Mount Gibson Iron

Koolan Island Iron Ore Mine and Port Facility Project

Marine Management Plan Revision

2013

Document Status		
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1 INTRODUCTION

1.1 BACKGROUND

Mount Gibson Iron Limited owns and operates the iron ore mine on Koolan Island in the Kimberley region of Western Australia. Koolan Island is located approximately one kilometre from the mainland and 130 kilometres north of Derby at approximately 16° 8' S and 123° 45' E within Yampi Sound (Figure 1). Koolan Island has an area of 2, 580 hectares and is approximately 13 km long and up to 4 km wide, with a high ridge along the southern side, representing the top of the iron formation. The coast is steep with narrow gullies and frequent embayments, but few beaches (Ecologia 2005).

Koolan Island is one of the largest of the many islands comprising the Buccaneer Archipelago located in the Kimberley region of Western Australia. Since Koolan Island is located within the boundaries of the West Kimberley it has been included in the heritage listing of the area.

Figure 1 - Location of Koolan Island in Western Australia

1.2 PROJECT COMPONENTS

Koolan Island was mined for iron ore between 1965 and 1993 by BHP. During that period approximately 68 million tonnes of high-grade haematite (67% Fe) ore was extracted from five pits, crushed and shipped from a wharf facility and this resulted in impacts to the marine environment.

A proposal by Mount Gibson Iron Limited to recommence mining and shipping of iron ore from Koolan Island (Ecologia 2005) was assessed by the Western Australian Environmental Protection Authority (EPA 2005) and approved in 2005. Construction for the operation began in June 2006, with sea wall construction completed in 2011, and mining commencing in 2007. All construction is now complete.

The project components of the present Marine Management Plan (MMP) are those described in the Environmental Referral Document (Ecologia 2005), and include the operation of:

- A seawall to protect the mine pit
- Disposal of pit dewatering to sea
- A wharf facility for docking of barges, loading iron ore and transfer stores and fuel
- Shipping operations associated with the facility
- General mining and land disturbance activities which may increase sediment runoff to the marine environment

1.3 OBJECTIVES

The purpose of the Marine Management Plan is to ensure that the operation of the Mount Gibson Iron Limited, Koolan Iron Ore Mine, does not impact outside the predicted footprint or compromise the ecological integrity and biodiversity of the area. This document has been prepared to meet the requirements for a Marine Management Plan under Ministerial Statement 715 Condition 7 (EPA 2005).

Ministerial Statement 715, Condition 7 states that:

7-1 Prior to the commencement of activities that may affect the marine environment; the proponent shall prepare a Marine Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority, the Department of Conservation and Land Management and the Department of Fisheries.

7-2 The proponent shall review and revise the Marine Management Plan required by condition 7-1 at intervals not exceeding four years.

7-3 The proponent shall implement the Marine Management Plan required by condition 7-1 and subsequent revisions required by condition 7-2.

7-4 The proponent shall make the Marine Management Plan required by condition 7-1 and subsequent revisions required by condition 7-2 publicly available.

This Marine Management Plan sets out procedures to:

1. *identify the potential direct and indirect impacts on the marine environment during all phases of project activities;*

2. *minimise the disturbance footprint of the seawall and the revetment structure;*
3. *identify the cause and effect pathways associated with the potential impacts identified in point 1 above;*
4. *spatially and temporally define the zones of direct and indirect impact on sediment and water quality and benthic habitat health, as well as the boundary of the zone beyond which the marine environment will be protected;*
5. *manage the direct and indirect impacts, identified in point 1 above, on sediment and water quality and benthic habitat health, including the use of geotextile materials;*
6. *analyse the quality of the water to be discharged from dewatering the Main Pit;*
7. *spatially and temporally define the mixing zones where water will be discharged to the marine environment;*
8. *manage impacts associated with dewatering discharge to the marine environment;*
9. *manage stormwater to minimise impacts on the marine environment from existing and proposed sources of sediment runoff;*
10. *establish suitable reference sites from which to collect data for sediment and water quality and benthic habitat health indicators and derive site-specific environmental quality criteria for the direct and indirect impact zones;*
11. *develop a marine environmental quality monitoring programme, which incorporates:*
    - *scale maps showing the locations of each monitoring site and reference site;*
    - *procedures for routine monitoring of sediment and water quality and benthic habitat health during the life of the mine;*
    - *the environmental quality criteria for triggering pre-determined management action(s) and where necessary the rationale for their derivation;*
    - *methodologies for evaluating data collected at the monitoring and reference sites against the environmental quality criteria; and*
    - *the pre-determined adaptive management actions which will be implemented in the event that environmental quality criteria are not being achieved;*
12. *carry out a baseline survey and regular ongoing surveys for introduced marine pests;*
13. *develop a spill contingency plan;*
14. *restore or rehabilitate the marine environment, where impacts have occurred outside the identified indirect impact zone, during the life of the mine;*
15. *restore or rehabilitate the marine environment during the decommissioning phase, and ensure there is no net loss of benthic primary producer habitats and where possible generate a net gain in the area of benthic primary producer habitat and/or their associated communities.*

2 DETAILS OF MONITORING PROGRAMMES

2.1 SUMMARY OF MONITORING AND MANAGEMENT

In order to achieve the marine management objectives, the MMP consists of both monitoring and management obligations (Table 1). These obligations are to be carried out at different frequencies depending on their significance and the likelihood and severity of impact. Monitoring is broken down into four major programmes to assess water and sediment quality, benthic communities, and introduced species.

Table 1 - A quick reference summary table of all monitoring and management obligations to be carried out by Mount Gibson Iron Ore (or by consultants on their behalf) at Koolan Island

	Frequency	Monitoring/Management Obligation
Monitoring		
Discharge	Daily (Monthly)	Measure TSS in settlement pond (monthly measure of conductivity and pH)
Water quality	Annual (post wet season)	Measure nutrients and collect water samples for metal analysis at monitoring sites
Habitat	Annual (post wet season)	Measure coral cover at monitoring sites
Sediment	Every 3 years	Collect sediment samples for analysis
Invasive pests	Every 3 years	Deploy (and collect after 3 to 6 months) pest collectors
Management		
Discharge	Daily	In case TSS exceeds 20 mg/L for a prolonged period of time (for example 7 days) further water quality and habitat monitoring will be undertaken and results of this monitoring forwarded to both the DEC and the EPA
Wildlife	July - Sept	Ships must travel at < 10 knots around Koolan Island and < 14 knots through migration pathways
	All times	Staff inductions to prevent human interactions with wildlife Relocate crocodiles where individuals pose threats and it is safe to do so
Spill response	All times	Trained spill response staff on site, regular drill activities, carry response equipment, induction for all employees Commence sediment monitoring within two months of spill, report to DEC within a further two months
Reporting	Annual/4 years	Annual report to EPA, revise MMP every four years

2.2 ENVIRONMENTAL QUALITY CRITERIA

This monitoring program aims to detect changes in the condition of the marine environment and to trigger management actions if the measured values at a site fall outside acceptable levels. These acceptable levels are referred to as trigger values, and are generally based on the results of monitoring at reference (unimpacted) sites. Thus, the condition of impact sites is assessed through comparison against reference sites. The level of the trigger values are defined by the sites level of protection.

Level of protection

The Koolan Island, Mt. Gibson Iron Ore project MMP follows the guidelines set by the Environmental Protection Authority (EPA) Environmental Quality Management Framework for the marine waters of Western Australia. Therefore, the Mt. Gibson Iron Ore project must adhere to the EPA Environmental Quality Criteria (EQC) for marine conservation. This is consistent with the National Water Quality Management System and the Western Australian State Water Quality Management Strategy.

Waters surrounding Koolan Island fall within an area recommended for reservation as a multiple use marine park (WACALM 1994), and therefore warrant a high level of protection (Table 2; Figure 2). However, much of the southern shoreline of Koolan Island adjacent to the project infrastructure has been substantially modified by past mining activities; when combined with mixing and hydrodynamic characteristics of the area some level of environmental impact is tolerable within some zones. A zone within 50m of the low tide mark adjacent to the seawall at Arbitration Cove is assigned a moderate level of protection and the mixing zone around the Main Pit dewatering discharge is an area of low protection (Figure 2).

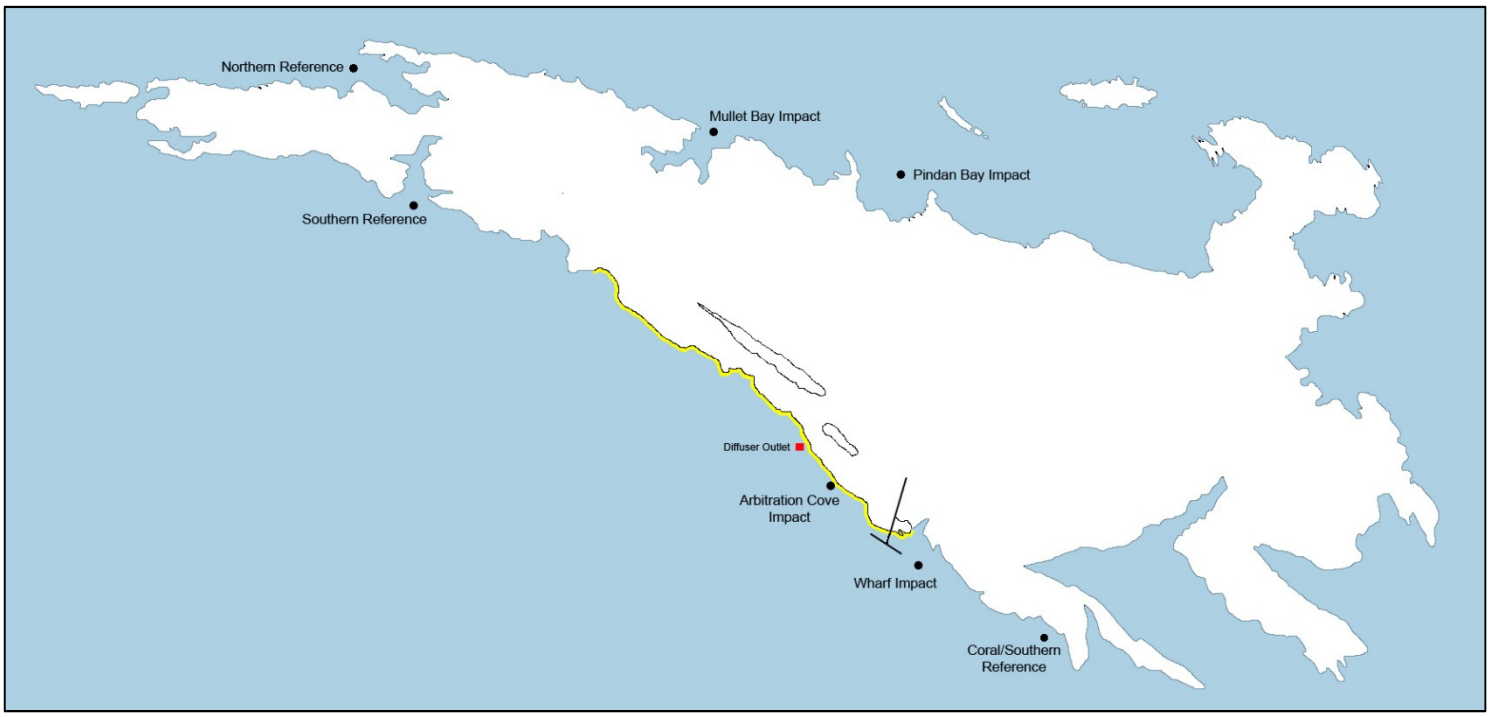

Figure 2 - Map of Koolan Island showing zones of environmental protection (blue – high level of protection, yellow – moderate level, red – low level), and monitoring sites (solid circles). Also displayed is the location of the diffuser outlet, wharf and settlement ponds.

Table 2 - Levels of ecological protection for the maintenance of ecosystem integrity defined by the EPA Environmental Quality Criteria

Level of Protection	Environmental Quality Criteria	
	Contamination	**Biological**
Maximum	No contaminants - pristine	No detectable change from natural variation
High	Very low level of contaminants	No detectable change from natural variation
Moderate	Elevated levels of contaminants	Moderate changes from natural variation
Low	High levels of contaminants	Large changes from natural variation

Trigger values

The trigger values which this project must adhere to are defined by the EPA EQC and take the form of either numeric fixed values or percentiles at appropriate reference sites for water quality and sediment monitoring (Table 3). The criteria in Table 3 relate to waters with a high level of ecological protection. For many of the parameters there is a fixed concentration value, generally set by the ANZECC guidelines (ANZECC & ARMCANZ 2000). If these levels are exceeded at the impact sites a management response is triggered; for example, if the median dissolved oxygen at the impact sites exceeds 90% saturation. In some cases the trigger values are defined as a percentile of the water quality at the reference sites. For example, an impact site is considered under pressure if the median temperature is higher than the 80^{th} percentile, or lower than the 20^{th} percentile, temperature calculated at the reference site. This allows for natural variability in background conditions.

The waters within the mixing zone around the dewatering outfall have been assigned a moderate and low level of ecological protection, respectively. Within these waters, the Western Australian Water Quality Management Framework requires that EQC be set for toxicants which may bioaccumulate, specifically cadmium and mercury. ANZECC guidelines (ANZECC & ARMCANZ 2000) recommend that in low protection zones, levels of 36 µg/L for Cadmium and 1.4 µg/L for Mercury are not exceeded.

The environmental quality criteria for benthic (coral) monitoring will be based on the EPA recommendation of a cumulative loss threshold of 1 % of coral reef habitat (EPA 2005), since the waters surrounding Koolan Island will be considered for inclusion in the marine reserve system. The EPA defines the area over which this allowable loss is calculated as a 'local assessment unit' to be defined by the proponent (EPA 2004). So, to be conservative, the coral cover at the impact sites shall be compared to the reference sites, and the cover at the impacts sites may not decline below 99% of the reference site. Coral cover at all sites will also be compared to baseline data to ensure that net loss of coral does not exceed 1% over the life of the project.

Table 3 - Water quality and sediment parameters, and the respective levels (defined by the EPA EQC) which trigger a management response.

Parameter	Trigger Value
Water Quality	
Turbidity	Median turbidity of impact site > 80th percentile of Reference site
Salinity	Median salinity of impact site > 80th percentile or < 20th percentile of Reference site
Temperature	Median temperature of impact site > 80th percentile or < 20th percentile of Reference site
Dissolved oxygen	Median dissolved oxygen of impact site < 90% saturation
Orthophosphate	Median OP of Impact site > 80th percentile of Reference site
Nitrate-nitrite	Median NO_x of Impact site > 80th percentile of Reference site
Aluminium	Median of Impact site > 80th percentile of Reference sites
Cadmium	95th percentile of Impact site > 0.7 µg/L (moderate protection trigger 36 µg/L)
Chromium	95th percentile of Impact site > 7.7 µg/L
Copper	95th percentile of Impact site > 0.3 µg/L
Lead	95th percentile of Impact site > 2.2 µg/L
Mercury	95th percentile of Impact site > 0.15 µg/L (moderate protection trigger 1.4 µg/L)
Nickel	95th percentile of Impact site > 7 µg/L
Iron	Median of Impact site > 80th percentile of Reference sites
Zinc	95th percentile of Impact site > 7 µg/L
Sediment	
Aluminium	Median of Impact site > 80th percentile of Reference sites
Antimony	Mean of Impact site > 2 mg/kg dry weight
Arsenic	Mean of Impact site > 20 mg/kg dry weight
Cadmium	Mean of Impact site > 1.5 mg/kg dry weight
Chromium	Mean of Impact site > 80 mg/kg dry weight
Copper	Mean of Impact site > 65 mg/kg dry weight
Iron	Mean of Impact site > 2x Mean of Reference Site
Lead	Mean of Impact site > 50 mg/kg dry weight
Nickel	Mean of Impact site > 21 mg/kg dry weight
Zinc	Mean of Impact site > 200 mg/kg dry weight
Tributyltin	Mean of Impact site > 5 mg/kg dry weight
TRH	Mean of Impact site > 10 mg/kg dry weight

2.3 SITE SELECTION

Sites were selected as they are believed to be representative of the island as a whole and are situated in areas most likely to be impacted by mining operations. Around Koolan Island there are four impact sites and three reference sites (Figure 2) used for the program. Not all environmental parameters are monitored at all sites (Table 4), as the distribution of likely impacts related to the source of potential contamination varies across the island.

Southern monitoring (impact) sites are selected to detect the effects of pit dewatering discharge and blasting (nutrients and water quality parameters) and include the following:

- Arbitration Cove – situated within 50m of the low water mark adjacent to the seawall, pre-existing spoil piles and the dewatering outfall/diffuser. In this area the level of ecological protection aims to retain a functional, but modified ecosystem as there is little coral in this area. This site has a distinct mixing zone, predicted to extend 150m from the diffuser in the longshore direction (northwest/southeast) and to be 80 to 100m wide
- Wharf (Mangrove Inlet) - immediately outside the 50m buffer zone around the shipping berth. The level of ecological protection in this area aims to retain a functional, but modified ecosystem

Northern monitoring (impact) sites consist of two embayments that are considered to be at risk from runoff impacts. These sites include the following:

- Mullet Bay – sampling around the seaward mouth of the bay inshore of the drop-off
- Pindan Bay – sampling around the seaward mouth of the bay inshore of the drop-off

Reference sites have been selected on the basis of their similarity to the Impact sites, while also ensuring they are far enough from the Impact sites to remain unaffected by any mine-related processes. The two reference sites include:

- Southern Reference site (Midjelena Bay) – will serve as a reference for the Arbitration Cove and Mangrove Inlet
- Northern Reference site (Mud Bay) – will serve as a reference for Mullet Bay and Pindan Bay Water Quality monitoring
- Coral/Southern Reference – will serve as a supplementary coral monitoring reference for southern impact sites as the Southern Reference site has only limited coral communities

Table 4 - Monitoring parameters used in this MMP and the sites at which they are monitored

	Turbidity, temp, salinity, DO	Dissolved nutrients and metals	Coral	Sediment
Arbitration Cove	X	X	X	X
Wharf	X	X	X	X
Mullet Bay	X		X	X
Pindan Bay	X		X	
Southern Reference	X	X	X	X
Northern Reference	X		X	
Coral Reference	X	X	X	

2.4 DAILY MONITORING

Mine water from dewatering within the Main Pit is discharged to the marine environment; thus, the quality of discharge water must be monitored and managed. Water is directed from the Main Pit to a settlement sump where suspended solids are allowed to settle out prior to discharge. This settlement sump reduces turbidity prior to discharge into the marine environment. The sump is lined with 250 mm compacted clay/siltstone with a permeability of $< 10^{-8}$ m/s, and a high density poly-ethylene (HDPE) plastic. Water from the sump is decanted into an outflow pipe and then gravity fed to the diffuser outlet 70 m offshore. The settlement sump is designed to provide a minimum 40 hour retention period and a minimum 98% reduction in suspended solids. This design results in a worst-case TSS of 20 mg/L being discharged through the diffuser. This filtered water is then discharged into the ocean through a diffuser outlet outside the pit boundary. This action is regulated by DEC licence 8148.

During dewatering, monitoring will include a daily (at least 8 out of 10 days) sample from the settlement pond water prior to discharge (Figure 3). A sample will comprise 1L of water for assessment of TSS by filtration at the onsite laboratory under NATA accredited procedures approved by DEC. In accordance with operating licence requirements, should TSS exceed 20 mg/L on any day, the event shall be reported to the regional office of the DEC immediately and advice sought on actions to prevent impact on the environment. These actions may include adding a filtration system to the discharge circuit or the recycling of dewatering discharge until TSS levels settle to acceptable levels. Action may also include the initiation of a dedicated monitoring event for habitat/coral community health. On a monthly basis, TSS samples from the settlement pond are supplemented by additional samples taken for electrical conductivity and pH.

A review of the discharge water quality indicates that there were no months where the average TSS exceeded the 20 mg/L allowable limit (Figure 3), indicating that there have been no prolonged events of poor water quality. Although there have been single instances where the TSS results from the discharge have exceeded this limit, these occurrences have and will continue to be managed as per the conditions of the DEC licence.

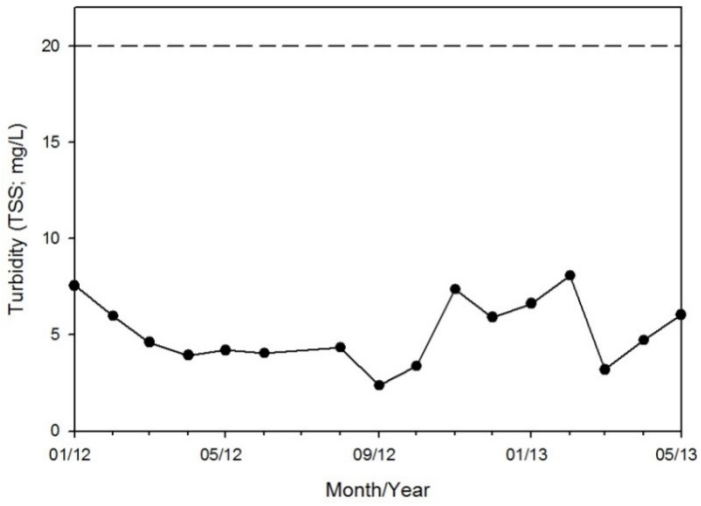

Figure 3 - Plot of Turbidity (TSS) data measured daily in the settlement pond (black dots, solid line); dotted line represents 20mg/L allowable limit for discharge water

2.5 ANNUAL MONITORING

A decline in water quality is considered the most likely impact of mine operation, and has the most significant environmental impacts. A decline in water quality is likely to have knock-on effects and may cause of other environmental degradation. The loss of benthic habitats is also highly significant, and is likely to be observed quickly following a decline in water quality. Coral communities are a valuable marine asset and should, therefore, be monitored alongside water quality. Both these monitoring programs shall be undertaken on an annual basis following the wet season. This encompasses periods when environmental conditions are at the most extreme due to the increased runoff.

Where the daily discharge monitoring exceeds 20 mg/L for a prolonged period of time (for example 7 days) further water quality and habitat monitoring will be undertaken and results of this monitoring forwarded to both the DEC and the EPA

2.5.1 Water Quality Monitoring

Potential impacts

Potential impacts resulting from mining and ship loading operations include:

- increased turbidity and sedimentation from multiple sources including dewatering, runoff, ore spillage and vessel movements
- alteration of salinity and temperature from dewatering
- increased concentration of dissolved metals associated with dewatering and possible product spillage
- increased concentration of nitrate-nitrite from blasting products during the mine operation
- increased nutrients from stormwater runoff

Monitoring design

All impact and reference sites (Figure 4) will be sampled for turbidity (Total Suspended Solids; TSS), temperature, salinity, dissolved oxygen (Table 4). Turbidity, temperature, dissolved oxygen and salinity will be recorded with an YSI 6820 (or equivalent) water quality sonde.

Ten samples will be taken at both the Northern and Southern Reference sites, and at Mullet Bay, Pindan Bay and Wharf impact sites (Figure 4). Fifteen samples are taken at Arbitration Cove and a further five samples are taken at the southern Coral Reference site (Figure 4). For impact sites five samples will be situated close to the impact (shore, seawall, or outfall) and five 100m from the impact source (a third set of five taken at Arbitration Cove). For reference sites, sampling will be distributed throughout the area. Samples consist of one surface (0.5m) and one bottom (1m above seabed) measurement. Where water depths are greater than 10 m, a mid-water sample will also be taken. The calculation of trigger values will take into consideration the distribution and depth of replicates (see Appendix B). At the southern impact sites, samples will be standardised and taken during a rising tide, approximately 2 hours after slack water.

Water samples for metal and nutrient analysis will be taken at the four southern sites, Arbitration Cove, Wharf and Southern Reference (Table 4). At these sites a clean 2.4L Niskin Bottle will be used to collect a water sample which will be flown to Murdoch University's Marine and Freshwater Research Laboratory in Perth the day after sampling. For detailed methodology see Appendix B.

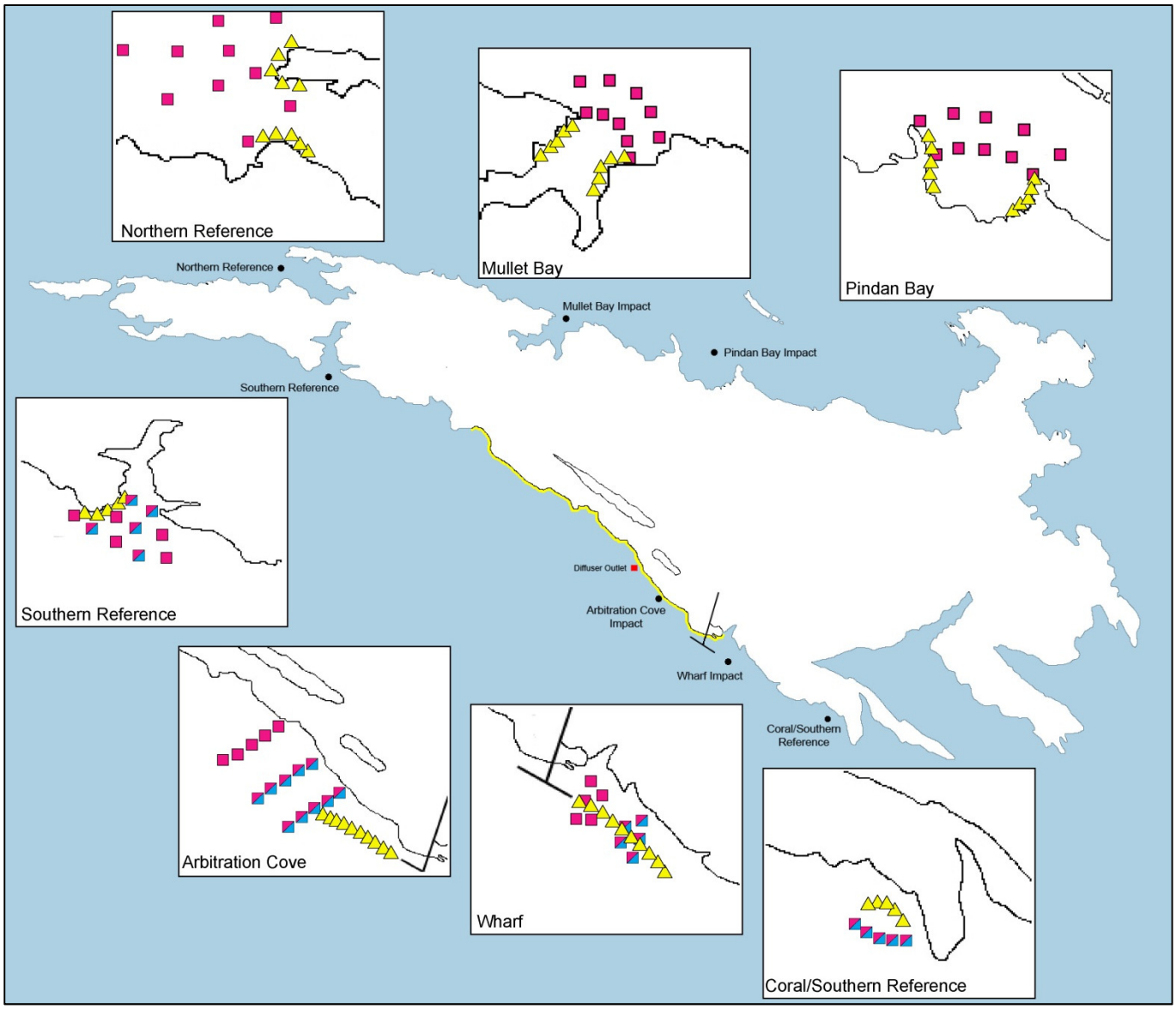

Figure 4 - Map of Koolan Island monitoring sites. Insets show a close up view of each of the monitoring sites displaying the distribution of samples taken for water quality and habitat monitoring (squares – water quality (solid pink squares are hand-held water quality readings only and blue/pink squares are both water quality readings and water sample for nutrient and metal analysis), yellow triangles – coral monitoring).

2.5.2 Habitat Monitoring

Potential impacts

Potential impacts on the marine habitats of the island can result in loss of coral cover, abundance and diversity, and are possible from:

- modification of the turbidity or sedimentation regime
- alteration to nearshore current patterns resulting from placement of structures

Monitoring design

Coral cover will be monitored at Arbitration Cove, Wharf, Mullet and Pindan Bays and Northern Reference (Table 4; Figure 4). Since little-to-no coral is present at Southern Reference which is used for water quality, a separate Coral Reference site has been established on the south eastern corner of the island (Figure 4). Within each site 10 samples will be taken by targeting areas where coral is present, therefore, samples are taken along the upper reef slope, which has the greatest coral cover, at approximately 12 m depth. The coral monitoring at reference sites to the south of the island will be split between both reference sites (five at Southern Reference, five at Coral/Southern Reference). Sample layout will be different at each site depending on the distribution of coral, but will generally be a set of five points along either side of the northern bays or in two groups of 5 at the southern sites; see Figure 4 for positioning.

Monitoring method

Due to the presence of crocodiles within the immediate area, surveys cannot be undertaken on SCUBA. Diver operation in cages is impractical and physical destruction of coral can occur. Thus, all underwater surveys use remote video methods.

One minute of video footage will be taken within a 5m x 5m area, at each of the sample points. Individual stills from the footage will be analysed for percent cover and species diversity using Coral Point Count with Excel Extensions (CPCE). Notes will also be made where excessive sedimentation, coral breakage, bleaching or any apparent change in composition or health in the community is visible in the imagery since the previous survey. For detailed methodology see Appendix B.

2.6 THREE YEARLY SAMPLING

Since the baseline survey, sediment monitoring has been, and will continue to be, undertaken at three year intervals as sediment quality will evolve slowly unless impacted by major spills. Where such spillage occurs and it is determined that it is necessary, a sediment survey will be undertaken within 2 months of the spillage and the results will be reported to the regional office of DEC within a further two months. A dedicated sediment survey may also be triggered by exceedence of water quality EQC. The requirement for this will be determined on a case by case basis.

The risk of invasion by introduced pests is also significant but pests are likely to take time to become established to a level that can be detected by sampling. Therefore, monitoring for marine pests will be undertaken every three years alongside the sediment monitoring program.

2.6.1 Sediment Monitoring

Potential impacts

Potential impacts resulting from shiploading, discharge of sediment in dewatering and runoff include:

- increased sedimentation during operation and pit-dewatering, including increased metals loads
- disturbance and resuspension of sediment from ship movements
- increased levels of ship antifouling residue in sediment

- spillage of ore or fuel

Monitoring design

Sediment monitoring will be undertaken at the three southern sites; Arbitration Cove, Wharf, and Southern Reference (Table 4; Figure 5). Sediment will also be monitored at one northern site at Mullet Bay as the baseline survey highlighted some heavy metal contamination in this area. Samples will be collected in pairs (approximately 1 to 5m apart) at five subsites within each site (Figure 5). The calculation of trigger values will take into consideration the distribution of replicates (see Appendix B).

Monitoring parameters

All impact and reference sites will be sampled for each of the Sediment parameters listed in Table 3. Sediment samples will be obtained from a boat using a hand-operated 2.4L stainless steel Petite Ponar Grab Sampler. For detailed methodology see Appendix B.

2.6.2 Introduced Marine Pests

Potential impact

Introduced marine organisms may compete with, predate on, or parasitise native flora and fauna, disrupting the local ecosystem and potentially spreading to other Australian ports. Within the Buccaneer Archipelago, introduced marine pests may also pose a significant threat to the local fishing and aquaculture industries.

Monitoring design

Monitoring for the presence of marine pests will be carried out at the sites frequented by shipping, and thus, are most likely to become invaded. These sites are Arbitration Cove and Wharf (Figure 5). Marine pests will be monitored through the deployment of collectors for three months. Marine pest collectors will be deployed in pairs (Figure 5), with one collector in the intertidal zone and one at around 10m depth. Collectors will be deployed on a 3-yearly basis.

Monitoring parameters

Collectors are designed according to CSIRO standards, and consist of four 150mm x 150mm x 4mm PVC tiles for sessile invertebrate recruitment and two 200mm x 200mm sections of “Astroturf” material for mobile invertebrate recruitment. Invertebrates removed from the collectors after the deployment period will be preserved and identified by specialists. The results of taxonomic assessments of the plants and animals collected will be compared with the 2005/6 baseline.

Management

The risk of introduction of marine pests on vessels used during construction was evaluated on the basis of the origin of those vessels. Where vessels originated outside Australia, hull inspections were required. Where vessels were from within Australia, the location of vessels within the past 12 months was evaluated to determine whether a hull inspection was required. If any exotic marine organisms, especially those on the ‘international target species list’, were identified at any time, the WA Department of Fisheries was notified. There were no known occurrences of this during construction and as construction has been completed, this management measure is no longer implemented.

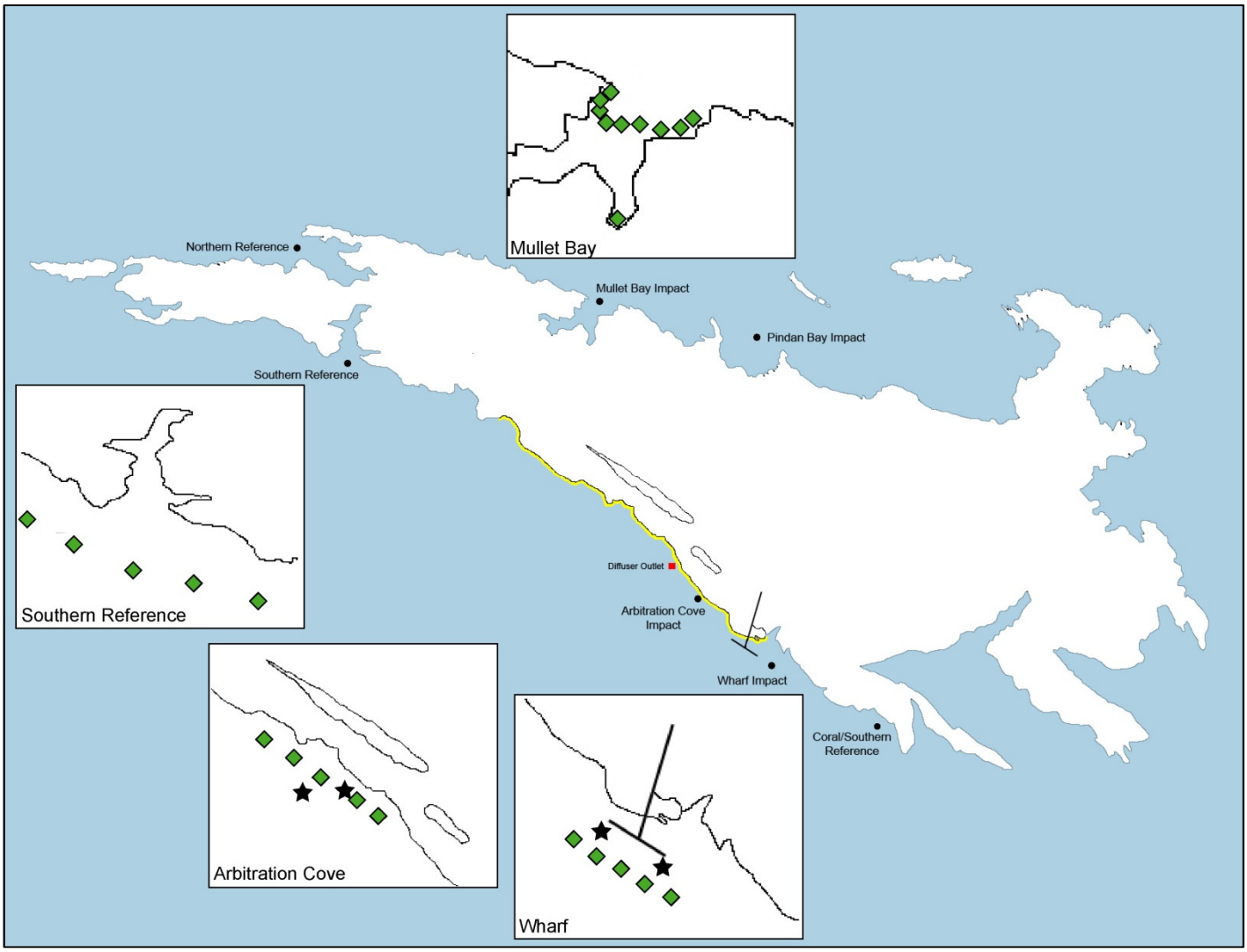

Figure 5 - Map of Koolan Island monitoring sites. Insets show a close up view of each of the monitoring sites displaying the distribution of samples taken for sediment and invasive species monitoring (green diamonds - sediment, black stars – position of invasive species collectors).

2.6.3 Wildlife

Humpback whales (*Megaptera novaeangliae*) migrate between summer polar feeding grounds and winter tropical breeding grounds each year (Dawbin 1966). Whales travel through the Kimberley area between late July and early September. Whales and calves spend time in calving areas between mid-August to mid-September, resting in Camden Sound before heading south. A number of whale sightings from boat based surveys have been made around Koolan Island (Jenner *et al.* 2001).

There is little information regarding dugong distribution and abundance in the Kimberley area. There are no published records of turtles from Koolan Island; however, marine turtles, particularly flatbacks (*Natator depressus*), are known to reside in the area. Both dugong and turtle usage of the area immediately surrounding the mine site is likely to be by transient animals. Saltwater crocodiles (*Crocodylus porosus*) are relatively common in the nearshore waters of the western Kimberley. Several crocodiles have been observed around the Koolan Island mining development.

Potential impacts on marine wildlife falls into four categories; noise, vessel interactions, human interactions and turbidity:

- Noise levels generated during ship loading, vessel movement, and operation of the mine and crusher plant can disturb or displace marine wildlife
- The movement of bulk container ships through migratory pathways, and breeding and resting areas of marine fauna may interrupt natural habits and pose a risk of vessel strike
- Increased turbidity from mining earthwork, clearing of vegetation and water discharge can disrupt fauna habits, reduce visibility and cause harmful algal blooms

Noise

On the basis that the Canal area appears to be of little importance to whales, dugong or turtles there is unlikely to be a risk of impact from noise sufficient to require monitoring. Anecdotal evidence and observations from visitors to the island suggest that whale numbers around the island have not declined over the life of the mine. Shipping noise may disturb humpback whales, where bulk carriers pass through the migratory path of the whales, however, since mining commenced there has been no evidence to suggest this is the case. Whales are observed frequently around nearby Cockatoo Island, sometimes with calves, where blasting is a daily occurrence at some times of the year. There are no studies on the effects of blasting noise on dugongs or turtles. However, blasting noise is unlikely to disturb turtles as there is no evidence of nesting on beaches on Koolan Island.

Vessel Strikes

The movement of bulk container ships through migratory pathways, and potentially through breeding and resting areas of humpback whales poses the risk of vessel strike. Since vessels operating in the immediate vicinity of Koolan will be infrequent (generally four or less per month) and generally slow-moving (less than 10 knots in the vicinity of the Island) there is little chance of vessel strike on whales. Further from the Island, inbound and outbound iron ore carriers will be requested to avoid whale calving areas and restrict ship speeds to less than 14 knots while passing through the known migratory pathways during peak migration periods.

Human Interaction

Inductions will include a section on the Wildlife Conservation Act and Regulations and the workforce will receive instruction to avoid direct human-wildlife interaction. The primary aim of the management plan will be to reduce human-crocodile interaction, so that these fauna do not pose a risk to human safety, without the need to trap or destroy crocodiles. Inductions will provide information directing people away from situations where crocodile attack is likely and firearms will be prohibited on the mine site. When approach to operational areas occurs crocodiles will be relocated to the channel by trained MGI environmental staff.

Turbidity

An increase in turbidity in the marine environment may occur as a result of mining earthwork, clearing of vegetation and water discharge. The main potential impact of increased turbidity on marine vertebrates is through the reduction of light penetration, which could disrupt natural behavioural patterns. Severe increases in turbidity, coupled with nutrient input, can also cause blooms of toxic algae. Through monitoring of turbidity and water quality (see above), significant degradation will be detected and the aim will be to keep TSS below 20mg/L. Sediment and drainage controls have been put in place to reduce discharge into the

marine environment, therefore increased turbidity around Koolan Island is unlikely to impact on marine vertebrate behaviour.

2.7 EMERGENCY SPILL MANAGEMENT

Potential impact

Spillage of liquids or solids into the environment may occur and can impact marine condition. In the event of a spill, emergency management will be required. The most likely spillages are:

- Hydrocarbons spilt during fuel or waste oil transfer to and from barges
- Loss of containment of hydrocarbons from vessels (e.g. tugs, bulk carriers)
- Loss of containment of hydrocarbons from fuel storage or plant on land

Management

The Koolan Island Emergency and Crisis Management Plan is the current standard for response to environmental incidents, including marine spills. Spill response and contingency plans will be maintained and reviewed as required and training exercises will be carried out with the relevant employees.

Hydrocarbon spill procedures (including operational and contingency standards) and equipment are to be in place at all times for land and marine based spills. A vessel must be retained on-site to deploy booms or other containment devices for minor spills. The marine contractor responsible for incoming vessel operations is required to carry oil spill response equipment on board all vessels used.

The operation will maintain a register of staff with appropriate spill response training including the use of spill containment and clean-up equipment. The Emergency Response Team will be sent to training courses, such as those run by WA DPI as it is required. When it is deemed necessary, the entire team will undertake an internal drill exercise which will simulate a potential scenario or incident, such as a small spill and clean-up in the marine environment. As required, a simulation exercise will be conducted under the supervision of WA DPI or regional ports, if these authorities express an interest in being involved.

2.8 REHABILITATION PLAN

If significant reductions in water and sediment quality are detected, those impacts will be investigated and assessed with a view to implementing measures which will return the water quality to acceptable levels (below trigger values). If coral communities become impacted while there is no detectable decline in water quality, it may be necessary to revise the water quality and sediment trigger values to prevent further deterioration; this will be determined on a case by case basis. Where exotic species are detected, action must be taken to minimise the impacts of the invasives. The area may be quarantined to prevent further spread and an eradication program may be implemented.

At the finalisation of the project, monitoring will continue for two years (one annual sample each year for water quality and coral habitat, plus a once off sediment and invasive pest sample). This information will be compared with baseline data collected in 2005. Where a significant difference in environmental quality is detected, restoration efforts will be investigated and undertaken as deemed necessary. The aim will be to return water and sediment quality to a natural state with time, and a revised monitoring program may be required to ensure this occurs. If degradation of coral has occurred, these populations

should be monitored under a suitably designed monitoring program. Where improvement does not occur, MGI may attempt to re-establish coral through a transplant and resettlement program.

At present the results of regular monitoring indicate that the implementation of a rehabilitation plan will not be required.

2.9 REPORTING AND REVIEW

Monitoring and observational data collected under this marine management program will be provided annually to the OEPA. An Annual Environmental Report (AER) will be prepared and submitted to the EPA by 31st of July each year. This report will be developed in accordance with the auditing requirements of ministerial statement 715 and the OEPA post assessment guideline for Compliance Assessment Reports.

This Marine Management Plan must be reviewed every four years, as required by Ministerial Statement 715. This revision will take into account the analyses of trends in the data and will include an assessment of the management plan's relevance to the current operations:

- A revision of the effectiveness in meeting the environmental objective (Ministerial Statement 715)
- Recommendations for changes to be made in response to significant changes in the operation and operational risk profile

A review record including summary of changes must be incorporated into the management plan and updated with each review. All revisions of the Marine Management Plan will be made publicly available on the Mount Gibson Iron Limited website.

Significant environmental incidents with potential to damage the environment will be reported as soon as practical to DEC in accordance with the regulations under the *Environmental Protection Act* and the mine's operating licence from DEC.

Table 5 - List of present and historical reviews/reports and other relevant documentation

Year	Author	Report No.	Report
2005	Ecologia	-	Koolan Island Mine and Port Facility. Environmental Referral Document
2006	MScience	MSA39R1	Koolan Marine Management Plan
2006	MScience	MSA67R1	Koolan Island: Main Pit Water Quality
2007	MScience	MSA39R2	Koolan Marine Monitoring Report: Baseline Data
2008	MScience	MSA107R6	Koolan Island Water Quality Trigger Review
2008	MScience	MSA110R1	Koolan Island Mine Pit: Sediment Elutriate Tests
2013	MScience	MSA39R1	Koolan Marine Management Plan
2013	MScience/APM/ MGI	-	Marine Management Plan Revision

3 RECOMMENDATIONS

The following alterations (Table 6) have been incorporated into the management plan and are suggested to increase the consistency, and thus effectiveness of the monitoring program.

Table 6 - List of areas where the monitoring program could be improved, how it was be fixed, and what this achieved

Monitoring Program	Problem	How it was fixed	What this achieved
Water quality	Inefficient frequency of WQ sampling	WQ monitoring should be undertaken annually, post wet season	No loss of rigour, however the process is more efficient
Habitat	No quantitative measure of potential loss of coral cover	Take stills from video footage, overlay points and use CPCE to calculate percent cover	Remove observer bias, allow for comparison between sampling times
Rehabilitation Program	Non-existent	Devise a plan, detail in report, implement in case of incident	In case of incident, sites can be treated

4 REFERENCES

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5 APPENDIX A

Risk Assessment

Prior to revising the Koolan Island MMP a risk assessment was carried out to quantify the likelihood and severity of impacts (Table A2). Then a revised assessment was carried out based on a reduction in likelihood as a result of implementing control measures. Severity cannot be reduced as the impact remains the same and control measures only reduce the likelihood of it occurring. Risks are ranked as low, moderate, high or extreme based on a combination of categorising severity and probability. So, a potential impact of mine operation is given a score for severity from 1 (insignificant) to 5 (catastrophic), and for probability between 1 (rare) and 5 (almost certain). See table A1 for all levels. For example, a loss of coral is considered moderately (3) severe, and without control measures the probability of this occurring is possible (3), therefore according to table A1 the risk of coral loss is high (16). With the implementation of water quality controls, as well as constant monitoring, the probability of coral loss drops to rare (1); however, if loss were to occur the severity would still be moderate (3). Therefore, the revised risk of coral loss after implementation of the MMP is at the low end of moderate (6).

In areas where high and moderate ecological protection are enforced (Figure 2) by the EPA, the risks must not exceed a moderate level. Thus in cases where the risk is categorised as high or extreme initially, management must reduce the frequency to a level that allows the rank to fall into the moderate or low categories.

Table A1 – Matrix of categories for assigning risk of impact of mining activities. The combination of severity and probability give the user a rank of Low (0-5), Moderate (6-11), High (12-17) and Extreme (18-25).

		Severity				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)*	Catastrophic (5)*
Probability	Almost Certain (5)	M (11)	H (13)	E (20)	E (23)	E (25)
	Likely (4)	M (7)	H (12)	H (17)	E (21)	E (24)
	Possible (3)	L (4)	M (8)	H (16)	E (18)	E (22)
	Unlikely (2)	L (2)	L (5)	M (9)	H (15)	E (19)
	Rare (1)	L (1)	L (3)	M (6)	M (10)	H (14)

*Note: The major and extreme severity levels are usually associated with the potential for loss of human life.

Table A2 – Risk assessment for potential impacts of Koolan Island mining activities and revised assessment after implementation of management controls

Potential Impact	Initial Assessment			Control Measures	Revised Assessment		
	Severity	Probability	Rank		Severity	Probability	Rank
Decline in water quality	3	3	16H	Retention of discharge in settlement pond and daily monitoring for TSS	3	1	M6
Loss of coral	3	3	16H	Monitor WQ to detect increases before coral loss occurs	3	1	M6
Contamination of sediment	3	3	16H	Retention of discharge in settlement pond for contaminant reduction prior to release	3	1	M6
Pest invasion	3	2	M9	Monitor for presence	3	1	M6
Wildlife disturbance	2	2	L5	Limit noise, vessel speed	2	1	L3
Human-wildlife interaction	2	2	L5	Induction and training, relocation of wildlife if necessary	2	1	L1
Loss of other habitat species (NOTE little to no seagrass in area)	1	3	L4	Monitor WQ to detect increases before loss occurs	1	1	L1

6 APPENDIX B

This appendix presents detailed methods for the monitoring program. Measurements are taken from the respective sites, and in some cases this is broken down into zones (inner and outer) and depths. It would be inappropriate to combine inner and outer (distance from impact) samples, samples from different impact and reference sites, or data from different depths. Thus, the calculation of means for comparison to trigger values (and in some cases the calculation of trigger values) shall be broken into site, zone and depth categories where appropriate.

Water quality monitoring methodology

All impact and reference sites will be sampled for turbidity, temperature, salinity, dissolved oxygen, metals and nutrients (Table 3). Turbidity, temperature, dissolved oxygen and salinity will be recorded with a YSI 6820 (or equivalent) water quality sonde. In water less than 10 m, samples will be taken one metre from the surface and one metre from the bottom. In water greater than 10m, a mid layer sample will also be taken. The depth of each site will be measured using the depth sounder on the survey vessel. A graduated cable connected to the YSI will be used to accurately measure depth.

Water samples for metal and nutrient analysis will be collected in a clean 2.4L Niskin Bottle. Similar to the YSI, the depth of each site will be measured using the depth sounder on the survey vessel. A graduated rope connected to the Niskin Tube will be used to accurately measure depth. Water will be passed through a 0.45 µm sterile filter into four vials for laboratory analysis. These four subsamples will be; 1 x 100 ml for Mercury, 1 x 10 ml for filtered metals and 2 x 10 ml for nutrients. Sealed bottles will be stored in a dark ice-filled esky and flown to Murdoch University's Marine and Freshwater Research Laboratory (or equivalent NATA accredited laboratory) in Perth the day after sampling.

In order to prevent sample contamination the vessel will be thoroughly washed down onsite prior to any sampling taking place, the Niskin bottle will be rinsed with 2 volumes of water between sample collection, and filters will be rinsed through with a minimum of 10 ml of sample prior to filling the sample vessels. New, non-powdered nitrile gloves and filters will be used by all sampling personnel at each sampling site and depth, and once sampling has commenced great care will be taken to avoid touching the inside of lids or rims of any of the sampling containers.

Benthic habitat/coral monitoring methodology

One minute of video footage will be taken within a 5m x 5m area, at each of the sample points. Samples must be taken at a consistent height above the substrate. For best image quality the ideal height above the coral is one meter.

Once returned to the laboratory this footage will be broken down into individual stills and 10 will be randomly selected from each piece of footage. In order to randomly select stills, the total number of stills will be determined, and a random number generator will be used to produce 10 numbers which represent the stills selected for analysis. Coral Point Count with Excel Extensions (CPCE) will be used to analyse percent cover and species diversity by overlaying 30 random points on each image. Thirty points per image will be selected because previous studies have found that this achieved the highest level of precision whilst considering efficiency (Stoddart et al. 2005). Notes will also be made where excessive sedimentation, coral breakage, bleaching or any apparent change in composition or health in the community is visible in the imagery since the previous survey.

Sediment monitoring methodology

Sediment samples will be obtained from a boat using a hand-operated 2.4L stainless steel Petite Ponar Grab Sampler which is designed to sample the top 5 to 10 cm of sediment. The depth of each site will be measured using the depth sounder on the survey vessel. A graduated rope connected to the Grab Sampler will be used to accurately measure depth. Sediment for analysis will be taken from the top 2 cm of the sediment profile in each grab, taking care to avoid sediment that is in contact with the metal sides of the grab. Three samples will be taken from each grab; the first for assay, the second held for confirmation if required and the third held to determine bioavailability if required. All samples will be placed into laboratory cleaned glass jars and sealed with Teflon lids. Samples will be held in an esky with ice, then refrigerated according to laboratory and NODGDM requirements. The second and third samples will be frozen until required.