The vegetation surrounding the Cracker Pit and the road reserve along the bitumen road from Marble Bar to Woodie Woodie mine have been subject to multiple disturbances resulting in a complete alteration of the natural vegetation structure.

8.5.4.2 Potential Impacts

Potential impacts of the proposed water supply pipeline corridors and borefields include:

- Direct clearing of vegetation.
- Introduction and spread of weeds along the length of the pipeline.
- Potential drawdown effects of the De Grey borefield on phreatophytic/vadophytic vegetation.
- Impediment of water flow and deposition of sediment in rivers, creek or drainage lines that are traversed by the pipeline.
- Establishment of the gas pipeline corridor.

Direct clearing of vegetation

The construction and maintenance of the pipelines will require direct clearing of vegetation to allow access to the pipeline along its length. Service corridors will be positioned along existing roads and tracks within pastoral lands and be buried. All soils and vegetation will be rehabilitated post construction. Clearing of vegetation up to 15m in width at certain locations may be necessary.

Direct clearing of the Woodie Woodie pipeline service corridor will potentially impact on 0.180 km^2 of vegetation; the De Grey service corridor will impact on 0.03 km^2 of vegetation; and the Canning service corridor will impact on a further 0.04 km^2 of vegetation. None of the 86 vegetation associations identified along the alignment of the Woodie Woodie services corridor, the 26 associations along the De Grey service corridor and in the borefield, or the 40 vegetation associations along the Canning service corridor and in the borefield, are threatened. However, it is recognised that *Eucalyptus camaldulensis* woodlands in drainage areas have a higher conservation value. One vegetation association within the Canning borefield, a *Dolichandrone heterophylla* woodland (Pw20), was located only in the north-east corner of the area surveyed. The survey area is toward the southern and eastern extent of the distribution of this species, therefore the vegetation association may have a higher conservation value.

Introduction and spread of weeds along the length of the pipeline

Clearing of vegetation from the service corridors and construction of the pipeline has the potential to introduce additional weed species or spread existing weed populations along the length of the corridor prior to native vegetation being able to re-colonise. *Cenchrus ciliaris* (Buffel Grass) is already present in drainage areas that service corridors will be required to traverse. In total, 18 weed species have been identified during flora surveys of the Woodie Woodie service corridor,, the De Grey borefield and service corridor and the Canning borefield and associated service corridor.

Potential drawdown effects of the De Grey borefield

The De Grey borefield is designed to abstract water from the semi-confined palaeo-channel aquifer which has the potential to draw down from the upper alluvial aquifer associated with the De Grey River. There is potential for phreatophytic and vadophytic vegetation to be adversely impacted in the event that water levels in the upper aquifer are not maintained within natural variations.

Potential drawdown effects of the Canning borefield

There are no known phreatophytic/vadophytic species occurring within the proposed Canning borefield, therefore vegetation is unlikely to be adversely impacted by drawdown.

Impediment of water flow in rivers, creeklines or drainage areas that are traversed by the pipeline

Construction of pipelines across drainage tracts, creeklines or rivers has the potential to alter surface hydrology and create drainage shadows, which may adversely impact vegetation both upstream and downstream of the pipeline.

8.5.4.3 Management of Impacts

Direct clearing of vegetation

The alignment of the services corridors have been selected to minimise impacts on vegetation. The use of existing roads, where available, as a construction platform will reduce the width of the easement required to the minimum of 15m.

- Vegetation clearance will be kept to a minimum particularly in those communities that have a higher conservation value such as the *Eucalyptus camaldulensis* woodlands in drainage areas.
- All soils and vegetation will be progressively rehabilitated post construction.

Potential drawdown effects of the De Grey borefield

The impact the borefield can have on the upper aquifer is considered low as annual flooding of the De Grey River each year recharges the aquifer (Aquaterra, 2007). As the De Grey borefield will ultimately be one of two water supplies servicing the project, a great deal of flexibility is available in terms of timing and quantity of supply. Water levels within the upper alluvial system that supports phreatophytic and vadophytic vegetation can be managed sustainably through the seasonal management of the borefield by regulating abstraction from near river bores to periods of river recharge (Aquaterra, 2007).

A De Grey borefield management program will be implemented whereby:

- A sustainable abstraction regime is employed.
- A monitoring regime is implemented that monitors phreatophytic vegetation bi-annually.
- If local impacts are noted then abstraction quantities and timing will be adjusted internally within the De Grey Borefield and quantity and timing ratios adjusted between the De Grey and Woodie Woodie supply.

Introduction and spread of weeds along the length of the water pipeline service corridor

A Vegetation and Flora Management Plan has been prepared and will be implemented over the project area, borefields, and service corridors. To minimise the introduction and spread of weeds along service corridors, the following management strategies will be incorporated:

- Construct the Woodie Woodie pipeline adjacent and parallel to the Warrawagine road to minimise impacts to the adjacent vegetation; and
- Construct the De Grey borefield pipeline adjacent to the Muccan Shay Gap Road reserve to minimise impacts to the adjacent vegetation;
- Construct the Canning borefield pipeline adjacent to the Borefield Road and Muccan-Shay Gap Road reserves to minimise impacts to the adjacent vegetation.
- Construct and maintain all pipelines utilising existing infrastructure (eg. roads and tracks) where possible to minimise impacts to the vegetation from vehicle use.

Impediment of water flow in rivers, creeklines or drainage areas that are traversed by the pipeline

In areas where surface sheet flow is significant, sufficient breaks in the mound of earth (or crown) remaining above the pipeline after burial, will be maintained to allow for sufficient water flow.

8.5.4.4 Management Plans

The project EMP will include environmental management plans necessary to manage potential environmental impacts (**Section 7.5**). The EMP will include stand alone environmental management plans for the management of specific potential environmental impacts associated with the project. A Vegetation and Flora Management Plan that includes management of weeds and native vegetation over the project area, service coridors, and water supply areas will be implemented.

8.5.5 Predicted Outcome

Based on the management approach and strategies identified above, the Spinifex Ridge Project is considered to meet the EPA objectives for terrestrial flora.

8.6 Terrestrial Fauna

8.6.1 Management Objective, and Applicable Standards and Guidelines

The EPA's objectives for the management of terrestrial fauna are to:

- maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge;
- protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*; and
- protect fauna listed on the relevant schedules of the EPBC Act.

Applicable guidelines include:

- EPA Guidance Statement No 56: *Terrestrial fauna surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).
- EPA Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA, 2002).

The management of terrestrial fauna over the project area, water supply areas and service corridors will abide by these objectives and be addressed in a specific Fauna Management Plan. Moly Mines will implement a number of specific management measures to ensure that impacts are minimised. Although management measures will consider all fauna, species of conservation significance will be a primary focus. Fauna of conservation significance include the recorded State and Federally-listed species; Northern Quoll, Orange Leaf-nosed Bat (Pilbara), Ghost Bat, Western Pebble-mound Mouse, Australian Bustard, Bush Stone-curlew and Rainbow Bee-eater.

8.6.2 Project Area

Table 8-11, below, provides a summary of the existing processes that currently threaten fauna in the project area, along with potential impacts associated with the proposed mining project. In order to guide management priorities, the relative degree of impact (seriousness of consequence, irrespective of the frequency of the threatening event or condition) has been assessed qualitatively as high, medium, or low (H, M, L). Where there was some uncertainty about the magnitude of the consequence, a conservative ranking has been assigned. For example, there have been relatively few studies of the impact of blasting noise on cave roosting bats, therefore (in the absence of experimental data) the potential consequence has been rated as "High".

Details of existing environmental impacts and potential project impacts are provided in **Sections 8.6.2.1** and **8.6.2.2**, respectively. **Table 8-13** provides a tabular summary of the assessed impact of the project on key fauna, given the proposed management controls. A narrative description of management controls proposed to address impacts assessed as having moderate to high consequences is given in **Section 8.7.2.3**.

- **Table 8-11 Qualitative Rating of Potential Impacts on Listed Species Over the Project Area**

	Potential Impacts of Proposal										Current Impacts		
	Clearing of habitat	Reduced connectivity	Changed hydrology	TSF	Dust	Light	Noise	Potential increase of exotics	Potential increased fire	Increased access	Altered fire regimes	Grazing	Introduced predators
Northern Quoll	M	M	M	L	L	L	M	H	M	L	H	M	H
Orange Leafnosed-bat	L	L	M	L	L	M	H	L	L	M	L	L	L
Mulgara	M	L	L	L	L	L	L	H	M	L	H	M	H
Pilbara Olive Python	M	M	M	L	L	L	L	M	L	L	M	M	M
Peregrine Falcon	L	L	L	L	L	L	M	L	L	M	L	M	L
Ghost Bat	L	L	M	L	L	M	H	L	L	M	M	L	L
Pebble-mound Mouse	M	L	L	L	L	L	L	M	M	L	M	M	M
Lakeland Downs Mouse	L	L	L	L	L	L	L	M	M	L	M	M	L
Australian Bustard	L	L	L	L	L	L	M	M	M	L	M	M	H
Bush Stone-curlew	L	L	L	L	L	L	M	M	M	L	M	M	H
Grey Falcon	L	L	L	L	L	L	L	L	L	L	L	M	L
Star Finch	L	M	M	L	L	L	L	L	L	L	H	M	L
Rainbow Bee-eater	L	L	L	L	L	L	L	L	L	L	L	L	L
Fork-tailed Swift	L	L	L	L	L	L	L	L	L	L	L	L	L
'Migratory birds'	L	L	M	M	L	L	L	L	L	L	L	L	L

8.6.2.1 Current Impacts

Threatening processes currently affecting biodiversity over the project area include altered fire regimes, grazing by introduced herbivores, impacts of introduced predators and weed invasion (OES, 2006e). It is impossible to separate the severity and scope of impacts associated with these threats as all processes are intimately connected. For example, over-grazing can facilitate the introduction and spread of weeds, and frequent hot fire leads to reduced heterogeneity in the landscape, including less shelter, leading to greater impacts on ground fauna from introduced predators.

The major influence over the project area is currently the effects of frequent hot fires. The area as a whole has been subject to a possible four fires within the last eight years and local fire refuges are critical for the maintenance of local biodiversity.

Active management by Moly Mines may potentially reduce threatening processes currently operating over the project area, particularly in respect to fire management and feral animal control.

8.6.2.2 Potential Impacts of Proposal

Potential impacts of the proposal to fauna over the project area include:

- direct clearance or disturbance of fauna habitat;
- reduced connectivity of fauna populations, and/or isolation of local habitats;
- alterations to hydrology;
- impacts associated with the waste landforms and the TSF, including mobilisation of metals;
- effects of light and dust, including toxicity associated with metals in dust;
- effects of noise;
- potential to increase populations of exotic species; and
- secondary impacts, such as off-road vehicles, increased access to sensitive habitats, and fire.

Details of these potential impacts are provided below, with management prescriptions given in **Section 8.7.2.3**.

1) Direct clearance or disturbance of fauna habitat

A primary impact to fauna from the project will be the direct loss of fauna habitat due to the clearing of vegetation. Six primary habitats were identified in the project area and are listed in **Table 8-12** (OES, 2006a).

The proposal will result in approximately 1,582 ha of vegetation clearing to accommodate the infrastructure footprint. Indicative areas of fauna habitats are given in **Table 8-12**. Note that two of the allied vegetation associations (H1 and H2) could not be differentiated between Basalt Ridge and Rocky Slope fauna habitats, as fauna habitats were discriminated on landform and substrate, rather than solely on vegetation type.

A key factor in determining the significance of impacts to fauna habitat is the value of the habitat units being disturbed. At the regional scale, all land systems affected by direct clearing are widespread and common in the bioregion, and no regionally significant fauna habitats have been identified within proposed clearing footprints.

▪ **Table 8-12 Area of Fauna Habitat Types that would be Impacted by the Project**

Fauna Habitat	Predominant Associated Land Systems	Allied Vegetation Associations	Indicative area to be impacted (ha)
Spinifex Plains	Macroy Land System	P1, P2, P3, P4, P5, P6, P7, P8, P9	995.62
Basalt Ridges	Rocklea and Talga Land Systems	H1 (part) H2 (part)	370.89
Rocky Slopes	Capricorn Land System	H3, H4 H1 (part) H2 (part)	51.39
Riverine Communities	Drainage lines through Macroy, Rocklea and Capricorn Land Systems	D2, D3, D6	8.85
Minor Drainage Lines	Drainage lines through Macroy, Rocklea, Talga and Capricorn Land Systems	D1, D4, D5, D7, D8, D9, D10, D11	86.78
Rocky Gullies	Capricorn Land System	D2, D4, D5, H1, H2, H3, H4	1.22

The majority of clearing, including that for the tailings dam, plant site, camp, and majority of waste landforms will be of the relatively flat and extensive spinifex plains (995.62 ha) of the Macroy land system which is widespread in the region, subject to frequent fire, and provides few natural refugia.

Species of conservation significance

At the local scale, Rocky Gully habitats (Coppin Gap and Kitty Gap), Rocky Slope habitat associated with the Talga Range, and Riverine Community habitat provide structural and/or mesic qualities important to a wide range of fauna.

Fauna of conservation significance known from the project area in Rocky Gully and Rocky Slope habitats include Northern Quoll, Orange Leaf-nosed Bat (Pilbara), Ghost Bat, and Rothschilds Rock-wallaby. In addition, the Pilbara Olive Python and Peregrine Falcon are predicted to occur in these habitats. The potential SRE taxa, *Quistrachia* sp. is also known from these habitats.

Clearing of Rocky Slope and Rocky Gully habitats associated with the Talga Range will be minimised and no significant impact to these species due to clearing is expected. The 1.22 ha of Rocky Gully habitat to be cleared is associated with the creation of a road through Kitty Gap by widening and upgrading an existing track.

The 51.39 ha of Rocky Slope habitat to be cleared is required to access the orebody. However, waste landforms and the TSF will be set back from the steep-sided upper sections of the Talga Range. The northern wall of the final pit will have a steep profile that is not inconsistent with the existing landform.

The 8.85 ha of Riverine Community habitat affected by direct clearing over the project area is widespread in the bioregion, and the area proposed for clearing is considered minimal in the regional context. Furthermore, rehabilitation of the diversion to Coppin Creek will replicate at least some of the Riverine Community habitat qualities currently present.

Bioregional endemic mammals

Bioregional endemic mammals recorded during surveys at Spinifex Ridge include: *Planigale* spp, the Little Red Kaluta (*Dasykaluta rosamondae*), the Pilbara Ningaui (*Ningaui timealeyi*) and the Western Pebble-mound Mound (*Pseudomys chapmani*). In relation to the *Planigale*, current taxonomy is unresolved, but it is likely that two taxa occur in the Pilbara, one from Cape Preston and the Hamersley Plateau, with the other widespread and common in the Pilbara. It is the latter that occurs over the project area. Taxonomy is currently being investigated by the Western Australian Museum. The Little Red Kaluta and Pilbara Ningaui are common and widespread in the Pilbara. The Western Pebble-mound Mouse is a Priority 4 listed species but is widespread in the Pilbara in suitable habitat. The project area offers no special or significant habitat for these species. The project will therefore not impact on the regional status of these species if implemented in accordance with this proposal.

Species complexes

Species complexes recorded at Spinifex Ridge where taxonomy is poorly understood include *Heteronotia binoei*, *Diplodactylus stenodactylus*, *Menetia greyii* and *Crytoblepharus plagiocephalus*. However, as these species are very common and widespread throughout Australia it is unlikely that the project will result in significant impacts on the regional status of these species.

Given that the faunal assemblages at Spinifex Ridge are similar to those occurring elsewhere within the region, that the area required for the proposal is small in comparison to that available in surrounding areas, that the particular habitats impacted are widespread in the bioregion, and that impact to locally-significant habitat is minimised, the potential loss of fauna habitat through direct clearing is not considered significant.

2) Reduced connectivity of populations and/or isolation of local habitats

Although direct clearing is unlikely to have any long-term impacts on terrestrial fauna populations, it does have the potential to contribute to habitat fragmentation at the local scale. Two habitats are recognised for their roles as fire refuges with linear configurations that facilitate immigration and emigration of fauna (OES, 2006e); the Rocky Slope habitat of the Talga Range, particularly the steep and fractured areas of the southern flanks, and Riverine Communities habitat. These habitats can be viewed in the context of ecological links to Coppin Gap (Rocky Gully habitat), which also acts as a local refugia.

One waste landform is proposed to be positioned adjacent to, and partially within, the Capricorn land system, within which the Talga Range is located (**Figure 1-1**). Direct clearance is likely to have minimal impact. However, a number fauna of conservation significance are likely to utilise the Talga Range and environs. Similarly, the more mesic habitats of the southern aspects of the range would be the likely habitats for short-range endemic species including the un-named terrestrial snail "*Quistrachia* sp." (OES, 2007b).

Positioning of the pit, tunnel, and waste landforms will be such that they will minimise impact to rocky ledges typical of the upper slopes of the Talga Range (that is, Rocky Slope habitat) to enable habitat use and dispersal routes to be maintained. Siting of the waste landforms is discussed in **Section 8.12.1**. Less than 52 ha of the Talga Range will be impacted, the majority of which incorporates only moderate slopes. Steeper and more rocky topography is located adjacent to the proposed pit location (**Figure 3-1**). Post-mining pit walls will have a similar topography to the existing steep slopes of the Talga Range.

3) Alterations to Hydrology

Alterations to natural hydrological cycles, both surface water and groundwater, can potentially impact fauna habitats associated with aquatic and riparian systems. In particular de-watering of the pit will affect groundwater levels that will potentially impact semi-permanent standing water associated with Coppin Gap. Results of modelling suggest that during "average" and "wet" seasons the influence of mine development will be within expected natural variations for pools within Coppin Gap. However, during extended periods of drought while the mine is operational water levels may fall below levels that may otherwise naturally occur (Aquaterra, 2007). Changes to groundwater levels within the calcrete and creek alluvials in close proximity to the pit also has the potential to affect phreatophytic (groundwater using) vegetation such as large eucalypts that provide important faunal habitat elements. Alterations to surface hydrology associated with the diversion of Coppin Creek also have the potential to affect riparian habitats and semi-permanent standing water associated with Coppin Gap. Impacts and management of groundwater and surface water are covered in **Sections 8.3** and **8.4** respectively, and impacts to fauna associated with the diversion of Coppin Creek are covered in **Section 8.7.2**.

4) Tailings Storage Facility

Although no migratory waders or other waterbirds were recorded during biological surveys over the project area (OES, 2006e) the construction of a TSF has the potential to attract migratory waders and other waterbirds that occur in the region by effectively creating habitat. Other birds may also drink from the TSF. Measurements of molybdenum concentrations likely in the tailings dam indicate that the maximum molybdenum concentration is likely to be relatively low, at 1mg/L (Campbell, 2007) compared to natural levels in Coppin Gap pool >0.1mg/L Mo. Concentrations of other metals in the tailings reporting to the TSF were not elevated.

A hazard evaluation commissioned by Moly Mines (Bennelongia, 2007) suggested that if the molybdenum concentration in the tailings dam does not rise substantially above the concentration of 1mg/L of molybdenum there should not be any danger to wildlife from drinking the water. A molybdenum level that is ten times the predicted value is not considered to pose any risk to fauna at Spinifex Ridge (Bennelongia, pers.comm).

Any overflow event would be most likely associated with general flooding resulting from cyclonic activity, resulting in a massive dilution that would preclude any downstream impacts. It is possible that aquatic plants and invertebrates may accumulate molybdenum, however, this risk cannot be accurately quantified without experimental investigation. The attractiveness of the facility to water birds will largely be dependent upon final design criteria.

5) Dust and Light

The impact of dust during construction and operational phases has the potential to locally impact fauna habitats primarily by smothering of vegetation, but can be mitigated by using standard management practices. Water to be used for dust suppression over the project area is classified as fresh and there is little potential for impacts on vegetation communities.

Concentraion of metals in dust has the potential to be highest in the molybdenum and copper concentrate products. These concentrates will be enclosed within sheds for storage and truck loading, and trucking will require covered loads for the bulk copper concentrate (molybdenum product will be in bulk bags in shipping containers). Toxicity associated with ingestion or inhalation of tailings is considered extremely unlikely given the low levels of metals (Mo 60 – 100 ppm) and hence the quantity of material required to be ingested. For example, review of environmental health impacts of the project (Glossop Consultancy, 2007) indicate that impacts from inhalable dust would be the rate determining contaminant, before any toxicity impacts from metals.

Potential impacts arising from illumination at night can arise from obtrusive light spill, by general luminance diffusion, reflection from existing surfaces or through atmospheric scattering. All of these may have a localised effect upon fauna but can be mitigated by implementing well-known and standard management practices.

6) Noise

Bats of conservation significance are known from the project area (OES, 2006e). Although no bat roosts of the Ghost Bat and/or Orange Leaf-nosed Bat have been located, these species would at least traverse the area during foraging, or possibly use caves within the Talga Range for temporary or seasonal roosting. Other bats are also likely to roost in the Talga Range, and a colony of over 30 Common Sheathtail-bats (*Taphozous georgianus)* has been recorded in a cave at Coppin Gap (OES, 2006e). Noise associated with the proposal, particularly associated with blasting, has the capacity to impact upon local fauna populations, and in particular bats of conservation significance.

7) Potential to increase populations of exotic species

The potential to introduce, or exacerbate the effects of, weeds and exotic vertebrate species is could increase with an increased human presence and greater vehicle movements over the project area (service corridors are discussed in **Section 8.6.4**) For example, at present there appear to be no introduced aquatic weeds or introduced fish in the surface water system (OES, 2006e; OES, 2006c), and relatively few weed species present (although Buffel Grass is widespread and abundant in drainage systems). An increased road network has the potential to introduce new weed species, and/or facilitate the spread of those already present, into new areas thereby impacting fauna habitats. Similarly, if waste disposal is not appropriately managed there is the potential to increase populations of feral predators (cats and foxes), which would subsequently impact local vertebrate populations.

8) Secondary impacts

An increased human presence over the project area has the potential lead to secondary impacts such as off-road vehicle use (spinifex communities are particularly susceptible to vehicle damage and may take many years to recover), increased fire, and disturbance to important habitats such as bat roosts and the Coppin Gap waterhole. Conversely, an educated workforce can help facilitate conservation management over the project area.

8.6.2.3 Management of Impacts

The overall management of fauna will be addressed by Moly Mines in a specific Fauna Management Plan. A management plan for Coppin Gap, that will incorporate fauna management, will also be developed by Moly Mines in close consultation with the Shire of East Pilbara and DEC. These EMPs will specify management measures to ensure that impacts to fauna are minimised over the project area. These measures are described below.

Direct clearance, reduced connectivity, or disturbance of fauna habitat

All clearing of vegetation will be kept to a minimum over the project area. Apart from the widening and upgrading of an existing track through Kitty Gap, clearing of Rocky Gully habitat will be avoided, and the discrete positioning of waste landforms will minimise impacts to Rocky Slope habitat (**Section 8.12.1**), and the connectivity attributes of the Talga Range.

The Coppin Creek diversion and mitigation of impacts to Riverine Communities is covered separately in Section 8.7.3. However, clearing or disturbance to riparian systems in general will be avoided wherever possible, and design criteria will position waste landforms and the TSF at least 750m from 100 year flood levels which is above Riverine Community habitat (Vegetation Associations D2 and D3). Where disturbance is unavoidable to Minor Drainage Line habitat, other than that impacted by direct clearing, sufficient culverting will be installed to maintain surface water flows.

Other management prescriptions to minimise direct clearance and disturbance to fauna habitat will include:

- Identification of all active mounds of the Western Pebble-mound Mouse in Basalt Ridge habitat with active mounds avoided wherever possible.
- Implementation of strategies to minimise the impacts to bats utilising caves and crevices in the Talga Range. This will include the establishment of buffer zones between mining activities and caves, blasting restricted to daylight hours and the use of directional lighting.
- Temporary capping of drill holes on completion of drilling and permanent capping when no longer required, as soon as practical.

- Topsoil and cleared vegetation returned to landforms that are contoured to resemble the surrounding topography. Progressive rehabilitation of disturbed areas will be implemented with the aim of reflecting the pre-disturbance state as closely as possible (**Section 9**).

Tailings Storage Facility

Assessment has indicated that there should be no danger to wildlife from drinking water from the TSF (Bennelongia, 2007) and that likelihood of TSF overflow is considered extremely low. It may be possible that aquatic plants and invertebrates accumulate molybdenum. The following management prescriptions will be implemented:

- The TSF will be fenced to exclude stock and other large vertebrates.
- The TSF design has the decant pond away from the bank of the TSF. Operation of the TSF aims to maximise water recycling by keeping the pond as small as practicable, thereby minimising the attractiveness to waterbirds.
- A monitoring program will be implemented that regularly measures molybdenum and other metals within the the supernatant pond, as well as within aquatic flora and invertebrates.
- The Fauna Management Plan will incorporate a monitoring program to document waterbird and other fauna usage of the TSF. If warranted, measures will be implemented to deter waterbird use of the TSF.

Dust and Light

Impacts of dust will be managed by implementing the strategies listed under **Section 8.9**. Water used for dust suppression over the project area has been categorised as fresh and will be sourced preferentially from: pit dewatering; harvested water from rainfall events; and from the process water supply source.

Potentially toxic dusts (ie dust from concentrate products) will be stored and loaded in enclosed sheds, and trucking of bulk copper concentrate will be in covered trailers. Molybdenum concentrate will be trucked in bulk bags in shipping containers.

Light will be managed over the project area according to Australian Standard AS 4282-1997 *Control of Obtrusive Effects of Outdoor Lighting*. Management strategies will include:

- location of lighting as close as possible to the target area of illumination;
- directing light sources at targeted work areas, preferably in a downwards direction;
- adopting a low vertical aiming angle of the light;
- directing light away from sensitive areas such caves in the Talga Range and riparian zones;
- conducting regular maintenance to maintain optimum performance; and
- conducting workforce awareness training to reduce light emissions.

Table 8-13 Summary of Potential Fauna Impacts and Recommended Controls

Species	Recorded (R)	Preferred habitats & disturbance required (ha)[2]		Summary of Impact and Required Controls
Northern Quoll *Dasyurus hallucatus*	R	RG RS RC	1.22 51.39 8.85	The Northern Quoll appears to be relatively common locally in suitable habitats, including sites approximately 50km to the north of the project area. There will be negligible disturbance to rocky gully habitat. A comparatively small area of rocky slope habitat will be required to be cleared over the project area, as well as a temporary loss of riverine community habitat until the Coppin Creekline diversion is rehabilitated. However, regional ecological linkages will be not be impacted: That is, an undisturbed riparian linkage from the project area downstream to the De Grey River, and rocky escarpment along the length of the Talga Range. Impacts of light and noise emissions can be mitigated using well-designed strategies. Appropriate fire management and feral predator control over the project area are likely to benefit this species.
Orange Leaf-nosed Bat *Rhinonicteris aurantius*	R	RG RS	1.22 51.39	Although the deep caves that provide the very restrictive breeding roost requirements of this species are unlikely to be present over the project area the species is likely to at least traverse the area during foraging, or possibly use caves within the Talga Range for temporary or seasonal roosting. There will be no disturbance to suitable rocky gully habitat, and although a comparatively small area of rocky slope habitat will be required to be cleared - this does not appear to contain the deep caves preferred by this species. Temporary or seasonal roost sites would be susceptible to light and noise emissions, particularly blasting. Blasting will be restricted to daylight hours, and Impacts of light can be mitigated using well-designed strategies.

[2] **Habitats:** **BR**: Basalt Ridges; **RC**: Riverine Communities; **RS**: Rocky Slopes; **MD**: Minor Drainage Lines; **RG:** Rocky Gullies; **SP**: Spinifex Plains

Species	Recorded (R)	Preferred habitats & disturbance required (ha)[2]		Summary of Impact and Required Controls
Mulgara *Dasycercus cristicauda*		SP	995.62	Core habitat of spinifex grassland at the appropriate successional stage is not present over the project area due to frequent fire and cattle grazing and the species was not recorded. Although a proportionately large area of potential habitat is to be cleared spinifex sandplain habitat is common and widespread in the region and the clearing of marginal habitat is unlikely to affect this species. The effects of frequent fire and predation by introduced predators is impacting populations. Appropriate fire management and feral predator control over the project area are likely to benefit this species, and the Mulgara may occur over the project area intermittently as regional and/or local conditions improve.
Pilbara Olive Python *Liasis olivaceus barron*		RG RS RC	1.22 51.39 8.85	The Pilbara Olive Python is common in the region in suitable habitat but was not recorded over the project area. There will be no disturbance to the preferred rocky gully habitat, and minimal disturbance to suitable rocky slope habitat. Major ecological linkages will be maintained through the persistence of the linkage along the length of the Talga Range. There will be temporary loss of riverine community habitat until the Coppin Creekline diversion is rehabilitated. However, major ecological linkages will be maintained: That is, an undisturbed riparian linkage from the project area downstream to the De Grey River, and rocky escarpment along the length of the Talga Range
Peregrine Falcon *Falco peregrinus*		RS	51.39	Although not recorded over the project area breeding habitat for this species occurs along extensive tracts of the Talga Range. The 51.39ha of this rocky slope habitat that will be disturbed does not provide extensive ledges or overhangs and this species prefers and it is unlikely to be impacted by the proposal.
Ghost Bat *Macroderma gigas*	R	RG RS RC	1.22 51.39 8.85	The Ghost Bat possibly roosts in caves within the Talga Range within the project area. The approximately 50ha of this rocky slope habitat that will be disturbed does not appear to provide extensive caves or overhangs, and this species is unlikely to be impacted by habitat clearance. However, roost sites are susceptible to human disturbance as well as noise and light emissions, particularly blasting. Blasting will be restricted to daylight hours and management strategies for noise and light will apply.
Western Pebble-mound Mouse *Pseudomys chapmani*	R	BR RS	370.89 51.29	Approximately 420ha of potential habitat will require disturbance. However, habitat is widespread in the region and due to the strict pebble size requirement of this species not all habitat to be disturbed would be utilised. Identification of all active mounds of the Western Pebble-mound Mouse in suitable habitat will be undertaken with active mounds avoided wherever possible.

Species	Recorded (R)	Preferred habitats & disturbance required (ha)[2]		Summary of Impact and Required Controls
Lakeland Downs Mouse *Leggadina lakedownensis*		SP MD	995.62 86.78	This species was not recorded over the project area and is only infrequently recorded during surveys, in part due to boom-bust cycles. Habitat is widespread in the region and not all habitat to be disturbed would be utilised, with a preference for areas of deep sands and cracking clays. Appropriate fire management and control of stock over the project area are likely to benefit this species.
Australian Bustard *Ardeotis australis*	R	RC MD BR	8.85 86.78 370.89	This species and preferred habitats are widespread throughout much of Australia and the clearance of habitat is unlikely to impact this species. Inappropriate fire regimes, grazing pressures and introduced predators all threaten this ground-nesting bird, and appropriate fire management, feral predator control, and control of stock over the project area are likely to benefit this species.
Bush Stone-curlew *Burhinus grallarius*	R	RC MD BR	8.85 86.78 370.89	This species and preferred habitats are widespread throughout much of Australia and the clearance of habitat is unlikely to impact this species. Inappropriate fire regimes, grazing pressures and introduced predators all threaten this ground-nesting bird, and appropriate fire management, feral predator control, and control of stock over the project area are likely to benefit this species.
Grey Falcon *Falco hypoleucos*		RC	8.85	This Grey Falcon has a very broad distribution across Australia and the loss of 8.85ha of riparian habitat is unlikely to affect this species. Furthermore, rehabilitation of the Coppin Creek diversion is likely to replace habitat qualities for this species lost through clearing.
Star Finch *Neochima ruficauda*		RC	8.85	The loss of 8.85ha of riparian habitat is unlikely to affect this species that is widespread through the bioregion. Rehabilitation of the Coppin Creek diversion is likely to replace habitat qualities for this species lost through clearing.
Rainbow Bee-eater *Merops ornatus*	R	RC MD SP	8.85 86.78 995.62	Although widespread in a variety of habitats this species is more likely to construct its nesting burrows in sandy-loamy soils of riverine communities, minor drainage lines and spinifex sandplains. Due to the broad habitat requirements of this species, the widespread nature of all habitats, and the fact that it is a common migrant in the bioregion, the proposal is unlikely to impact this species.
Fork-tailed Swift *Apus pacificus*		Overfly all habitats		The Fork-tailed Swift is an aerial species that may over-fly the Project Area only and will be unaffected by the proposal.

Species	Recorded (R)	Preferred habitats & disturbance required (ha)[2]		Summary of Impact and Required Controls
'Migratory Waders and Waterbirds'		RC MD	8.85 86.78	Preliminary assessments indicate that there should be no danger to wildlife from drinking water from the proposed TSF, and that downstream risk from overflows is considered low. Nevertheless, the TSF will incorporate design features that deter birds including locating the supernatant pond away from the bank of the facility and ensuring the banks of the facility do not provide attractive landing sites for waterbirds and waders.

Noise

Noise and other disturbance have the capacity to impact upon local fauna populations, and particularly the impacts associated with blasting on bats of conservation significance. The creation of an access tunnel through the Talga Range during the construction period and ongoing pit blasting during operations are of particular relevance. “Best industry practice” will be implemented by Moly Mines to mitigate impacts, including the avoidance of blasting during night time hours to minimise disturbance to bat roosts.

Specific management strategies to minimise the impacts of noise over the entire project area are discussed in **Section 8.11**.

In the long term, at mine closure the formation of a tunnel through the Talga Range has the potential to increase local bat habitat, including for species of conservation significance such as the Orange Leaf-nosed Bat (Pilbara) and Ghost Bat.

Exotic species

A number of exotic vertebrate species are known from the project area including donkeys and camels (OES, 2006e). Feral cats were recorded during surveys but foxes were not, and the location of the site is on the edge of this species ‘normal’ distribution. However, it is likely that foxes would occur over the project area from time-to-time, particularly after a series of seasons of above average rainfall. The local wild dog population may also currently be suppressing the number of foxes present and, if controlled, fox numbers may rise through mesopredator release.

Management of feral animals over the project area will ensure:

- All feral animals, as well as native animals, cannot access waste products, which could potentially increase abundances of both groups at the local scale.
- Feral animals and dingoes will be managed and controlled over the project area in liaison with the local pastoralist, the Department of Agriculture and Food, and DEC. Management prescriptions will be included in the overall Fauna Management Plan.

Secondary Impacts

Prevention of fire over the project area will be a key priority for Moly Mines operations, especially in consideration of highly flammable spinifex vegetation and the impact of frequent fire on habitat quality. An on-site management presence and improved response to wildfire is likely to reduce the impacts of fire regimes currently affecting the project area. Other measures to protect fauna from secondary impacts of the proposal will also be implemented:

- Fire management will be addressed in the Fauna Management Plan and will be based upon fire exclusion within the project area. A regional approach will be adopted to fire management and suppression in liaison with neighbours, including the local pastoralist, DEC, and FESA.
- Off-road vehicle use will be strictly controlled over the project area with no driving permitted off designated routes. Strict speed limits will apply over the project area and on all haul roads, and all

vertebrate fauna deaths over the project area will be reported through the site incident management procedures.

- Access to sensitive habitats of the Talga Range and Coppin Gap will be regulated through the implementation of the Fauna Management Plan and Coppin Gap Management Plan. Information related to fauna of conservation significance, and interactions with fauna, will be included in all site inductions.

8.6.3 Creekline Diversion and Coppin Gap

8.6.3.1 Potential Impact of Proposal

A diversion of Coppin Creek and pit dewatering is required to access the ore body at Spinifex Ridge. The diversion will redirect surface water from Coppin Creek around the pit area and into an existing creekline that flows into Coppin Gap. Potential impacts to fauna from the creekline diversion and pit-dewatering include:

- loss of riparian habitat due to clearing required for the pit;
- potential degradation of riparian habitat, including Coppin Gap, downstream of the diversion;
- reduction of habitat connectivity; and
- potential impacts to phreatophytic vegetation due to changes in groundwater as a consequence of pit de-watering.

Disturbance and potential hydrological changes due to the Coppin Creek diversion and pit de-watering have the potential to impact locally significant terrestrial fauna habitats such as riparian zones and waterholes, by changing the flooding and drying (hydric) cycle, as well as increasing erosion and/or sediment loads. Changes to groundwater levels also have the potential to impact phreatophytic (groundwater using) flora such as eucalypts and melaleucas which are important elements of fauna habitat.

Avoidance and mitigation of hydrological impacts to surface water are discussed in **Section 8.4** and groundwater in **Section 8.3** and are therefore not discussed further here. Effective management of these issues will result in no significant impact to fauna. It should be noted that pit-dewatering will not be discharged into Coppin Creek, and that the diversion path will not be dammed or otherwise 'regulated,' with the objective of duplicating natural flow regimes (**Section 8.4**).

Apart from direct disturbance to riparian habitat, the Coppin Creek diversion has the potential to reduce the connectivity of fauna populations. Riparian zones are important conduits for dispersal for many terrestrial fauna species, particularly in the arid zone.

8.6.3.2 Management of Impacts

Mitigation of impacts associated with the Coppin Creek diversion has largely been addressed through appropriate design criteria, but will also be contingent upon the success and timing of rehabilitation of the diversion channel, designed to replicate the ecological functioning of the existing creekline. Moly Mines will prepare a Coppin Gap Management Plan that will include all mitigation strategies pertaining to the diversion of Coppin Creek. Rehabilitation objectives are included in **Section 9**.

Management prescriptions will ensure that the semi-permanent waterbody at Coppin Gap and associated habitats within the Coppin Gap Reserve (No. 31047) are preserved and managed for their conservation values. Management prescriptions will be devised in collaboration with the Shire of East Pilbara and the DEC, and include management strategies for fauna habitat protection, as well as access management pertaining to both Moly Mines staff and public visitation.

Loss of riparian habitat

Riparian habitat to be cleared to access the ore body is well represented in the region and has been included in clearing calculations for Riverine Community habitat in **Section 8.7.2**, and the allied Vegetation Associations (D2 and D3) in **Section 8.5**. Muture eucalypts provide hollows for fauna such as bats and parrots, however, loss of this small amount of habitat will have negligible impact on local or regional populations. Furthermore, rehabilitation of the diversion to Coppin Creek will replicate at least some of the Riverine Community habitat qualities currently present.

The diversion channel will be designed to facilitate the establishment of vegetation, and a range of techniques will be used to establish vegetation in the diversion channel including seeding, planting seedlings and translocation.

Potential degradation of riparian habitat downstream of the diversion

The existing riparian vegetation of Coppin Creek downstream of the diversion will be retained, and surface water flows outside the diverted area will be maintained. The key faunal habitat elements associated with the riverine community are the deep-rooted phreatophytic overstorey of eucalypts and melaleucas. These may be partly or wholly dependent upon groundwater and therefore not totally reliant upon surface water flows (see potential impacts to phreatophytic vegetation).

Diverted surface water will be directed into an existing drainage line that feeds Coppin Gap. If surface water flow in the creek diversion is not well-managed, scouring or sedimentation of the existing downstream drainage line may result. The following management prescriptions will be implemented by Moly Mines:

- surface water flows through the diversion will incorporate water management features that replicate natural conditions, such as boulders and rocks to slow velocities, and sediment traps and basins will be installed where appropriate (**Section 8.4.3**);
- monitoring methodologies for the Coppin Creek riparian system have been established (OES, 2006c). After the completion of the diversion an annual monitoring program will be implemented to assess the health of downstream riparian vegetation; and
- if negative impacts attributed to the Coppin Creek diversion are detected then design elements of the diversion will be re-assessed and mitigation strategies implemented.

Reduction of habitat connectivity

Riparian zones are important conduits for immigration and emigration for many terrestrial fauna species, particularly in the arid zone. The Coppin Creek diversion will at least temporarily impact fine-scale connectivity attributes. It should be noted, however, that habitat connectivity between Coppin Gap downstream to the De Grey River is considered more important in the regional context than upstream from Coppin Gap where Coppin Creek diminishes over a relatively short distance.

Vagile groups such as birds and bats that utilise riparian vegetation for regional movements will be unaffected by a gap in riparian vegetation at the scale proposed. Although typical habitat of the invertebrate SRE taxa *Quistrachia* sp. identified from the project area is rocky ranges rather than creeklines, invertebrates that are reliant on mesic qualities over short distances may be impacted until the diverted system incorporates the required ecosystem attributes possessed by the original system. Similarly, some vertebrate species such as fish populations are isolated in waterholes or pools such as Coppin Gap for long periods of time, but require regular genetic mixing between populations during flood events.

The objective of the Coppin Creek diversion will be to mimic the natural system as far as possible (**Section 8.4)** and will:

- reproduce pre-development flood levels;
- not incorporate design elements such as dams and locks that impede movement of aquatic species; and
- incorporate a rehabilitation plan that aims to mimic the predominant faunal habitat attributes of the D3 Vegetation Association. That is, containing *Eucalyptus camaldulensis* and *Melaleuca glomerata*. Abiotic habitat elements of rocks, boulders and logs will also be used to provide cover.

Impacts to riparial habitat

Management of impacts to phreatophytic vegetation is covered in **Section 8.5**. If monitoring reveals that water levels at Coppin Gap are affected by the de-watering of the pit or that riparian vegetation is being impacted, appropriate strategies to minimise the impacts of drawdown will be considered, such as:

- Artificially maintaining the water levels at the Coppin Gap by the addition of appropriate, high-quality water.
- Artificially recharging the upper alluvial or calcrete aquifers with water of equivalent quality.
- Implementing an engineering solution that confines or separates the aquifer around the vicinity of the pit from Coppin Gap so that drawdown does not occur.

8.6.4 Water Supply Areas and Pipelines

Service corridors associated with the project will connect the project area to the De Grey borefield and either the Canning borefield or the in-pit water supply at Woodie Woodie. Service corridors will be positioned adjacent to existing roads and tracks within pastoral lands and the pipeline will be buried, therefore stock or wildlife movement will not be impeded. Service corridors will be 30 m wide and clearing of vegetation up to 20 m in width at certain locations may be necessary where the gas and water pipelines share the same easement and where soil conditions prevent steep trenches remaining stable. Typical clearing widths for pipelines will be <5m. All soils and vegetation will be rehabilitated promptly post construction.

8.6.4.1 Potential Impacts

Impacts associated with the construction and operation of the water supply areas and associated service corridor and pipeline could include:

- Introduction and spread of weeds along the length of the pipeline.
- Temporary loss of habitat, and disturbance to sensitive habitats such as riparian zones during construction.
- Fauna mortality due to entrapment in excavated trenches.
- Potential drawdown affects of the De Grey borefield.
- Establishment of the gas pipeline corridor

8.6.4.2 Management of Impacts

The overall management of fauna will be addressed by Moly Mines in a specific Fauna Management Plan that will specify management measures to ensure that impacts to fauna are minimised over service corridors and water supply areas.

Weed management over service corridors will be incorporated into a Vegetation and Flora Management Plan. Strategies will include the implementation of vehicle hygiene procedures for vehicles traversing service corridors.

Temporary loss of and disturbance to fauna habitat

Habitats identified along the service corridor route are widely distributed throughout the Pilbara Bioregion and given the significant amount of intact vegetation through which service corridors pass little impact to fauna or fauna impact is expected.

General management strategies for the service corridors will include:

- Alignment to follow existing tracks or clearings wherever possible.
- All hollow logs and branches to be returned intact as part of the vegetation rehabilitation plan.
- Important habitat entities such as trees and large termite mounds, to be marked and avoided wherever possible.
- Pipeline crossings over the Oakover River, Nullagine River, and Yilgalong Creek to avoid key riparian habitat of large eucalypts and sedgelands wherever possible.

Fauna mortality due to entrapment in excavated trenches

Fauna mortalities have been experienced during the construction of trenches for pipeline burial in the past. Trenching management prescriptions that will be implemented to avoid fauna mortality will include limiting the length of open trench at any time, and the trench remaining open for the shortest practical time. A ‘fauna clearing team’ will also be established for the duration of construction and will inspect open trenches each morning

Potential drawdown affects of the De Grey borefield

Pools and riparian vegetation associated with the De Grey River, a wetland listed on the Directory of Important Wetlands in Australia (WA065) are located within 5 km of the De Grey borefield. A description of the aquifer and proposed management of the borefield is discussed in **Section 8.3.3**.

Changes to the nature of persistence of these pools (eg. duration, timing, water quality), particularly during the drier winter months, would have a significant impact to a wide range of fauna, including migratory birds. However, risk of impact to pool and riparian habitats is considered low because water in the upper alluvium that supports these systems can be managed sustainably, predominantly through the seasonal management of the borefield by regulating abstraction from near river bores to periods of river recharge. Because the De Grey borefield will ultimately be one of two water supplies servicing the project a great deal of flexibility is available in terms of timing and quantity of supply (**Section 8.3.3**). A De Grey borefield management and monitoring program will be implemented, whereby:

- A sustainable abstraction regime is employed.
- A monitoring regime is implemented that:
  - monitors phreatophytic vegetation bi-annually, and;
  - monitors semi-permanent pools bi-annually.

If local impacts are noted:

- Abstraction quantities and timing will be adjusted internally within the De Grey Borefield as well as quantity and timing ratios between the De Grey and either Woodie Woodie or Canning supply.

8.6.5 Management Plans

The project EMP will include environmental management plans necessary to manage potential environmental impacts (**Section 7.5**). A Fauna Management Plan will be included as a stand alone plan and include management of fauna over the project area, service coridors, and water supply areas.

8.6.6 Predicted Outcome

Based on the management approach and strategies identified above, the Spinifex Ridge Project is considered to meet the EPA objectives for terrestrial fauna. Fauna populations, terrestrial fauna habitats, and the conservation status of fauna of conservation significance including the recorded species; Northern Quoll, Orange Leaf-nosed Bat, Ghost Bat, Western Pebble-mound Mouse, Australian Bustard, Bush Stone-curlew and Rainbow Bee-eater, will not be adversely impacted by the Spinifex Ridge Project if the outlined management measures are implemented.

8.7 Aquatic Ecology

8.7.1 Coppin Gap

8.7.1.1 Management Objectives, Standards and Guidelines

The EPA objectives for the management and maintenance of wetlands and rivers, surface water and groundwater are:

- To maintain the integrity, ecological functions and environmental values of wetlands and rivers.
- To maintain the quantity of water so that existing and potential environmental values, including ecosystem function, are protected.
- To protect the environmental values of areas identified as having significant environmental attributes.
- To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses.
- To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.

Applicable guidelines include:

- ANZECC/ARMCANZ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000)

8.7.1.2 Current and Potential Impacts

Current Impacts

Current impacts to Coppin Gap relate to the site being an infrequent tourist destination, and also pastoral management activities, cattle grazing, frequent fire and weeds. In that context, the site has been classified according to ANZECC guidelines as 'slightly to moderately disturbed' (ANZECC/ARMCANZ 2000). Major impacts to the system to date have included the introduction of weed species mainly at the entrance to the gap, probably through a combination of human visitation and the grazing of cattle. Roads into Coppin Gap have been created and are used irregularly.

Potential Impacts

A creek diversion will be constructed upstream of Coppin Gap, redirecting the existing creekline around the proposed pit (**Section 8.4**). The potential impacts of the creek diversion and pit-dewatering to Coppin Gap include:

- Erosion and sedimentation.
- Altered water levels or hydrological regimes.
- Diminished water quality.

These impacts may contribute to the following:

- Change in community structure and habitat.
- Loss of riparian vegetation.

Details of these potential impacts are provided below.

1) Erosion and Sedimentation

The diversion of Coppin Creek upstream of Coppin Gap may alter sedimentation in the Coppin Creek diversion channel. However, hydrological modelling shows that flood levels and flow velocities, and subsequently sediment levels, will be effectively unchanged in Coppin Gap, following construction of the creek diversion (**Section 8.4**). Increases in turbidity that result from altered flow rates, erosion and sedimentation are potentially detrimental to the biological diversity, community structure, habitats and water quality within an aquatic ecosystem. Elevated turbidity reduces the amount of light entering the system, potentially impacting algae and macrophytes that are present in the water column (DOE, 2003; ANZECC/ARMCANZ, 2000; OES, 2006c). Also, increases in sediment load may result in the increased transport of pollutants through the aquatic system, as pollutants are generally adsorbed onto sediment particles (ANZECC/ARMCANZ, 2000).

2) Altered water levels or hydrological regimes

In terms of surface water, the Coppin Creek diversion may result in a minor reduction to the flow volumes and peak discharges through Coppin Gap for the 100 year, 72 hour ARI storm event, but no likely changes in flow volumes and peak discharges for 2 year, 72 hour ARI storm events. Minor changes to flood levels in Coppin Gap are also likely for the 100 year 72 hour ARI storms, but no changes are expected for the 2 year 72 hour ARI storms (**Section 8.4**).

The regional groundwater response to dewatering is predicted to be relatively localised with the development of a steep hydraulic gradient surrounding the mine void due to the low permeability of the surrounding fresh rock mass. However, there is the potential for groundwater drawdown in excess of natural variation to occur within the calcrete and alluvial aquifers adjacent to the pit, particularly in the vicinity of drainage lines between the mine and Coppin Gap (Aquaterra, 2007). Results of modelling suggest that during “average” and “wet” seasons the influence of mine development will be within expected natural variations for pools within Coppin Gap. However, during extended periods of drought while the mine is operational water levels may fall below levels that may otherwise naturally occur (Aquaterra, 2007).

Changes to the water regime can have negative implications for all wetland processes and functions such as growth and reproduction of aquatic biota (Boulton and Brock, 1999).

Changes to the water regime may affect the biota of Coppin Gap, particularly, the riparian vegetation and macroalgae. Of the riparian vegetation, the Lake Club-rush (*Schoenoplectus validus*) acts as a filtering mechanism for water entering Coppin Gap from the upstream catchment. This species requires stable water levels, and will tolerate water levels from dry up to 1.5m (Chambers *et al*., 1995).

The loss of this buffer zone would also increase the likelihood of impact to water quality. In terms of macroalgae, the charophyte *Chara globularis* is well-adapted to altered water regimes, but is an important habitat for macroinvertebrates. In that regard, declines in water level could lead to a reduction of biomass and therefore habitat.

3) Diminished water quality

Water quality in Coppin Gap has the potential to be impacted by the upstream creek diversion (mentioned in 1 above) and/or discharge from the mine void, waste landforms or mining infrastructure, or from increased vehicular use.

If increased sedimentation or discharge from any upstream mining activity or infrastructure enters Coppin Creek, it may be transported to Coppin Gap and affect the water quality of the semi-permanent pool at Coppin Gap. This would have subsequent impacts to biodiversity through changes in habitat dynamics.

Impacts to biodiversity and habitat may cause further declines in water quality through facilitating the colonisation of nuisance algae and contributing to the degradation of water quality. Altered conditions may provide an opportunity for “weed species” to establish and become dominant in the ecosystem, resulting in the loss of species diversity within the habitat.

8.7.1.3 Management of Impacts

A Coppin Gap Management Plan has been developed, which includes management and mitigation strategies related to all potential impacts listed. The key aspect of the management plan focuses on maintaining the sediment loading, hydrological function and water quality of Coppin Gap within the limits of natural variation.

Management prescriptions will ensure that the semi-permanent waterbody at Coppin Gap and associated habitats within the Coppin Gap Reserve (No. 31047) are preserved and managed for their ecological function, and aesthetic and environmental values. The aquatic surveys conducted to date have not identified any rare or locally endemic species, and all taxa were considered common to both the project area and ephemeral systems of Australian inland waters.

Sedimentation and water quality at Coppin Gap will be controlled by using appropriate engineering strategies to provide a stable flow profile, and slow the rate of surface water flow upstream of Coppin Gap. Engineering strategies will include, but not be limited to:

- the incorporation of water management features that replicate natural conditions, including floodplain zones and diversion structures;
- appropriate design in terms of cross section and path, flow profile, drainage, and disturbance footprint;
- containment of water from operational areas including waste landforms with the water re-used in the mine water circuit;
- the installation of sediment traps and basins;

- the installation of diversion structures around mine infrastructure and pit bunds to minimise erosion; and
- appropriate waste landform design to incorporate water management features that minimise the potential for sediment-laden surface water runoff.

If water levels at Coppin Gap are affected by the de-watering of the pit, appropriate strategies to minimise the impacts of drawdown will be implemented (**Section 8.3.1**) such as:

- Artificially maintaining water levels at the gap by addition of appropriate, high quality water.
- Artificially recharging the aquifer.
- Grouting of aquifer between Coppin Gap and the pit to manage drawdown in the longer term.

The TSF will be located downstream of Coppin Gap and therefore not influence water quality. Water quality of Coppin Gap will be maintained predominantly by the appropriate management of waste landforms proposed to be placed in the catchment (**Section 8.12.1**), in particular:

- Waste landforms will be constructed above predicted 100 year flood levels.
- Soils will be stockpiled to minimise erosion potential.
- PAF material will be appropriately encapsulated (detailed in **Section 8.12**).
- Seepage and runoff from waste landforms containing PAF material will be directed to the cut-off section of Coppin Creek and reused in the mine water circuit.

Monitoring

Interim monitoring methodologies for the Coppin Creek riparian and aquatic systems, have been defined (OES, 2006c), and indicators and standards for turbidity, sedimentation, and water quality have been identified (OES, 2006c). A comprehensive aquatic ecology monitoring program will be developed by Moly Mines and include appropriate standards and strategies to differentiate between impacts attributable to the proposal and those associated with natural variations.

8.7.1.4 Management Plans

A Coppin Gap Management Plan will be implemented to manage potential environmental impacts (**Section 7.5**). The Coppin Gap Management Plan will be included as a stand alone plan and include management prescriptions relating to the aquatic ecology aspects of Coppin Creek and Coppin Gap. A comprehensive ecological monitoring program will be included in the Coppin Gap Management Plan, as well as management, implementation and contingency strategies.

8.7.1.5 Predicted Outcome

Based on the management approach and strategies identified, and the absence of rare or locally endemic species, the Spinifex Ridge Project is considered to meet the EPA objective for wetlands and rivers by maintaining the integrity, ecological function and environmental values of Coppin Gap.

8.7.2 Coppin Creek

8.7.2.1 Management Objectives, Standards and Guidelines

The EPA's objectives for the management of surface water and wetlands are:

- To maintain the integrity, ecological functions and environmental values of wetlands and rivers.
- To maintain the integrity, ecological functions and environmental values of the ecological linkages.
- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses.

Applicable guidelines include:

- ANZECC/ARMCANZ *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000)

8.7.2.2 Current and Potential Impacts

Current Impacts

Impacts affecting Coppin Creek in the vicinity of the proposed mine site include frequent fire, grazing by cattle and other feral animals, and weed invasion (OES, 2006e; OES, 2006d; OES, 2006c). Frequent fire, including a bushfire during February 2005 has affected most of the riparian vegetation in the vicinity of the creekline resulting in the invasion of weeds (predominantly Buffel Grass) into the creekline. Some sections of Coppin Creek, particularly those upstream of the proposed pit, have also been impacted by grazing resulting in some bank erosion.

Potential Impacts of the Proposal

The existing creekline through the pit area will be destroyed due to the construction of the mine void. The creation of the creek diversion channel upstream of Coppin Gap will redirect surface water from Coppin Creek around the pit area (**Section 8.4**). Potential impacts of the creekline diversion and pit de-watering to Coppin Creek include:

- Reduction of habitat connectivity.
- Changes in natural surface water flow regimes, upstream and downstream of the mine void, potentially resulting in:
  - Scouring and erosion of the creek downstream of the creek diversion; and
  - Potential impacts on water quality (increased sediment loads and/or discharges from other areas).
- Potential impacts to groundwater as a consequence of pit de-watering.

These impacts may contribute to the following:

- Change in community structure and habitat.
- Loss or degradation of riparian vegetation and habitat.

Details of these potential impacts are provided below.

1) Reduction of habitat connectivity

The development of the pit will result in the destruction of some creekline habitats. In addition, the creekline will become disconnected which will have implications for the movement of aquatic biota (Bunn and Arthington, 2002). The baseline survey shows that the aquatic habitats and species found in Coppin Creek are not locally or regionally unique, so the destruction of some creekline habitats is not considered significant (OES, 2006c).

Connectivity of the aquatic habitat between Coppin Creek and Coppin Gap is important to ensure the continuity of biota through the creek system. The creekline upstream and downstream of the pit will be connected by the diversion channel.

2) Changes in natural surface water flow regimes

Potential changes in flow regime due to the Coppin Creek diversion and pit de-watering have the potential to impact important aquatic habitats such as riparian zones, and important taxa such as aquatic macrophytes, by altering the hydric cycle, erosion, sediment loads and water quality.

The flow regimes and water quality within the riparian zone immediately upstream of Coppin Gap are particularly important, as the aquatic macrophytes in this area may be impacted by changes in these aspects. Macrophytes such as Lake Club-rush (*Schoenoplectus validus*) are prevalent in the creekline and are likely to be impacted by changing water regime (Chambers *et al.*, 1995). While these macrophytes are not locally or regionally unique or significant, they have an important function in maintaining and regulating the quality of water entering and within Coppin Gap.

3) Potential impacts to groundwater as a consequence of pit de-watering

Two sections of the creekline immediately upstream and downstream of the mine void may be affected by pit de-watering, due to changes to natural groundwater variations within calcrete and alluvial aquifers adjacent to the pit, particularly in the vicinity of drainage lines between the mine and Coppin Creek (**Section 8.3.1**).

Potential impacts in this area relate to the loss or degradation of riparian vegetation and macrophytes, which would cause a decline in water quality, and a loss of habitat for macroinvertebrates.

Riparian vegetation associations to be cleared to access the ore body are well represented in the region and have been included in clearing calculations for riverine community habitat in **Section 8.7.2**, and the allied Vegetation Association (D3) in **Section 8.5.3**.

Riparian vegetation and macrophytes in Coppin Creek provides habitat for aquatic biota, particularly in the area just upstream of Coppin Gap where surface water backs up in flood events. Many of the taxa identified in Coppin Creek prefer and flourish in the sheltered littoral zones amongst the vegetation and will therefore be impacted by the death of riparian vegetation.

8.7.2.3 Management of Impacts

A Coppin Gap Management Plan has been developed, which includes management and mitigation strategies related to all potential impacts listed.

The management plan focuses on the design criteria of the Coppin Creek diversion and the success and timing of rehabilitation strategies, which are critical in determining the level of impact and likelihood of impact mitigation in Coppin Creek. Appropriate management measures will also ensure the maintenance of hydrological function, water quality, ecological function, and aesthetic and environmental values.

Reduction of habitat connectivity and changes in natural surface water flow regimes

The objective of the Coppin Creek diversion will be to incorporate design features that reproduce natural conditions as closely as possible (**Section 8.4**), to maintain current flow velocities and flood levels in both Coppin Creek and Coppin Gap.

Sedimentation and water quality at Coppin Gap will be controlled by using appropriate engineering strategies to provide a stable flow profile, and slow the rate of surface water flow upstream of Coppin Gap. Engineering strategies will include, but not be limited to:

- The incorporation of water management features that replicate natural conditions, including floodplain zones and diversion structures.
- Appropriate design in terms of cross section and path, flow profile, drainage, and disturbance footprint.
- The installation of sediment traps/basins where appropriate.
- The installation of diversion structures around mine infrastructure and pit bunds to minimise erosion.
- Appropriate waste landform design to incorporate water management features that minimise the potential for sediment-laden surface water runoff.

The TSF will be located downstream of Coppin Gap and away from the Coppin Creek floodplain, therefore not influence water quality in Coppin Creek. Water quality of Coppin Creek will be maintained predominantly by the appropriate placement and management of waste landforms proposed to be placed in the catchment (**Section 8.12.1**), in particular:

- All waste landforms will be constructed above predicted 100 year flood levels.
- Soils will be stockpiled to minimise erosion potential.
- PAF material will be appropriately encapsulated.
- Appropriate controls to mitigate seepage and sedimentation transport from waste landforms will be implemented; and

- Seepage from waste landforms will be captured, with water re-used for dust suppression or processing where practical.

Potential impacts to groundwater as a consequence of pit de-watering

Management and monitoring of groundwater is discussed in **Section 8.3.1**. If a comprehensive monitoring program indicates that water levels at Coppin Gap are being affected by the de-watering of the pit, appropriate strategies to minimise the impacts of drawdown will be implemented such as:

- Artificially maintaining water levels at the gap by addition of appropriate, high quality water.
- Artificially recharging the aquifer.
- Grouting of aquifer between Coppin Gap and the pit to manage drawdown.

Monitoring

Interim monitoring methodologies for the Coppin Creek riparian and aquatic systems, have been defined (OES, 2006c), and indicators and standards for tubidity, sedimentation, and water quality have been identified (OES, 2006c). A comprehensive aquatic ecology monitoring program will be developed and include appropriate standards and strategies to differentiate between impacts attributable to the proposal and those associated with natural variations.

8.7.2.4 Management Plans

A Coppin Gap Management Plan will be included as a stand alone plan and include management prescriptions relating to the aquatic ecology aspects of Coppin Creek. A comprehensive ecological monitoring program will be included in the Coppin Gap Management Plan, as well as management, implementation and contingency strategies.

8.7.2.5 Predicted Outcome

Based on the management approach and strategies identified above, and the fact that no rare or locally endemic species have been identified, the Spinifex Ridge Project is considered to meet the EPA objective for wetlands and rivers by maintaining the integrity, ecological function and environmental values of Coppin Creek.

In particular, the integrity of the riparian zone immediately upstream of Coppin Gap, downstream of the creek diversion channel, will be maintained through appropriate engineering and design strategies.

8.8 Subterranean Fauna

8.8.1 Management Objectives, Standards and Guidelines

The EPA’s objectives for the management of subterranean fauna are to:

- ensure adequate protection of important habitats for these species;
- maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge;

- protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*; and
- protect fauna listed on the relevant schedules of the EPBC Act.

Applicable guidelines include:

EPA Guidance Statement 54: *Consideration of subterranean fauna in groundwater and caves during environmental impact assessment in Western Australia*. (EPA, 2003).

The management of subterranean fauna over the project area and borefields will comply with the EPA's objectives and will be addressed in a Subterranean Fauna Management Plan. Moly Mines will implement a number of specific management measures to ensure that impacts are minimised.

8.8.2 Project Area

8.8.2.1 Potential Impacts

Stygofauna have been identified within the project area during four surveys (**Section 4.10**). Potential impacts should be considered in the context of limitations, specifically, the increasing knowledge of stygofauna and their distributions in the Pilbara and the significant difficulties in sampling and analysing samples from the extensive areas of suitable habitat throughout the Pilbara. The potential impacts of the proposal to the project area include:

- Loss of habitat through mining.
- Loss of habitat and changes to groundwater levels.
- Groundwater contamination.
- Potential incursion of saline water.

Details of these potential impacts are provided below.

Loss of habitat through mining

Stygofauna communities occur over the project area in the vicinity of the ore body. The creation of the open pit as well as mine dewatering has potential to impact on these communities. The significance of the impact depends on the magnitude of the dewatering process and whether any species are restricted to the area of impact (Humphreys, 2002).

Loss of habitat is inevitable during the construction of the proposed open pit, however only a small proportion of the calcrete aquifer will be removed. The aquifer types to be partially removed during mining are all locally represented (Aquaterra, pers. comm.).

Loss of habitat and changes to groundwater levels

Dewatering activities are considered to be one of the key impacts of most Pilbara mining proposals, and vary according to the project and life of mine. In particular, stygofauna may not persist in habitats that are dried for extended periods, which has implications for the local distribution. Pit dewatering will be undertaken within the project area, which will affect local groundwater levels (**Section 8.3**).

Groundwater contamination

Chemical spills, toxic leachates from mine waste, nutrients in sewerage, and other products of human activities can lead to declines in groundwater quality. High organic loads may lead to the anoxic conditions in groundwater, which will adversely affect subterranean communities, even though some of these animals are tolerant of low oxygen levels (Danielopol *et al*., 2003).

Mining at Spinifex Ridge has the potential to expose and mobilise metals, acid-forming materials and other contaminants that may affect groundwater quality. Compromised or altered groundwater quality has the potential to impact local stygofauna habitat, to the detriment of stygofauna. Potential sources of groundwater contamination over the project area include:

- Leachate seepage from the TSF.
- Leachate seepage from waste landforms.
- Hydrocarbon spills.

Potential incursion of saline water

At Spinifex Ridge, the mining pit will be a groundwater sink. Groundwater within the pit will most likely become increasingly saline over time until salt saturation is reached. However, water is expected to remain within the pit as the surrounding rock mass is very tight and the groundwater gradient will prevent migration (Aquaterra, pers comm.).

8.8.2.2 Management of Impacts

A Coppin Gap Management Plan will be developed to include management, monitoring and mitigation strategies, related to all potential impacts listed, in accordance with EPA Guidance Statement No. 54.

Appropriate management of the potential impacts to stygofauna requires an understanding of the abundance, diversity and geographic distribution of subterranean fauna. The data available indicates that all taxa recorded to date from within the part of the project area that may be affected by groundwater drawdown and/or habitat impacts occur elsewhere in the locality and region, including one species of limited known regional distribution which requires further assessment. The long term survival of these species is therefore not likely to be at risk from loss of habitat or groundwater drawdown associated with the project. Additional measures to avoid or manage impacts may be implemented if the August survey of the project area identifies any new species.

Moly Mines will, however, implement environmental management procedures at the project area, which will serve to minimise the impacts on groundwater, and therefore habitat for subterranean fauna. These measures are described below.

Changes to groundwater levels

The groundwater drawdown effects of the proposed open pit within the project area are expected to be minor and localised. Dewatering requirements are expected to be low due to low groundwater flow rates (<20 L/s). A steep cone of depression will ensure that the effects of drawdown are localised (**Section 8.3**). Management measures to be implemented include:

- Monitoring of drawdown and flow rates during the life of the project, to allow corrective measures to be implemented, if required.
- Management of drawdown around Copping Gap pool, if it occurs, with addition of equivalent quality water to maintain a minimum level.
- Reuse of water pumped from the pit in the mine water circuit

Groundwater contamination

Strategies to minimise leachate seepage from the TSF and waste landforms, and spills, are described in **Sections 8.12.1, 8.12.2** and **8.12.4**. In summary, the key management measures to be implemented include:

- Develop and implement a Groundwater Management Plan.
- Maintaining groundwater quality through appropriate management of spills, sewage, drawdown and leachates.
- Appropriate positioning and management of the TSF and waste landforms, including appropriate water recovery strategies.
- Ongoing assessment of mine waste components to identify potentially problematic materials.
- The correct storage, handling and management of hydrocarbons and other potential contaminants with contingency plans in place for spill clean-ups.

8.8.3 Water Supply Borefields

8.8.3.1 Potential Impacts

Stygofauna are known to occur in the vicinity of the proposed borefields. Potential impacts should be considered in the context of limitations, specifically, the increasing knowledge of stygofauna and their distributions in the Pilbara and the significant difficulties in sampling and analysing samples from the extensive areas of suitable habitat throughout the Pilbara. The potential impacts to subterranean fauna from the operation of these proposed borefields include:

- loss of habitat through changes to groundwater levels (**Section 8.3.2**); and
- potential incursion of saline water. The De Grey water quality will increase in salinity over time, but this is expected to be within the salinity variation that is currently observed. Groundwater quality at Woodie Woodie is described as brackish, with a total dissolved solids (TDS) concentration typically within the range of 750 – 3,490 mg/L (OES, 2007c). Woodie Woodie is actively recharged by the Oakover River and in that regard, saline incursion is not considered to be an issue, if this water source were to be used.

8.8.3.2 Management of Impacts

The data indicates that the majority of taxa recorded to date from within the Woodie Woodie and De Grey borefields, which may be affected by groundwater drawdown, occur elsewhere. Exceptions are two endemic taxa of potential significance at Woodie Woodie, and one potentially-new species at De

Grey. At Woodie Woodie, the significant species were collected near the edge of the >5m drawdown contour, in an area that has been previously mined and dewatered. At De Grey, the potentially-new species has been identified from a pastoral bore (‘control bore’) in poor condition. Further hydrological work is required to determine the influence of dewatering on this bore, but preliminary assessment shows that this area is unlikely to be impacted by dewatering. Further surveys and genetic analysis are required for the borefields to provide conclusive information about species’ identity and distributions.

Moly Mines will implement environmental management procedures over the borefields which will serve to eliminate or minimise the impacts on groundwater. These are described below.

De Grey Borefield

Loss of habitat through changes to groundwater levels

The borefield design will incorporate bores sited to manage drawdown across the borefield, to limit impacts to the upper aquifer and associated pools in the De Grey River. Specifically, Moly Mines will implement a program of seasonal management of the borefield, regulating abstraction from near-river bores in periods of recharge. There will be no significant drawdown of the local aquifers. Because the De Grey borefield will ultimately be one of two water supplies servicing the project a great deal of flexibility is available in terms of timing and quantity of supply (**Section 8.3.3**).

- Monitoring of water quality, drawdown and flow rates within a comprehensive borefield monitoring program, during the life of the project, to allow corrective measures to be implemented if required.
- Use of multiple borefields to supply the project, reducing the demand on individual borefields.

Woodie Woodie

Loss of habitat through changes to groundwater levels

Groundwater modelling shows that the aquifer system is highly permeable and is laterally extensive, and that it is possible to pump an additional 600L/s of additional groundwater from a single source location, such as the proposed Cracker Pit, for a ten year period with no significant change to the system. The extent of the 5m drawdown contour may increase by 600m laterally, but would be constrained to areas of high permeability (GRM, 2006). Only minor drawdown of the aquifer will occur leaving a large saturated zone remaining. In that regard, there will be no significant loss of stygofauna habitat. Because the Woodie Woodie borefield will ultimately be one of two water supplies servicing the project a great deal of flexibility is available in terms of timing and quantity of supply. Measures that will be undertaken to minimise the risk of impact include:

- monitoring of water quality, drawdown and flow rates within a comprehensive borefield monitoring program, during the life of the project, to allow corrective measures to be implemented if required; and
- use of multiple borefields to supply the project, reducing the demand on individual borefields.

8.8.4 Sampling and Monitoring

In order to meet current standards for stygofauna monitoring, further sampling and assessment of stygofauna is required. These surveys will be undertaken using the following approach:

- consult with DEC about additional sampling requirements and responses to potential impacts as required during the commissioning phase of mining;
- identify stygofauna taxa in the proposed project and borefield area to the lowest possible taxonomic level according to current knowledge;
- assess the conservation significance of any new taxa found;
- map the local distribution of taxa sampled; and
- submit samples of interest to the WA Museum as required.

8.8.5 Predicted Outcome

Based on the management approach and strategies identified, the project is considered to meet the EPA objective for the adequate protection and survival of subterranean communities and their habitat.

8.9 Air Quality

With the exception of greenhouse gas emissions (**Section 8.10**), atmospheric dust will be the dominant component of air emissions from the project, and has the greatest potential to result in adverse impact if not managed appropriately.

Other air quality emissions include exhaust fumes from mobile equipment, blasting fumes and evaporative emissions from processing facilities. Greenhouse gas emissions are discussed separately in **Section 8.10**. The project's emissions will be estimated continually and recorded in the site's NPI database. The NPI will be submitted to the DEC at each reporting period. However, the potential impacts associated with these emissions are considered negligible and are therefore not considered further.

The potential impacts associated with dust generation and proposed management strategies are discussed below.

8.9.1 Management Objective, Applicable Standards and Guidelines

The EPA's objective for the management of air quality is:

- To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

As discussed in **Section 4.11.1** the project area is recognised as being in an arid environment where background levels of dust frequently exceed the NEPM standard of 50 $\mu g/m^3$ adopted by the EPA in preference to the setting of a regional standard.

Applicable guidelines and standards include:

- EPA Guidance Statement No 18, *Prevention of Air Quality Impacts from Land Development Sites* (EPA, 2000a).

- National Environment Protection (Ambient Air Quality) Measure (NEPC, 2003).

8.9.2 Potential Impacts

Potential impacts of the proposal on air quality relate to:

- elevated particulate and/or metal concentrations in the atmosphere affecting public health and surrounding flora and fauna; and
- reduced visual amenity.

Potential fugitive and point-sources of dust generation have been identified as:

- areas disturbed by construction activities (clearing of native vegetation and disturbance of topsoil and subsoil);
- areas disturbed by mining activities, including waste emplacement areas and other portions of the mine site exposed to wind;
- waste rock handling and stockpiling activities (including loading and unloading, dumping and shaping of waste);
- movement of vehicles on unsealed roads;
- drilling and blasting;
- crushing, screening, transporting and preparation of ore;
- dust liftoff from the TSF; and
- molybdenum and copper concentrate stockpiles.

Potential dust emission sources from service routes include:

- construction and trenching of water supply pipelines; and
- maintenance activities servicing the borefields and pipelines.

The nearest sensitive receptor is Yarrie Homestead, located 25 km from the project site and is not expected to be impacted by dust from the project.

Dust generation does have the potential to negatively affect surrounding vegetation, but this is likely to be a minor impact providing that standard dust suppression measures are implemented. The Pilbara is also recognised as a naturally dusty habitat, and therefore fauna and flora would be well adapted to periods of intense wind-blown dust through natural events.

Dust generation also has the potential to impact tourist visitation of Coppin Gap. Wind in the region, discounting cyclonic activity, is predominately north/north-westerly through the summer months and south/south easterly through the cooler months from April to September. The Talga Range, being the dominant topographical feature in the area is likely to have a reducing effect on dust generation at the project site by attenuating wind patterns at ground level.

8.9.3 Management of Impacts

Notwithstanding the predicted low impact of dust-generating activities, a range of control measures will be implemented by Moly Mines. These controls will be based on current best practice techniques employed generally in open pit mines in Western Australia. The main components of the controls can be summarised as follows:

Dust control measures during the construction phase will include:

- minimising the footprint and clearing of temporary lay-down areas;
- scheduling soil stripping to minimise areas of exposed ground;
- watering access roads and exposed ground;
- road surfacing; and
- restricting the speed of vehicles travelling on unsealed surfaces.

Dust control practices to be implemented during the operational phase of the project will include:

- regular watering of haul roads and other unsealed internal roads;
- minimising the area of soil stripping ahead of operations to minimise areas of exposed ground;
- prevention of truck overloading and resulting spillage during loading and hauling;
- regular maintenance of all haul roads;
- progressive rehabilitation of mine landforms;
- timely rehabilitation of redundant access tracks;
- limiting the freefall height during ore and waste stockpiling and dumping operations;
- fitting of water sprays to the primary crusher, conveyor and stockpile feed points;
- storage and loading of concentrate within an enclosed facility;
- trucking using covered trailers (for copper concentrate) and shipping containers (for molybdenum); and
- appropriate covering of conveyors.

Water to be used for dust suppression will be sourced preferentially from: pit dewatering; harvested water from rainfall events; and from the process water supply source.

8.9.4 Predicted Outcome

Based on the management approach and strategies identified above, the project is considered to meet the EPA objective for air quality, and will not adversely affect environmental values or human health, welfare or amenity.

8.10 Greenhouse Gases

8.10.1 Management Objectives, Standards and Guidelines

The management objectives for greenhouse gas (GHG) emissions are to minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.

Applicable guidelines and standards include:

- EPA Guidance Statement No. 12 *Minimising Greenhouse Gas Emissions* (EPA, 2002).

8.10.2 Potential Impacts

The greenhouse effect is a natural phenomenon that warms the earth and enables it to support life. However, since the industrial revolution, the amount of greenhouse gases in the atmosphere has increased dramatically, resulting in increased global warming.

In 1998, the Australian Government committed to limit GHG emissions in the period of 2008 to 2012 to 108% from 1990 emissions by signing the Kyoto Protocol. The Government has not yet ratified the Protocol.

The six GHG's specifically covered by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF6) and nitrous oxide (N_2O) (Commonwealth of Australian, 1998). To compare warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents (CO_2-e), where the potential of each to lead to heating in the atmosphere is expressed as a multiple of the heating potential of CO_2.

GHG emissions from the Spinifex Ridge Project are expected to arise from the following sources and activities:

- combustion of diesel fuel from the operation of heavy and light vehicles and other machinery;
- generation of electricity from an on-site gas-fired power station;
- decomposition of sewage produced onsite;
- decomposition of solid waste produced onsite;
- detonation of explosives utilised for blasting; and
- clearing of vegetation and decomposition of the biomass.

GHG emissions have been estimated in accordance with Australian Greenhouse Office (AGO) methodologies for Greenhouse Challenge Plus members, taking into account full fuel cycle emissions. Activities on site result in estimated annual operational GHG emissions of approximately 631,614 t CO_2-e. Given the operation will process 20 Mtpa of ore and produce a total of 71,000 tpa (23,000 tpa of molybdenum and 48,000 tpa of copper) of concentrate the GHG efficiency of the operation will be approximately 31.6 kg CO_2-e/t of ore processed, or approximately 8.9 t CO_2-e/t concentrate produced. Over 99% of these emissions are generated from the combustion of fuel and the generation of electricity for the project. **Table 8-14** summarises the estimated greenhouse gas emissions for the operation of the Spinifex Ridge Project.

- **Table 8-14 Estimated Greenhouse Gas Emissions**

Emission Source	Annual Emission during Operations (t CO_2-e)
Land Clearing	0
Fuel Use	238,377
Energy Use	388,522
Wastewater	93
Solid Waste	3,553
Explosives	1,069
Processing	No greenhouse gas emissions are generated from ore processing. Emissions from the process plant are directly related to fuel and energy use.
TOTAL	**631,614**
Greenhouse Efficiency	**31.6 kg CO_2-e per tonne of ore processed**
	8.9 t CO_2-e per tonne of concentrate produced

Note: The total GHG emissions for fuel use and energy generation reflect the full fuel cycle emissions (i.e. direct emissions from the project and indirect emissions from fuel production off-site).

Land clearing will not contribute GHG emissions, according to the AGO emissions estimation methodology, although approximately 1,630 ha of clearing is required for the project. The vegetation type at Spinifex Ridge varies from grassland, to open woodlands and open rocky hill slopes. Under the AGO 2006 workbook guidelines, clearing of this type of vegetation does not constitute land use change as defined below.

"Land use change, or deforestation, refers to the deliberate, human-induced removal of forest cover (trees with a potential height of at least two metres and crown cover of at least 20 per cent in patches greater than 0.2 hectare in area) and replacement with a non-forest land use." (AGO, 2006)

As such, there are no greenhouse gas emissions arising from the removal of vegetation at Spinifex Ridge under the AGO method of emissions estimation. Rehabilitation offsets generated from progressive rehabilitation of disturbed areas will minimise the greenhouse impacts associated with clearing.

8.10.3 Management of Impacts

Moly Mines is committed to undertaking management practices to ensure that GHG emissions are minimised as far as practicable, and will join Greenhouse Challenge Plus program, developed by the Australian Greenhouse Office. The Greenhouse Challenge Plus is a cooperative partnership between industry and the Australian Government, with the following objectives:

- reduce greenhouse gas emissions (including promotion of awareness of greenhouse gas abatement opportunities in industry);
- accelerate the uptake of energy efficiency;
- integrate greenhouse issues into business decision-making; and
- provide more consistent reporting of greenhouse gas emissions levels.

Opportunities to minimise GHG emissions will exist during each core phase of project development, namely design, construction and operation, to reduce emissions as low as reasonably practicable.

Moly Mines will register with and participate in the Australian Government's Energy Efficiency Opportunities Program. This program works to identify cost effective energy savings opportunities for businesses. To meet the requirements of this initiative, Moly Mines will:

- register with the DoITR;
- prepare and submit an assessment and reporting schedule;
- conduct assessments; and
- report on assessment outcomes and business response.

Design Phase

During the design phase, GHG emissions can be effectively reduced by maximising energy efficiency and selecting technologies that utilise clean fuel alternatives. The majority of emissions from the project are generated from the use of diesel and energy consumption.

Large quantities of diesel are utilised mainly to operate the fleet of heavy and light vehicles. Vehicle emissions are discussed below. Haulage distances and grade directly affect the amount of diesel consumed by vehicles, and therefore the amount of greenhouse gases emitted. The following key items have been adopted in the design to minimise haulage distances as far as practicable:

- development of a transport tunnel through the Talga Range. This provides for the shortest travelling distance for the transfer of ore from the mine to the processing plant and also allows for a conveying system to be adopted rather than conventional haulage by heavy vehicles. The alternative option considered during design was the haulage of ore around Talga Range via Kitty's Gap or along a designated haul road further to the west; and
- waste rock landform placement that occurs within close proximity to the open pit with due consideration also given to several other environmental and social constraints. This ensures that heavy haulage traffic is maintained to the south side of the Talga Range only, thereby reducing travel distances.

A number of power supply options were considered during the design process. Notably, these options included various fuel types which included natural gas and diesel. The preferred option is to generate power onsite using a natural gas fired reciprocating engine power station as the use of natural gas is considerably more efficient than diesel in terms of greenhouse gas emissions, with the emission factor for diesel 69.4 kg CO_2-e / GJ compared to the emission factor for natural gas of 52.7 kg CO_2-e / GJ (AGO, 2006).

Both reciprocating engines and gas turbine engines were considered. After reviewing the lifecycle costs along with fuel consumption and emissions, preference was given to the reciprocating engines. Gas turbine engines were estimated to produce significantly more CO_2 when compared to reciprocating engines. The selection of reciprocating engines results in an annual saving of approximately 140 000 t/yr of CO_2.

Construction Phase

During construction and subsequent operation of the project, the land area and total amount of biomass cleared will be minimised as far as practicable. Cleared vegetation will be stockpiled where practicable, and used in rehabilitation to provide mulch and a seed source to assist revegetation. Temporary laydown areas will be progressively rehabilitated.

The construction phase will involve a considerable amount of vehicle movement. Where possible, such vehicle movements will be minimised by avoiding duplication of activities, for example double-handling of material. Vehicles will also be regularly serviced and maintained such that they operate efficiently.

Operation Phase

Prior to operations commencing, suitable management measures to reduce greenhouse emissions from the project will be identified. Such management measures may include:

- use of technology with the lowest emissions where possible;

- greenhouse gas emission estimation for key sources;
- periodic energy audits;
- membership and active participation in the Greenhouse Challenge Plus programme;
- evaluation and implementation of greenhouse gas offset measures; and
- contribution to research and development in greenhouse gas abatement and technological advancement in carbon sequestration.

Waste landforms and the outer embankment of the TSF will be progressively rehabilitated providing some limited carbon sequestration.

8.10.4 Predicted Outcome

Based on the selection of the best available technology for power generation on site, the predicted outcome is consistent with the EPA objective to minimise emissions to levels as low as practicable.

8.11 Noise, Blasting and Vibration

8.11.1 Management Objectives, Standards and Guidelines

The EPA's objective for the management of noise is:

- To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

Applicable standards and guidelines include:

- *Environmental Protection (Noise) Regulations 1997*;
- EPA Draft Guidance Statement No 8: *Environmental Noise* (EPA, 2007); and
- Preliminary Draft Guidance for EIA No. 14, *Road and Rail Transportation Noise* (EPA, 2000).

Baseline noise surveys (**Section 0)** indicate that background noise levels can exceed the overnight, evening and daytime regulatory Assigned Noise Levels *(Environmental Protection (Noise) Regulations 1997)* exclusive of any mining-related activities (Herring Storer, 2006).

8.11.2 Potential Impacts

The proposal has the potential to alter the existing noise emissions over the project area and along infrastructure corridors. The major sources of noise emissions from the proposal include:

- Project Area
  - construction activities;
  - mobile plant and equipment;
  - fixed plant;
  - blasting operations
  - power station; and
  - aircraft.

- Infrastructure corridors
  - construction (water pipelines); and
  - transport of materials (road transport to Port Hedland).

The nearest noise sensitive premises to the project area is Yarrie Homestead, 25 km to the north, and the nearest town is Marble Bar approximately 50 km south-west. Proposed infrastructure corridors are aligned with existing roads and tracks.

The potential noise related impacts over the project area include:

- reduced amenity to nearby residents;
- reduced amenity to visitors at Coppin Gap; and
- disturbance to nearby bat roosts and other fauna utilising Coppin Gap.

Potential noise related impacts over infrastructure corridors include:

- temporary reduced amenity to nearby residents during construction of infrastructure; and
- reduced amenity to nearby residents due to increases in traffic.

The project area is located in an isolated area and impacts to noise sensitive premises from the construction and operation of the minesite and infrastructure corridors will be minimal due to the separation distance.

Impacts from noise will primarily be associated with the minesite affecting visitation of Coppin Gap, and blasting and vibration potentially affecting nearby bat roosts and other fauna utilising Coppin Gap and adjacent habitats.

8.11.3 Management of Impacts

Activities contributing to noise emissions would consist of the use of mobile equipment predominantly associated with open pit mining, the dumping of rock and overburden on waste landforms and the crushing and screening of ore for feed into the grinding and milling circuits of the processing plant. The main source of impact noise will be from blasting activities in the pit. Hard rock on the surface will necessitate blasting commencing at an early stage of pit development.

Noise from the mining operation will reduce as the pit increases in depth. It is estimated that within 6 months of the commencement of operations, the pre-strip will have been completed and truck loading operations will be taking place below surface level. Based on the current mining schedule, the rate of descent into the pit is estimated to be approximately 80 m per year.

Specific strategies to mitigate the impacts of noise will be employed by Moly Mines. These strategies will be based on EPA draft guidance statements (EPA, 2007; 2003) as well as current best practice techniques employed generally in open pit mines in Western Australia.

Best management practices that will be applied to reduce project noise emissions are listed below.

- Evaluation of noise emissions on selection of equipment.
- Consideration of noise generation through project design.
- Engineering controls on equipment incorporated to reduce noise emissions.
- Ongoing maintenance of equipment.
- Scheduling blast times and the use of noisy equipment to daylight hours to reduce impacts on bat roosts.
- Educating staff on the effects of noise and the use of quiet work practices.

Specific operational strategies that will be applied to reduce project noise emissions will include:

- Minimising movement of trucks on ridgelines and exposed haul routes where their noise can propagate over a wide area, especially at night;
- Siting of truck park-up bay at a suitable distance from the accommodation village;
- Siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area, or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise;
- Where there are several noisy pieces of equipment, scheduling operations so they are used separately rather than concurrently;
- Employing ‘quiet’ practices when operating equipment, such as the positioning of idling trucks in appropriate areas;
- Adjusting reversing alarms on heavy equipment to make them ‘smarter’, limiting acoustic range to the immediate danger area;
- Using equipment with efficient mufflers and using quieter engines (such as electric instead of internal combustion);
- Fitting efficient enclosures and housings around noisy machinery; and
- Using high-pressure hydraulic systems to split rock instead of hydraulic or pneumatic hammers.

Equipment, machinery and locations on site that have the potential to exceed Occupational Health and Safety noise levels will be appropriately signed and demarcated as necessary. Noise awareness will be ongoing for all employees throughout the project and will commence at pre-start inductions. Appropriate hearing protection devices will be supplied to all employees and the site Personal Protective Equipment Policy will require the wearing of hearing protection in “mandatory” zones.

8.11.4 Predicted Outcome

Based on the management approach and strategies identified above, the project is considered to meet the EPA objective for noise. No unacceptable noise will be generated during the construction and operation of the project and environmental values and human health, welfare and/or amenity will not be adversely affected.

8.12 Waste Management

Waste management covers both process waste materials (waste rock **Section 8.12.1** and tailings **Section 8.12.2**) and general waste (**Section 8.12.3**)

8.12.1 Waste Rock Landforms

8.12.1.1 Management Objectives, Standards and Guidelines

Waste rock from the mine will be placed in three waste landforms. These landforms will be located to the west (Landform 1), south-west (Landform 2) and south-east (Landform 3) of the mine pit (**Figure 8-8**). At their final extent the landforms will occupy a footprint of 400 ha, will have concave outer slopes, and will be a maximum of 240 m RL, representing a maximum height of approximately 60 m relative to local surface levels, and well below the height of the Talga Ridge.

The waste rock to be generated during mining has been classified according to its expected geochemical properties, particularly its potential for acid formation. These properties are considered to be the principal determinant of its potential for impact. The key features that have been used in developing management strategies for the waste rock are the levels of contained molybdenum, copper and total sulphur. The potential impacts of this material and the related management strategies are discussed below.

The objective for managing waste rock is to store the waste in landforms that have as little impact on the surrounding environment as can be achieved practicably, in terms of the successful operations of the mine. This will be achieved by optimising landform design and cost, at the same time as incorporating placement strategies to minimise risks from any potentially-hostile material.

Applicable guidelines and standards include:

- Leading Practice Sustainable Development Program for the Mining Industry, Department of Industry, Tourism and Resources, (Commonwealth of Australia, 2007):
  - '*Managing Acid and Metalliferous Drainage*',
  - '*Mine Rehabilitation*'
- Guidelines for Mining Proposals in Western Australia. Department of Industry and Resources, February 2006.

8.12.1.2 Potential Impacts

The potential impacts from the waste landforms and the contained waste rock are as follows:

- loss of vegetation over the planned area of placement;
- release of leachate that may be acidic and contain elevated levels of salts and metals, due to *in situ* acid formation from contained sulfidic waste rock;
- off-site movement of sediment and subsequent contamination of surface water;
- groundwater contamination;
- risk to fauna health and safety;

- risk to public health and safety; and
- disruption to visual amenity.

8.12.1.3 Management of Impacts

The location and design of the landforms has been developed to minimise potential impacts according to the principles and constraints detailed below. Strategies are presented according to each related potential impact.

Loss of vegetation

- The quantity of mine waste and thus the landform footprints will be minimised through detailed mine planning.
- The area of vegetation to be cleared to accommodate the waste landforms will be minimised through the use of optimisation planning software.
- Vegetation will be established where possible on the upper landform surfaces and batters of the landform, by salvaging the skeletal local topsoil and subsoils.

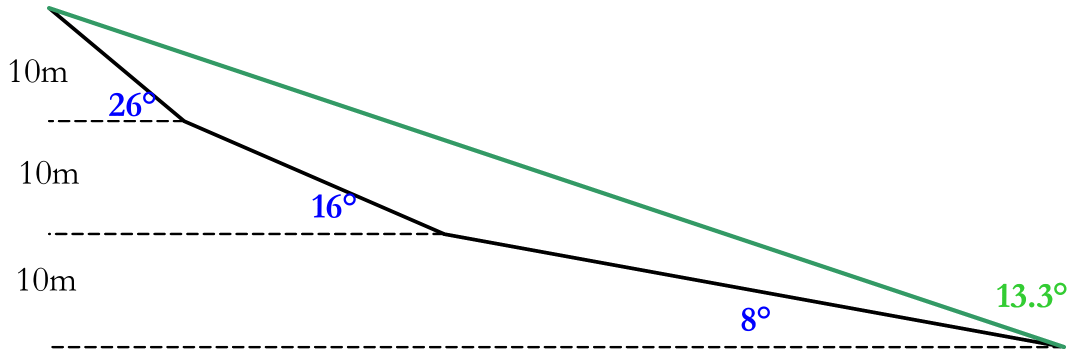
Risk to fauna

- The impact on the locally-important rocky slope habitat in the upper slopes of the Talga Range will be minimised by having waste rock set back from the south-facing rock escarpment on the Talga range.
- Rocky island habitats of competent waste rock will be created across the final upper surfaces.

Off-site movement of sediment

- Potential off-site impact from the waste will be minimised by applying the primary constraints that all waste will be placed within the Coppin Creek catchment area, and will not be placed closer to Coppin Creek than the estimated level of a 100 year flood (Aquaterra, 2006).
- Potential erosion of outer faces and consequent off-site transport of sediment, will be minimised by constructing outer slopes of the waste landforms with a concave profile, made up of a mixture of topsoil and rocky benign waste. The outer faces will have an average slope of 13.3^o, made up of slope segments at 8^o, 16^o and 26^o, with each segment representing 10m in vertical height (**Figure 8-6**). A wide bench (20m) will be constructed below the upper 30m lift to allow any upper surface run-off to be controlled.

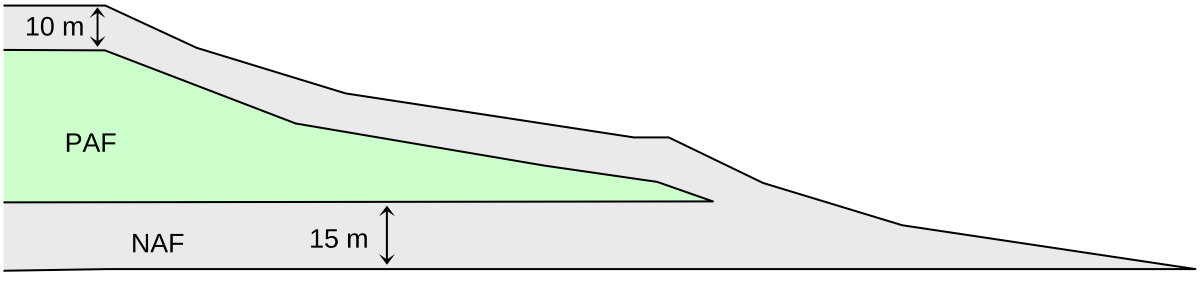
Any surface flow and contained sediment from Landforms 1 and 2 will be directed to the cut-off section of Coppin Creek, providing separation from the Coppin Creek catchment as modified by the diversion channel. Run-off from Landform 3, which will not contain PAF material, will be directed through sediment-trapping ponds before eventual release into the diverted Coppin Creek.



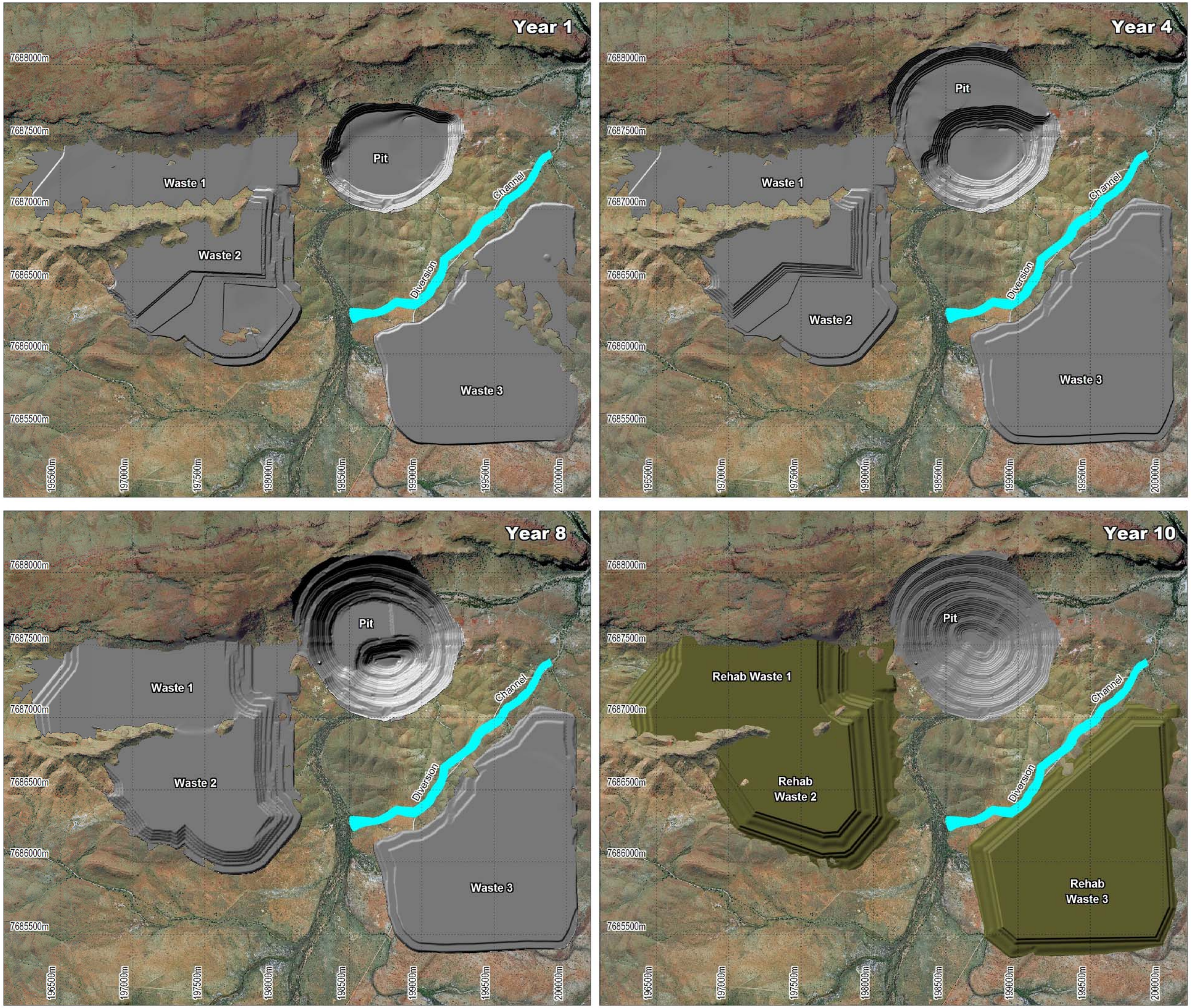
- **Figure 8-6 Cross-section of Waste Landform Outer Batters**

Release of leachate and potential groundwater or surface water contamination

- During operations, waste will be classified as PAF or NAF, based on total sulphur content. Waste with greater than 0.32% total sulphur will be classified as PAF.
- NAF waste rock will be placed as a base in the landforms, including to a depth of at least 15 m in natural drainage lines, to minimise potential impacts on the quality of through-flow seepage under the landforms.
- PAF waste rock will be placed only in Landforms 1 and 2, where a base of NAF waste has been pre-deposited.
- PAF waste in Landforms 1 and 2 will be encapsulated, laterally and above, (>10m) with NAF waste, which will be compacted above the PAF waste (**Figure 8-7**). The upper layers of this encapsulation material will act as part of a store-and-release cover system.
- Topsoil and growth medium, as available, will be placed on flat upper surfaces of the landform, and vegetation established where possible to create a store-and-release cover system, that minimises the potential for through-drainage into underlying PAF waste.
- Detailed characterisation of the physical properties of the upper layer of NAF wastes and topsoils, together with modelling of likely infiltration, will be completed prior to construction of the store-and-release cover layer. The thickness of the layer and or the particular NAF waste materials to be used will be adjusted if necessary to ensure that the objective of minimal through-drainage is achieved (Landform Solutions, 2007).



- **Figure 8-7 PAF Encapsulation Schematic**



MOLY MINES LIMITED

Spinifex Ridge Project
Western Australia

Figure 8-8

Years 1, 4, 8, 10
Pit & Waste Dump Designs

0 1.4km

Map Projection: MGA 51 (GDA94)

Compiled: 10 / 7 / 2007	Compiled by: MOL
Updated : 10 / 07 / 2007	Checked by : MOL
Plan No :	Revision No : A

File: j:\3100 spinifex ridge mo\14 gis\user working data\per\per_figure_8.6 - A3.wor

Location Diagram :

Visual amenity

- Waste landforms will not exceed 240 mRL in elevation, which will be below the height of the Talga Range, and will be geotechnically stable.
- The visual amenity of the waste landforms will be enhanced by constructing concave slopes that will be consistent with the surrounding landscapes, by covering outer slopes with topsoil as available and establishing vegetation of local species where possible.

8.12.1.4 Predicted Outcome

Proposed classification and placement strategies for waste rock throughout the operations of the mine, supported by on-going characterisation and modelling, optimised landform design, and control of potential surface flow, will ensure that potential impacts are minimised.

8.12.2 Tailings and Process Waste

8.12.2.1 Management Objectives, Standards and Guidelines

The management objective is to ensure that tailings and process wastes do not adversely affect the groundwater or surface water quality or lead to soil contamination.

8.12.2.2 Potential Impacts

Tailings from the processing plant will be stored in a large circular TSF approximately 2,900m in diameter (~660ha footprint) and with embankment walls a maximum of 25m in height. If not appropriately engineered, the TSF has the potential to be unstable and to erode, presenting risks of groundwater, surface water and soil contamination, and health and safety issues.

Seepage from the TSF has the potential to raise the level of the groundwater and alter the groundwater quality within the area. An estimate of seepage losses from the TSF has been made based on the output from the water balance model for the TSF. Assuming a permeability of 10^{-7} m/s, this seepage loss is estimated at 1.2% of the water delivered to the TSF (DE Cooper & Associates, 2007). This is a relatively conservative estimation, and some of the seepage will be recovered through the underground drainage system or via the monitoring and production bores, as detailed in **Section 8.12.2.3** below.

Conservative (worst case scenario) modelling indicates that any contaminant plume originating from the TSF will not exceed the guidelines for molybdenum in drinking water (NHMRC, 2004) of 0.05 mg/l to a distance of approximately 2.5km over 20 years (Aquaterra, 2007).

Impacts on groundwater are further discussed in **Section 8.3**.

8.12.2.3 Management of Impacts

The construction of the TSF at Spinifex Ridge Project will comply with all relevant Australian Standards. The TSF will be constructed to minimise seepage and potential groundwater quality impacts. A collection sump will be established at the upstream toe of the embankment, where the embankment crosses a stream bed. This will control any seepage before it enters fractured basement rock likely to occur in the creek bed. A sediment trench will be constructed downstream of the peripheral embankment, which serves to collect any tailings in the event of an accidental discharge.

A comprehensive network of groundwater monitoring and production bores will be established to monitor groundwater levels and quality on a regular basis which will be outlined in the Groundwater Management Plan.

During operation, important aspects of tailings management will include:

- the tailings storage will be operated using the principles of sub-aerial deposition;
- regular rotation of the deposition point around the full length of the peripheral embankment;
- ensuring that there is never water ponding adjacent to the peripheral embankment; and
- regular removal of all available water from the surface of the TSF through the decant system.

Regular inspections and operational checks of the TSF including the pipeline infrastructure between the plant and the facility will be conducted. TSF management options will be considered in the ongoing Mine Closure Management Plan (**Appendix F**) for the site.

8.12.2.4 Predicted Outcome

Due to the benign nature of tailings and the water associated with tailings, and the application of the management practices outlined to ensure that minimal seepage will occur, it is anticipated that the tailings and process wastes will not adversely affect the groundwater or surface water quality or lead to soil contamination.

8.12.3 General Waste

8.12.3.1 Management Objectives, Guidelines and Standards

The management objective for waste management is to minimise, re-use and recycle waste where possible and ensure wastes do not adversely affect groundwater or surface water quality or result in soil contamination.

Applicable guidelines and standards include:

- EPA Position Statement No. 7 *Principles of Environmental Protection* (EPA, 2004b).

8.12.3.2 Potential Impacts

General waste that will be generated during construction and operation of the mine will include:

- construction wastes;
- maintenance wastes (e.g. batteries, tyres, scrap metals);
- sewage and greywater from site amenities and on-site accommodation facilities; and
- miscellaneous wastes (e.g. putrescible wastes, old equipment).

The generation of waste during construction and operation activities has the following potential impacts:

- soil contamination;
- groundwater and surface water contamination;
- risk to public health and safety;
- risk to fauna health and safety; and
- disruption to visual amenity.

8.12.3.3 Management of Impacts

A Waste Management Plan will be developed for the construction and operation phases of the project as part of the Environmental Management Programme (refer to **Section 7.5**). This plan will incorporate the "Waste Hierarchy" of:

- Avoid the use of certain materials (if possible) if they are difficult to manage.
- Reduce the amount of waste produced.
- Replace the use of difficult to dispose of materials, with more environmentally acceptable ones.
- Segregate waste for easier management.
- Recover/ Reuse waste where feasible.
- Recycle waste by reprocessing where feasible.
- Dispose wastes in an environmentally responsible manner, where no other options are available.

Waste management on-site will comply with relevant local and state regulations and Australian Standards. Liquid and solid wastes will be treated on-site or disposed of to an appropriately licensed on-site landfill facility. Where this is not feasible, material will be managed on-site to prevent groundwater and surface water contamination or risk to human health. This may include storing waste materials in designated areas that have adequate separation distances from drainage lines, adequate surface water drainage systems and appropriate bunding.

Waste management practices and requirements will be outlined during contractor and employee inductions so that the entire workforce understands and complies with site waste management practices.

Many waste materials produced are typically a result of traditional work practices. The principle of waste avoidance is effective for waste materials that are difficult to manage or dispose. Minimising waste generation can be effectively achieved by considering alternative work practices or improving the traditional practices. Moly Mines will aim to avoid and reduce project waste where possible. This can be achieved through:

- purchase of stock in bulk to reduce packaging;
- purchase of stock in refillable containers;
- purchase of stock packaged in recyclable packaging;
- minimising the use of consumables in disposable containers; and

- include waste minimisation strategies in contracting and procurement documentation to ensure that suppliers and contracting organisations reduce waste prior to delivery on site and facilitate waste reduction strategies through their activities and supplies.

The reuse of waste materials is an effective method to minimise waste volumes, removes the need for new products to be purchased and avoids additional packaging waste. For materials that cannot be reused they will be recycled where possible. To assist in waste reuse and recycling, such wastes will be segregated within a designated area.

The following opportunities for waste reuse will be investigated:

- refilling of containers such as bulka-boxes containing oils and lubricants;
- mulching of vegetative waste; and
- potential repair and reuse of conveyor belt.

Sewage and greywater from the administration buildings and accommodation camp will be treated on-site using package sewage treatment plants, before being evaporated or used to irrigate landscaped areas around the village and administration areas.

Typical waste materials that are recyclable include:

- scrap metal;
- batteries;
- waste oil and oil filters;
- paper and cardboard;
- aluminium and steel; and
- plastic containers/bottles.

Non-hazardous, non-reusable and non-recyclable wastes will be disposed of to an on-site landfill. The landfill will be licensed by the DEC and operated in accordance with licence conditions, relevant legislation and standards.

8.12.3.4 Predicted Outcome

Proposed management plans and waste handling procedures will adopt the waste hierarchy to ensure that potential impacts are minimised. These management strategies will ensure that solid and liquid wastes will have a negligible impact on the environment.

8.13 Dangerous Goods, Hazardous Materials and Waste

8.13.1 Management Objective, Standards and Guidelines

The management objective for dangerous goods and hazardous materials is to ensure that these goods and materials are stored and handled appropriately to prevent risks to public health and to prevent groundwater, surface water or soil contamination through leaks, spills and emergency situations.

Applicable guidelines and standards include:

- EPA Position Statement No. 7 *Principles of Environmental Protection* (EPA, 2004b);
- Controlled Waste Guideline Series (DoE, 2004);
- Australian Standard AS 1940-2004. *The storage and handling of flammable and combustible liquids*; and
- Australian Standard AS 4326-1995. The storage and handling of oxidising agents.
- Australian Standard AS 1940-2004. The Storage and Handling of flammable and combustible liquids.

8.13.2 Potential Impacts

A number of dangerous goods and hazardous materials will be stored on-site including explosives, hydrocarbons, acids and alkali.

Incorrect storage, management and disposal of dangerous goods and hazardous substances and subsequent discharges to the environment have the potential to:

- contaminate surface water, groundwater, the atmosphere and soil;
- impact on flaura and fauna;
- cause acute and/or chronic toxic hazards;
- cause flammable or explosive hazards;
- be a risk to public health and safety;
- increase disposal costs and
- create poor visual amenity.

8.13.3 Management of Impacts

The transport of hazardous substances to the mine will be undertaken in accordance with the *Dangerous Goods (Transport) (Road and Rail) Regulations 1999* and the Australian Code for the Transport of Dangerous Goods by Road and Rail, inclusive for all transport contractors to attain relevant permits and licences from DOCEP. The storage and handling of other hazardous materials and wastes including, but not limited to, all general and controlled wastes will comply with all relevant local and state regulations, including the *Environmental Protection (Controlled Waste) Regulations 2004* and Australian Standards.

During construction and operation, Moly Mines will ensure dangerous goods and hazardous substances and wastes are stored according to Australian Standards, and will minimise the risk of contamination at all times. Storage of explosives will be in licensed magazines in accordance with the *Explosives and Dangerous Goods Act 1961*.

Bunding will be designed according to design principles stated in the *Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992* where:

- storage areas shall be a low permeability (of 10^{-9} m/s or less) compound;
- bunding capacity to be adequate to contain no less than 100% of the volume of the largest storage vessel or interconnected vessel;
- design of storage areas such that jetting from any storage vessel or fitting be captured within the bunded area;
- design of storage areas such that they:
  - are graded or include a sump to allow recovery of liquid;
  - are chemically resistant to the hazardous material being stored; and
  - include valves, pumps and meters associated with transfer options, wherever practicable.

Storage of bulk fuel will be in above ground tanks, either within impermeable, bunded enclosures, or in double-skinned tanks. During detailed engineering design, appropriate bunding and drainage systems will be included for areas of the operation with the potential to be contaminated with hydrocarbons or other hazardous materials. This will include refuelling areas, storage areas, vehicle washdown areas and workshops.

A Hazardous Material and Spill Management Plan, which will include management of hazardous wastes, will be implemented as part of the site Environmental Management Programme. Hydrocarbon and hazardous substance/waste management during construction and operation will be based around a framework that:

- minimises the number of bulk fuel storage areas;
- reduces the volume of hydrocarbon and hazardous waste materials;
- ensures appropriate storage and handling procedures;
- ensures appropriate clean up procedures for spills; and
- defines environmentally acceptable methods for the disposal of waste.

Depending on volumes of hydrocarbon contaminated wastes that may be generated during construction and operation, an on-site landfarm may be established to enable management of these wastes locally. Moly Mines will ensure that any landfarm will meet relevant requirements and shall consult with DEC prior to construction. If a landfarm is constructed, suitable putrescible wastes may also be treated through the facility, which may provide soils for landscaping or rehabilitation programs.

8.13.4 Predicted Outcome

Proposed management procedures for the handling of hazardous materials/wastes will avoid and minimise the potential for groundwater, surface water and soil contamination.