EcOz Environmental Services

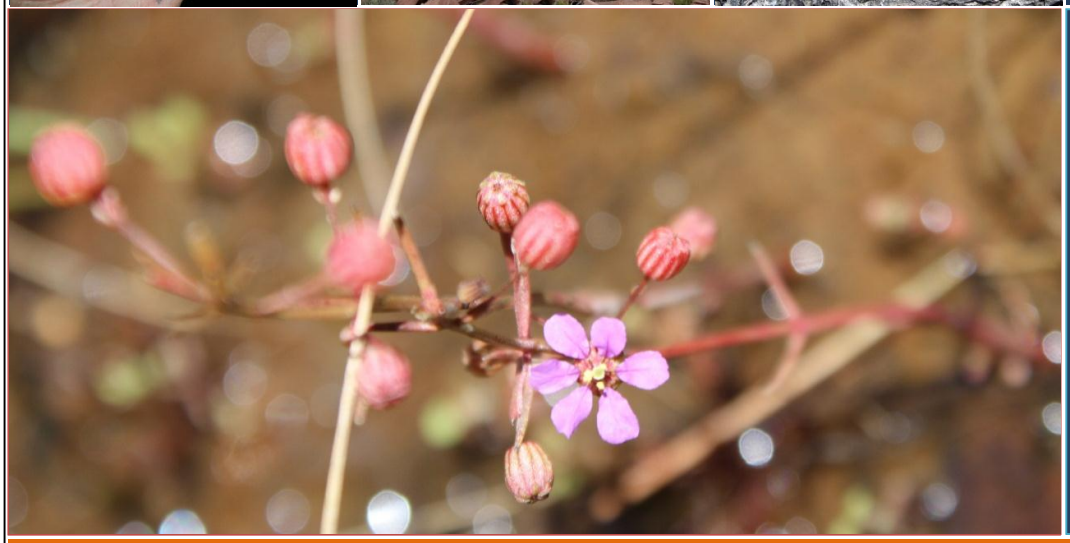
WesternDesert RESOURCES

Chapter 9
Risk Assessment

Western Desert Resources Limited
Roper Bar Iron Ore Project



2012



www.ecoz.com.au

Document Control Record

Prepared by:	Jeff Richardson	Approved by:	Ray Hall
Position:	Snr Environmental Scientist	Position:	Principal
Signed:		Signed:	
Date:	18/06/2012	Date:	18/06/2012

REVISION STATUS

Revision No.	Description of Revision	Date	Approved
1A	First Issue	28/02/12	RH
1B	Review	19/03/12	JR
1C	Review	21/03/12	JS
1D	Review	12/04/12	JR
2A	Review	15/04/12	RH
2B	Review	16/04/12	RH
2C	Submit to Government	18/06/2012	RH

Recipients are responsible for eliminating all superseded documents in their possession.

EcOz Pty Ltd
trading as EcOz Environmental Services
ACN: 143 989 039

Winlow House, 3rd Floor
75 Woods Street
DARWIN NT 0800
PO Box 381, Darwin NT 0800
Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Document Reference Number: DW120004-C0302-EIA-R-0048 Version F

Contents

Tables

Figures

9 Impacts and Risk Assessment

9.1 Introduction

This risk assessment describes the process and presents results of an assessment of the environmental risks relevant to the Roper Bar Iron Ore Project. It is designed to identify the potential hazards that affect human health, the socio-cultural environment, and the natural environment. The approach is systematic and congruous with international best practice standard methodologies including:

- AS/NZS ISO 31000:2009: Risk management - Principles and Guidelines (Standard)
- HB 203:2006: Environmental risk management - Principles and process (Guide)
- HB 158:2010: Delivering assurance based on ISO 31000:2009 - Risk management - Principles and Guidelines (Guide)

The project's key risks were provided by NRETAS through the EIS Guidelines (Appendix A), secondary risks identified during the development of this EIS are also presented.

The implementation of the risk management program is outlined within the Environmental Management Plan (EMP); Appendix C.

9.1.1 Data Supporting Risk Assessment

Preliminary risk assessments were carried out using available data to generate a baseline understanding of potential risks and mitigation strategies. A range of environmental surveys were undertaken for this risk assessment; including:

- Noise baseline data and modelling;
- Hydrogeology and ground water testing and modelling;
- Geotechnical and geological investigations;
- Acid Mine Drainage investigations;
- Surface water investigations;
- Terrestrial and aquatic flora and fauna studies;
- Biting insect surveys;
- Archaeological investigations;
- Social Impact Assessment; and
- Targeted stakeholder consultation.

9.1.2 Risk Groupings

The Guidelines present five key risks relevant to this development; these and their environmental objectives are given below:

1. Risks to surface and ground water resources:
    a. Waterways in the area are in near pristine condition. Water quality may be impacted by discharge of wastewaters to surface water or runoff containing elevated sediment concentrations.
    b. To ensure that groundwater quality and quantity is protected both now and in the future, such that ecological health and the health, welfare and amenity of people and land uses are maintained.
2. Risks to biodiversity:

a. To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge; and
b. As an action of the Territory 2030 Strategic Plan, intensive developments are to operate under a 'no net biodiversity loss principle' and the Proponent will need to demonstrate that the project can proceed without net loss of biodiversity.

3. Rehabilitation success and mine closure:

    a. Rehabilitation of the site will be done in a manner that requires minimal inputs of maintenance post closure, but maximum protection of the environment from seepage of contaminants, weed incursion, erosion or other impacts.

4. Social and cultural impacts:

    a. To analyse, monitor and manage the intended and unintended social consequences, both positive and negative, of the project and any social change processes.

5. Cumulative impacts.

    a. An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation.

9.1.3 Risk Assessment

Risk is defined as the chance of something happening that will have an impact on objectives. The risk assessment process involved reviewing the objectives and outcomes from the Guidelines and identifying the hazards (defined as anything that will cause harm and can affect meeting of outcomes and objectives). Each hazard was analysed for likelihood and consequence and a risk ranking was developed for the inherent value. Management programs were considered for each hazard and a new likelihood, consequence and risk ranking (now the residual risk) was defined.

The ranking for event consequence is shown in Table 9-1. The likelihood of an event occurring provides a measure of the known or anticipated frequency of occurrences (see Table 9-2). Combining likelihood with consequence (see Table 9-3) provides guidance on risk levels of each aspect and enables ranking of priorities.

The following sections describe in detail for each risk the development of the inherent risk rankings, the proposed hazard management and the subsequent residual risk. These sections also make reference to the data and information that supports these decisions.

Table 9-1: Consequence ranking

Consequence		
1	**Insignificant**	No measurable impact on the environment. No injuries. Low-nil financial loss.
2	**Minor**	Minor, temporary environmental impact. No publicity likely and no stakeholder concerns. First aid treatment required. Medium-low financial loss.
3	**Moderate**	Substantial temporary or permanent minor, localised environmental damage. Stakeholder enquires (this may include government, unions or public). Medical attention required. High-medium financial loss.
4	**Major**	Substantial or permanent environmental damage. Prosecution possible. Loss of company credibility and high stakeholder interest. Permanent injuries. High financial loss.
5	**Catastrophic**	Widespread severe and permanent Environmental damage. Major stakeholder and media interest. Prosecution likely. Permanent injury or death. Extreme financial loss.

Table 9-2: Qualitative measures of likelihood

Probability/Likelihood			Likelihood Criteria
A	**Rare:**	Practically impossible, will only occur in exceptional circumstances. Has never occurred in the industry.	0-1%
B	**Unlikely:**	Could occur at some time but highly unlikely. Has occurred in the industry previously.	1-10%
C	**Moderate:**	Might occur at some time. Has occurred in associated companies previously.	11-50%
D	**Likely:**	Known to occur or will probably occur in most circumstances**.** Has occurred several times/year in associated companies.	51-90%
E	**Almost Certain:**	Common or repeating occurrence. Is expected to occur several times/year in any associated business.	91-100%

Table 9-3: Risk rankings used by combining consequence with likelihood levels for each aspect identified.

		Consequence				
Likelihood		1	2	3	4	5
	A	1	3	6	10	15
	B	2	5	9	14	19
	C	4	8	13	18	22
	D	7	12	17	21	24
	E	11	16	20	23	25

Where;

Red =	extreme risk	intolerable
Purple =	high risk	intolerable or tolerable
Yellow =	medium risk	tolerable or acceptable
Green =	low risk	acceptable

9.2 Surface and Groundwater

This section examines the potential impacts that this development may have on the surface and groundwater resources and values that are described in Chapter 6. For both surface and groundwater, the primary risks are associated with water quality and/or quantity and for the purposes of this discussion, have been divided into the following themes:

i. Surface water hydrology;

ii. Surface water quality;

iii. Groundwater levels; and

iv. Groundwater quality.

In some cases, a particular activity may pose a risk to both surface and groundwater or in the case of groundwater dependent ecosystems (GDE's), changes in groundwater levels may influence surface water hydrology. Aquatic ecosystem health is closely linked to surface water quality and hydrology and risks to aquatic biodiversity are discussed in further detail in Section 9.3.

Inherent risks, mitigation measures and residual risks in relation to the above four themes are summarised in Table 9-5 and discussed in further detail below.

9.2.1 Surface Water Hydrology

The main potential risks to surface water hydrology are the alteration to surface water flows associated with:

i. Haul road crossings; and

ii. Towns River re-alignment.

Hydrology Inherent Risk Profile

As outlined in Chapter 6, there are a large number of streams that will be crossed by the proposed haul road from the mine site to the Bing Bong Loadout Facility, including several major rivers. In the absence of appropriate design and construction, stream crossings (e.g. bridges, culverts, causeways) could lead to a localised alteration of stream hydrology (e.g. increased velocities associated with constriction of flows). Alterations to stream hydrology involving increased flow velocities could affect migration patterns of some aquatic species, such as the freshwater sawfish (*Pristis microdon*). This is considered to be a major consequence (i.e. substantial or permanent environmental damage) and in the absence of appropriate mitigation measures, is moderately likely (i.e. might occur at some time) to occur. This results in a high inherent risk of impact to aquatic environments.

During the haul road construction process, there will need to be some temporary modification of flow pathways within river channels to enable construction to proceed in dry conditions (e.g. constriction of flows). As detailed in Section 2.6, flows in streams will be maintained at all times and any alteration to flow patterns within the stream channels will only be temporary (i.e. 3-4 months). Consequently, this is considered to have a minor consequence and a moderate likelihood, resulting in a 'medium' inherent risk of impact to aquatic environments.

As described in Chapter 2, WDRL proposes to construct a permanent re-alignment of the Towns River to enable mining in some areas in the vicinity of the current stream alignment. Potential impacts associated with re-alignment of the natural stream channel may include loss of existing stream habitats and changes to stream hydrology and habitats, resulting in possible effects on ecological processes (e.g. fish migration) and changes to sedimentation regimes. Although the Towns River in the vicinity of the proposed mine pit contributes a relatively small proportion of the entire catchment (see Chapter 6), in the absence of appropriate design and construction, there would be 'major' consequences (i.e. substantial or permanent environmental damage) to the local and downstream aquatic environment and a 'moderate' likelihood (i.e. might occur at some time) of this occurring. This results in a 'high' inherent risk of impact to aquatic environments.

Hydrology Risk Mitigation

To minimise the potential risks associated with alteration to surface water flows associated with haul road stream crossings, their design and construction will incorporate appropriate engineering principles and natural flows will be maintained at all times. Details of construction techniques and engineering principles are provided in Section 2.6.

The re-alignment of the Towns River will be undertaken according to the following principles:

i. There will be no increase in the exiting water velocity
ii. There will be no changes in water quality
iii. There will be no overall changes in water quantity (no water will be used or diverted)

Section 2.13 and Appendix N2 describes the proposed re-alignment in detail.

The diversion of the Towns River will be designed and constructed in such a way that although the path of the stream channel will be permanently altered, natural flow patterns within the constructed channel and discharge (i.e. volumes, velocities and timing) to downstream areas will be maintained as close as possible to current conditions. The flood protection measures considered most likely to be sustainable over the long term is to re-align the stream channel with a trapezoidal cross section (30m wide and 3m deep) with uniform slopes (no steeper than 1 in 1) and embankments to direct the flood waters around and downstream of the mine. The entrance and exit to the channel will have a bell shape to intake and discharge flood waters. This option will require minimum maintenance and allow the stream to re-settle and establish its own morphology within the channel provided. Erosion protection and sediment control are to be achieved by providing a 0.5m thick rock armour cladding in the base and along the embankments to some 0.5m above the 100-year ARI flood level. This cladding will be allowed to silt and establish vegetation naturally, and with assistance during later years, approximately two seasons following construction, once the re-aligned channel has settled.

Hydrology Residual Risk

The above mitigation measures reduce the risk of hydrological impacts associated with the construction of haul road stream crossings to 'low' level and the crossings themselves to a 'medium' level.

The above mitigation measures reduce the risk of hydrological impacts associated with the re-alignment of the Towns River to a 'medium' level.

9.2.2 Surface Water Quality

As outlined in Chapter 6, surface water quality in the project area is generally very good with low concentrations of ions, metals and nutrients. However, baseline water quality data indicate that turbidity is naturally high for a catchment that is largely undisturbed. Surface water systems are particularly susceptible to changes in water quality associated with mining activities that may lead to inputs of contaminants from:

i. Acid/metaliferous drainage (AMD) from ore and/or waste rock;
ii. Suspended solids and turbidity in run-off from disturbed areas;
iii. Spills/leaks of hazardous chemicals; and
iv. Sewage and other wastes.

Surface Water Quality Inherent Risk Profile

The transfer of rock materials from underground to the ground surface may result in the mobilisation of solutes (e.g. metals, salts) to that may lead to degradation in quality of downstream surface and/or groundwaters. The risk of contaminant mobilisation is increased significantly with the occurrence of potentially acid forming (PAF) materials and as outlined in Chapter 3 and Appendix K, there are some PAF materials that will be mined in the project area and require active management. In the absence of

appropriate management, acid/metalliferous drainage has the potential to impact water quality and subsequently, aquatic ecosystem health for a considerable distance downstream. An example of a potential 'worst-case scenario' in relation to downstream impacts of AMD is the former Rum Jungle mine in the NT, where significant ecological impairment was recorded for a distance of up to 15 km downstream and a measurable effect for a distance of up to 30km downstream (Jeffree and Williams 1975). In the absence of appropriate management and/or mitigation measures, the consequence of this impact is considered to be 'major' (i.e. substantial or permanent environmental damage) and the chances of it occurring are 'likely' (i.e. known to and will probably occur), resulting in an 'extreme' risk of impact to downstream surface waters quality.

Within the mine project area and proposed haul road route, there are some soil types that pose an inherently high risk of erosion, as outlined in Chapter 3. Land clearing for mining and ancillary activities (e.g. pits, stockpiles, waste dumps, roads, processing areas, etc.) involves the removal of vegetation and in many cases, the soil surface cover. This may lead to erosion of soils/subsoils and subsequent transport of sediments into downstream aquatic environments in surface run-off. Significant erosion associated with an inappropriately designed and/or constructed re-alignment of the Towns River could also impact on downstream surface water quality (e.g. increased suspended solids). Increased sedimentation and turbidity can affect the functioning of aquatic environments in a number of ways, such as smothering of habitats, inhibition of photosynthetic activity and ecological effects (e.g. changes in visibility affecting predatory species). In the absence of appropriate mitigation measures, there are likely to be 'major' consequences (i.e. substantial or permanent environmental damage) with a 'moderate' likelihood (i.e. might occur at some time), resulting in a 'high' risk of impact to downstream aquatic environments.

As outlined in Chapter 2, the storage and handling of hazardous materials is primarily associated with hydrocarbons. Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream surface quality. In the absence of appropriate mitigation measures, there are likely to be 'major' consequences (i.e. substantial or permanent environmental damage) with a 'moderate' likelihood (i.e. might occur at some time), resulting in a 'high' risk of impact to downstream aquatic environments.

As outlined in Chapter 2.9, treated sewage water will be disposed of by land irrigation. If the disposal location has a connection to a drainage line, there is a moderate risk of impacts on downstream surface water quality associated with elevated nutrient concentrations. Irrigation of water in a small area could also lead to waterlogging of the soil and potentially a localised effect on vegetation (e.g. change in species composition). If not located or managed appropriately, domestic waste disposal may also pose a risk to surface water quality. Remaining non-hazardous (inert and putrescible) solid wastes will be disposed of in an on-site, trench type landfill. If the disposal trench location has a connection to a drainage line, there is a 'moderate' consequence (i.e. substantial temporary or permanent minor environmental damage) and 'moderate' likelihood (i.e. might occur at some time), resulting in a 'medium' risk of impacts on downstream surface water quality associated with elevated nutrient concentrations.

Surface Water Quality Risk Mitigation

Proposed measures to manage PAF materials are outlined below and in Appendix K and Chapter 2. In summary, this will involve a comprehensive mine waste management procedure including:

- Undertaking further drilling, construction and mining that includes ongoing identification, sampling and analysis of wastes with the view to minimize waste materials and to facilitate proper treatment and disposal in a suitably located, appropriately designed and constructed facility for the blending and encapsulation of PAF materials.

  Most of the PAF materials would originate from known locations and depths and may therefore be readily blended and/or encapsulated (preferred) with materials from shallower depths having acid neutralising capacities (ANC).

- Ongoing monitoring of waste qualities and volumes and the systems designed for the blending and encapsulation of PAF materials.

- Whilst sufficient identification and characterisation have been undertaken for the purposes of approvals, further on-going AMD investigations and assessments will be undertaken focussing on zones of uncertainty and within pit footprints for verification purposes to adequately quantify and manage waste residuals over the long term.

  As such geochemical kinetic field tests will be implemented to verify the potential for acid formation and the sulfide oxidation rates (SoRs) of the materials classifying as PAF, including those that fall within the zone of uncertainty.

- The implementation of methods for prevention, minimisation and mitigation of ARD is captured in a well devised Management Procedure to guide future approaches, investigations, assessments, designs, construction and operation, including identification, treatment and safe long term disposal.

Overall management options entail:

- The development of a Risk Assessment Framework for the Management of PAF Materials which would promote better environmental practice and continuous environmental improvement and awareness of AMD issues in the site.

Specific practical AMD management entails:

- Waste rock to be managed and disposed of undergoes site control and monitoring during mining and excavation activities.
- On-going risk assessments to define impacts on the local ecosystems and downstream environments including the performance of selected methodologies for the on-going identification, prevention, treatment and remediation of AMD and the development, rehabilitation and closure of the mine.
- To mine selectively until sufficient NAF/ANC materials are available to construct containment measures for the PAF materials.
- An upfront engineering approach to prevent AMD:
    - Construct engineered beds and/or cells for the disposal by encapsulation of PAF materials. Inhibition of oxygen and water into PAF materials is to be achieved by engineered dry covers. Using mining pits for the disposal of PAF materials will only be considered if it doesn't result in the sterilisation of ore reserves.
    - Encapsulation of PAF materials with ANC or NAF materials. Mine infrastructure includes adequately engineered waste rock dumps, drainage systems, sediment traps, seepage diversion barriers and collection ponds, and embankments to prevent surface waters entering the waste rock dumps containing PAF materials.
- Continuous management of PAF materials involves:
    - Characterisation/screening of waste rocks.
    - Kinetic tests to investigate SoRs and potential quality of drainage from mine waste structures.
- Monitoring will include surface water structures conveying and containing waters from ore and waste rock dumps. Shallow and deep bores for ground water monitoring will be constructed up and downstream of these facilities (refer Chapter 6).
- Identification of clay materials to be used to construct an impermeable base for the Waste Rock Dump and for providing a landscaped cap during rehabilitation with the view to minimize ingress of oxygen and infiltration of rain. The weathered NAF rock materials, excluding those that are potentially acid forming, may be used for constructing pads and walls.

Any contaminated water associated with PAF materials will be monitored and managed in accordance with:

i. A detailed Water Management Plan, to be developed by WDRL and approved by the regulating authorities prior to commencement of mining; and

ii. A detailed PAF Management Plan, to be developed by WDRL and approved by the regulating authorities prior to commencement of mining.

To mitigate potential impacts of increased turbidity and suspended solids associated with construction and mining works, monitoring and management of runoff will be undertaken in accordance with the Erosion and Sediment Control Plan (Appendix L) and Water Management Plan (to be finalised prior to project commencement). This will include the construction of settlement ponds in key areas, to enable adequate settling of suspended materials prior to use or discharge. Wherever possible, any discharge points will be located so that water flows into relatively flat, vegetated areas rather than directly into drainage lines.

Hazardous materials and wastes will be stored in appropriately labelled containers within purpose built dangerous goods and chemical storage containers. These are self-bunded, ventilated and are compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the *UN Recommendations for the Transport of Dangerous Goods – Model Regulations*) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery of contaminated soil).

All sewage wastewater generated from the mine site and main camp will be treated to a high quality and recycled according to the Northern Territory Department of Health *Guidelines for Management of Recycled Water Systems* (2011). The recycled water will be used for irrigation and dust suppression around the mining site. Irrigation of recycled water will be in accordance with the *Guidelines for Management of Recycled Water Systems* (Department of Health 2011a) and *Environmental Health Factsheet No. 513 Recycled Water Irrigation: Information Guide for Applicants* (Department of Health 2011b). The trench landfill will be located at least 150m away from any surface water pathways.

A comprehensive surface water monitoring program will be undertaken at the mine site, which will include sampling of both potential sources of contamination (e.g. sediment basins) and natural surface waterbodies upstream and downstream of mining infrastructure. Details of the proposed monitoring program are provided in Chapter 6 and the Erosion and Sediment Control Plans (Appendix L). Data will be stored in an appropriate database and reviewed at regular intervals (i.e. as data become available), to assess whether mining activities are impacting on surface water quality or if there are any trends in water quality that provide early warning of potential impacts.

Surface Water Quality Residual Risk

The mitigation measures outlined above will reduce high risks to surface water quality to moderate or low risks.

9.2.3 Groundwater Levels

As outlined in Chapter 6 and Appendix E, groundwater resources in the mining project area are comprised of two well-defined near surface systems:

1. A shallow highly localised unconfined aquitard system located at between 25 to 30m depth among a highly weathered sequence of sandstone interbedded with siltstones; and

2. A shallow semi-confined to confined aquifer system among the Sherwin Ironstone Formation (SIF) located between 50 to 60m below ground level, particularly where the shallow dipping reserves were observed to exist.

The primary means of groundwater abstraction associated with the proposed mining activities will be via pit dewatering. As outlined in Chapter 2.9, groundwater sourced from pit dewatering will be utilised in the processing plant and there will not be a requirement to discharge excess groundwater to surface water. Groundwater will also be abstracted for the purposes of potable water, camp ablutions and during construction of the haul road.

Groundwater Levels Inherent Risk Profile

The main potential impacts of groundwater abstraction include alteration to local or regional groundwater levels and availability, potentially affecting groundwater dependent ecosystems. Pit dewatering is likely to result in a localised effect on groundwater levels. The groundwater conceptual model for the project area and an assessment of the potential presence of groundwater dependent ecosystems (Chapter 6) indicates that there is unlikely to be any significant natural discharge of groundwaters to surface water within the project area. Consequently, the risk of significant effects on regional groundwater levels is considered to be medium. However, there is a small spring located at the south-eastern corner of the project area that is likely to be affected by pit dewatering activities. Groundwater assessment of the area has indicated that the spring is connected to the annually recharged, close to surface aquifers and not the deep aquifers. The shallow aquifers are rainfall dependant and likely to dry up during period of low or extended below average rainfall. The vegetation around the identified spring does not differ significantly from the surrounds indicating that it is not a permanent source of water.

Groundwater Levels Risk Mitigation

To confirm the predicted medium risk of regional groundwater impacts associated with pit dewatering activities, monitoring of groundwater levels will be undertaken in accordance with a Water Management Plan, to be developed by WDRL and approved by regulatory authorities prior to commencement of mining activities. There are no specific measures proposed to mitigate impacts of pit dewatering on the spring in the south-eastern corner of the project area, as inputs to surface water from this location are insignificant and impacts are likely to be restricted to a localised modification to vegetation composition and structure.

Groundwater Levels Residual Risk

The mitigation measures outlined above will reduce medium risks to groundwater levels to low risks.

9.2.4 Groundwater Quality

As outlined in Chapter 6 and Appendix E, existing groundwater quality in the project area is variable but relatively high in solutes. The main potential risks to groundwater quality are associated with inputs of contaminants from:

i. Acid/metaliferous drainage from ore and/or waste rock; and

ii. Spills/leaks of hazardous chemicals

Groundwater Quality Inherent Risk Profile

As with surface waters, there is a risk of contamination of groundwater associated with storage of PAF materials on the ground surface. This may occur if water (i.e. rainfall) that has entered the storage facility becomes contaminated and then leaches into the soils and groundwater beneath the facility. In the absence of appropriate mitigation measures, there is a high risk of impact to groundwater quality. If there are PAF materials within pit walls, these may also react to contaminate surface waters within the pit and subsequently contaminate groundwaters, if there is a connection to aquifers through the pit walls.

As outlined in Chapter 2, the storage and handling of hazardous materials is primarily associated with hydrocarbons. Potential impacts associated with spills or leaks of hazardous materials include contamination of downstream groundwater quality and, in the absence of appropriate management/mitigation measures, there is a high risk this occurring. Contamination of groundwater also has the potential to impact on surface water, in areas where there may be discharge of shallow groundwater to surface water.

Groundwater Quality Risk Mitigation

Proposed measures to manage PAF materials are outlined below and Appendix K. In summary, this is detailed above in the Surface Water Quality Risk Mitigation section. The prevention of impacts to surface water will prevent potential impacts to ground water, as will the appropriate design and construction of impervious pads for the short and long term storage of PAF materials so as to prevent the infiltration of waters into the groundwater.

Any contaminated water associated with PAF materials will be monitored and managed in accordance with:

i. A detailed Water Management Plan, to be developed by WDRL and approved by the regulating authorities prior to commencement of mining; and

ii. A detailed PAF Management Plan, to be developed by WDRL and approved by the regulating authorities prior to commencement of mining.

A comprehensive groundwater monitoring program will be undertaken at the mine site, which will include sampling of both deep and shallow aquifers, upstream and downstream of mining infrastructure. Details of the proposed monitoring program are provided in Chapter 6. Data will be stored in an appropriate database and reviewed at regular intervals (i.e. at least quarterly), to assess whether mining activities are impacting on groundwater quality.

It is unlikely that potential groundwater contamination will migrate off site during mining, as infrastructure such as ore stockpiles and waste rock dumps (WRDs) are located upstream of the open pits and these will be protected by engineered bunds, seepage and runoff collection ponds and sediment collection ponds. Modelling has demonstrated that groundwater flow will be towards the open pits, which will intercept pre- and post-mining contamination, if any. However, in the event that monitoring data indicates a potential impact of mining activities on groundwater quality, an investigation will commence immediately and involve the following:

i. Re-sample monitoring bores to confirm apparent trend;

ii. Determine potential source(s) of contamination and the risk of ongoing or more extensive contamination, utilising the expertise of an experienced hydrogeologist; and

iii. If required, determine and implement appropriate mitigation measures.

Where current management and/or mitigation measures are deemed inadequate, WDRL will provide and implement additional and/or engineer new measures to remediate and prevent further and possible future contamination.

In order to mitigate the potential risk of groundwater contamination from spills/leaks of hazardous materials and wastes, these will be stored in appropriately labelled containers within purpose built dangerous goods and chemical storage containers. These are self-bunded, ventilated and are compliant with AS1940-2004 Storage and Handling of Flammable and Combustible Liquids. These containers are suitable for the storage of paint, thinners, oils, diesel, chemicals, Class 3 flammables substances (as classified in the *UN Recommendations for the Transport of Dangerous Goods – Model Regulations*) and other potentially dangerous liquids. In the event that a spill or leak is detected, steps will be undertaken immediately to contain the leak/spill and if required, remediation measures will be implemented (e.g. recovery of contaminated soil).

Groundwater Quality Residual Risk

The mitigation measures outlined above will reduce high risks to groundwater quality to moderate or low risks.

9.3 Terrestrial and Aquatic Biodiversity

This section examines the potential impact that this development will have on the terrestrial and aquatic biological values of the region; this includes all species that spend the major part of their existence in

freshwater or on land; a discussion on marine biodiversity is in a subsequent section. This discussion is supported by literature review, as well as desktop and field survey done specifically for this development.

The region of the proposed development has substantial biodiversity conservation values. For example much of the development is within the Limmen National Park, nearby to the development there are internationally recognised sites for migratory birds (Bamford et al 2008) and numerous threatened species have been reported nearby to the development (see Appendix D). These values are reviewed, risk determined and mitigation measures identified.

For this discussion terrestrial and aquatic biodiversity has been subdivided into the following groups:

(i) Threatened species;

(ii) Migratory birds;

(iii) Sensitive habitats;

(iv) Vegetation communities; and

(v) Weeds.

For each of these groups the status, supporting data, inherent risks, mitigation strategies and residual risks will be identified. A summary of this discussion is in Table 9-5 below.

9.3.1 Terrestrial Threatened Species

To understand the regional assemblage of terrestrial threatened species the following studies were performed:

(i) Desktop survey;

(ii) Flora and fauna field survey; and

(iii) Bat survey.

Collectively these reports identify the threatened species of the development area, their ecology and the likely threats that this development will have on these species and these reports have been used to develop an understanding of the risk profile and risk mitigation for these species.

The list of threatened species, probability of occurrence and impact that this development will have on those species is outlined in Chapter 4; which concludes that most threatened species will not be affected because:

(i) No critical habitat is affected by the development (though see Section 9.3.3 below about sensitive habitats within development envelope);

(ii) These species are wide ranging to the extent that the range of these species is much wider than the spatial extent of the development; and

(iii) Other processes such as the cane toad and habitat alteration due to changes of fire regime may have had a greater impact than this development.

Chapter 4 concludes that there are two terrestrial threatened species that may be deleteriously affected by this development, namely:

- Thorny Solanum (*Solanum carduiforme*)
- Northern Quoll (*Dasyurus hallucatus*);

A discussion on the biology and habitat of each of these species can be found in Chapter 4.5.

The potential impacts of this development on these species are:

(i) Direct mortality, here this refers to mortality due to mine construction or operations;

(ii) Loss of habitat (i.e. changes in habitat quantity); and

(iii) Changes in habitat quality (including hydrological changes and noise).

Direct mortality refers to an immediate impact from this development such as road kill and death during clearing or operation of the haul road. There is no clearing of critical habitat of any regional threatened species and it is considered unlikely that any threatened species will be encountered on a road.

Loss of habitat refers to the removal of habitat for a species at either the population or regional scale. There will be approximately 1050ha cleared for this development: 450ha at the mine site, 550ha for the haul road and 50ha for the Loadout Facility. There is no clearing of critical habitat of any regional threatened species and it is unlikely that any of these will be in the clearing envelope.

Terrestrial Threatened Inherent Risk Profile

Direct mortality is deaths during construction or operation; this includes deaths during clearing of vegetation and operating the haul road. The quoll is was a wide ranging species utilising a range of habitat types with a more recent preference for rock habitats (Chapter 4); similarly the solanum has fidelity for this habitat thus any modification of this habitat is considered to have a potential impact on these species; however, the biological survey work for this EIS found neither species (Appendix D) even though suitable rocky habitat was surveyed extensively. The consequence of direct mortality during construction is considered minor: minor temporary environmental impact; the likelihood of such an event is also considered moderate: might occur at some time. This gives a risk profile of moderate.

Direct mortality also applies to the haul trucks killing quolls on the road; this would be most likely, if at all, where the road goes over or near to rock habitat. The consequence of such road kill events would be minor (temporary environmental impact) with the likelihood of unlikely (could occur but highly unlikely) giving a risk profile of low.

The reduction of habitat extent could, without mitigation, have an effect on terrestrial threatened species. The quoll was a wide ranging species but is generally now found in rocky habitat. The solanum is found only on conglomerate rock formations and larger sandstone ridges. Some of this habitat may be affected along the haul road. As this habitat is not uncommon in the region the consequence of this is considered moderate: permanent localised environmental damage. The likelihood is mediated by the fact that neither the solanum nor quoll was found during biological survey (see Chapter 4); given this it is considered that the likelihood of such an event is moderate, giving a risk profile of 13 high risk.

Habitat quality for terrestrial species may be affected by:

(i) Noise effects
(ii) Weeds
(iii) Changes in fire regimes
(iv) Poor rehabilitation techniques

The impacts of noise in relation to human receptors are discussed in Section 9.8.3; here the effect on noise on environmental receptors is considered. Noise may have a deleterious effect on species that live or travel through or nearby to the mine site and associated plant, the haul road and the Bing Bong loading facility. There will be an increase of noise in these areas, however it is thought that this will be localised and have no major effect to the extent that noise will be localised to the sites described above. The Northern Quoll has not been recorded near the mine and it is unlikely that either will be found at the Bing Bong loading and port facility particularly post-cane toad invasion. Consequently discussion will focus on the haul road. The consequence of the effect of noise from the haul road on the quoll is unknown but it is expected to be minor as the haul road will be a narrow strip in a large habitat. The likelihood of this hazard is considered to be unlikely. This gives an inherent risk profile of low risk.

Weed invasion due to the establishment of the haul road is a high risk for retaining habitat quality (see Section 9.3.6). However, in the most likely habitat for these two species (rocky areas) it is unlikely that there will be substantial weed establishment: the sandstone areas are highly desiccated have little soil (and what is there is typically depleted shallow sands). Subsequently, for these threatened species in this development a weed invasion would be small and localised and the consequence would be minor,

the likelihood of a substantial weed invasion in these habitats-for the reasons mentioned above- is considered unlikely, giving a risk rating of Low.

Changes in fire regimes are implicated as one of the most important landscape scale ecological threatening processes in northern Australia. In the contest of this development, however, the development's proponents are not obligated to manage fire except in protecting life and property through fire-break installation (see Section 9.8.1). Consequently, this hazard will not be further discussed.

For these species it is unlikely that rehabilitation will have an effect: rehabilitation will occur at the mine site and along the stream diversion: both unlikely habitats for these species. Consequently, this hazard will not be further discussed (for rehabilitation risks for the broader development see Section 9.5).

Threatened Risk Mitigation and Residual Risk Profile

The effects of direct mortality due to construction will be mitigated by ensuring habitat clearing is kept to a minimum and that specific habitat disturbance (in this instance rocky habitat) is avoided where possible. WDRL is committed to minimising habitat clearing by adhering to vegetation management plans. During the biological field survey for this project neither of the two threatened species considered here were found. Nevertheless, to reduce the probability of impacts during construction and operation to the quoll preferred habitat for the species (large rocky boulders or scree) was mapped (see Appendix D) with the intent of ensuring, where possible, avoidance of these areas during construction.

While it is known that the solanum occurs on sandstone, there are no known occurrences of the species along or nearby to the development area (it is known from 40km south of the haul road corridor). Mitigation for this species is ensuring that vegetation impacts/clearing is kept to a minimum.

By locating and avoiding rocky outcrops during construction the risk profile has been modified. The consequence is altered as any impact will be more localised then a no mapping exercise; the consequence is now considered to be minor. The likelihood of a direct effect on quolls during the construction phase by avoiding rocky habitats and on the solanum by vegetation clearing now makes an impact unlikely, giving a risk profile of low.

During the operational phase the ongoing risk to quolls is road kill. The risk is highest along the haul road where suitable rocky habitat is found. The risk of a road kill event on such a low density species was always low and by keeping the haul road away from suitable habitat the probability of road kill is reduced further; the consequence stays as minor but the likelihood is now considered rare retaining a risk profile of low.

Retaining habitat quantity for both the quoll and solanum requires that preferred habitat for these species is retained. For the quoll the process of locating and mapping preferred habitat is described in detail in Appendix D (and discussed above). As the solanum has not been recorded within (or nearby to) the development envelope any process that reduces the amount of habitat disturbance would reduce the probability of impact. As there is a reduced possibility of impacting these species by habitat removal any impact to these species would be localised (ie the regional extent would not be impacted). As a result of these measures the consequence of this hazard is now considered to be minor and a likelihood of unlikely giving a risk profile of low.

As discussed above the only habitat quality threats operative on terrestrial threatened in this development species are weeds and noise.

There will be no specific management response for noise; as discussed above risk is low and there are limited opportunities to mitigate further.

The risk profile of weeds or the project is high (see Section 9.3.6); in the context of threatened species however the inherent risk is considered to be low as the habitat for the threatened species discussed here is on a desiccated rock areas with thin and depleted soils. A Weed and Pest Management Plan (WPMP; Appendix F) has been developed as part of the EIS with the stated aims of reducing the extent of current weed infestations and ensuring no new weed species enter the development area. The WPMP

is applicable to the habitats discussed here but the risk profile, even with this mitigation measure, remains as Low.

9.3.2 Aquatic Threatened Species

A desktop study and aquatic survey has been performed for this EIS (see Chapter 4 and Appendix D). From this work a list of threatened species, probability of occurrence and impact that this development will have on those species is outlined in Chapter 4.

Chapter 4 concludes that there are four aquatic threatened species that may be deleteriously affected by this development, namely:

- Gulf Snapping Turtle (*Elseya lavarackorum*);
- Dwarf Sawfish (*Pristis clavata*);
- Freshwater Sawfish(*Pristis microdon*); and
- Green Sawfish (*Pristis zirjon*).

A discussion on the biology and habitat of each of these species can be found in Chapter 4.5.

Aquatic species can be affected by changes in habitat condition ie changes in water quantity and quality. Hazards to water quality and quantity for this development specifically include:

- Any changes in water quantity due to the realignment;
- Increased turbidity due to erosion;
- Changes in water quality due to acid mine drainage;
- Changes in water quality due to pollutants eg hydrocarbons.

Aquatic Threatened Species Risk Profile

For this risk analysis we assume that any changes in the above parameters may have deleterious consequences on aquatic threatened species; consequently the risk profile, management and mitigation is considered to be the same as that for each of the hazards discussed elsewhere within this risks chapter; specifically see Section 9.2.

9.3.3 Migratory Shorebirds

The migratory shorebirds of the area are described in Chapter 4. In summary migratory shorebirds are known to use three areas nearby to the development all are within Sites of Conservation Significance (SOC) (Harrison *et al.* 2009). The first is near the Bing Bong Loadout Facility which is within the McArthur River Coastal Floodplain SOC; the second is The Edward Pellew Island Group SOC which is offshore from loading facility at Bing Bong; the third is Limmen Bight and Associated Floodplains SOC which is at the mouth of the Limmen Bight and Towns Rive (Figure 5.8). Even though it is believed that migratory birds do not utilise the area immediately near the Bing Bong port facility (Appendix D; Xstrata Zinc 2010) for comprehensiveness this section will examine the potential threats and risk profile to migratory as if these species are found there.

Migratory Risk Profile

The hazards to each SOC are also hazards to other values. For instance changes in water quality is considered a key risk for this project as well as potentially having an effect on the SOC. Rather than repeat the risk analysis this section identifies the hazards operative on each SOC and refers to where in this risks section it appears (see Table 9-4).

Table 9-4 The hazards affecting migratory birds in each of the Sites of Conservation Significance (SOC) nearby to the RBIO development and the Risk Section in which the hazard, hazard mitigation and risk profile is addressed.

Hazard	SOC			Risk Section
	Bing Bong	Edward Pellew	Limmen	
1. Changes in stream water quality affecting shoreline habitat due to:				
a. Bridge installation increasing bank erosion and altering sedimentation regimes.	X		X	9.2.2
b. Hydrocarbons spills	X	X	X	9.2.2
c. Acid forming materials either affecting water quality through secreting from the ore body or from raining on stock piles at Bing Bong or from vehicle accident dumping these materials into stream	X		X	9.2.2
2. Spills of hydrocarbons onto shore from ships or barges	X	X		9.4.1
3. Dust affecting water and/or air quality	X		X	9.8.4
4. Noise affecting bird use nearby to the port facility.	X	X		9.8.3
5. Light at night-time affecting normal behaviour.	X	X		9.4.2

9.3.4 Sensitive Habitats

Sensitive habitats is a term used in the guidelines that includes ecosystems that provide important ecological functions including e.g. riparian vegetation, protected area buffer zones, refugia, important habitat corridors, or geological features which may support unique ecosystems (escarpments, gorges, gullies etc.). This section will look specifically at maintaining these habitats during the construction process; ongoing issues such as weeds are dealt with elsewhere.

A number of specific sensitive habitats were defined within this development's envelope, specifically:

(i) Wetlands;

(ii) Rocky outcrops;

(iii) Riparian vegetation;

(iv) Mangroves; and

(v) Rainforest.

Chapter 4 discusses the biodiversity including the sensitive habitats of the region, it concludes that no patches of rainforest are encountered in this development, nor are any patches of mangroves disturbed, consequently they are not examined in this risk analysis. The effect of the realignment of the Towns River and the impacts on connectivity and riparian vegetation is discussed in Section 9.3.7.

Sensitive habitat survey work includes:

(i) Vegetation mapping at the mine site;

(ii) Wetland mapping along the haul road;

(iii) Rock pile mapping along the haul road; and

(iv) Riparian vegetation mapping along the haul road.

Appendix D describes the vegetation, wetland, rockpile and haul road riparian vegetation mapping processes and outcomes.

Sensitive Habitats Inherent Risk Profile

There is potential impact on these communities through:

(i) Direct impacts such as clearing of the habitat during mine related clearing; and

(ii) Indirect impacts that influence ecological processes that support and maintain the habitat or its values, for example altering hydrology of ephemeral wetlands nearby and downslope of the haul road.

Without an expressed need to protect these sensitive habitats they would not have been identified, mapped and management strategies employed, thus there would be a high likelihood that some examples of these habitats would be adversely affected. These habitats, though, are not uncommon. Considering this the consequence of the development continuing without any mitigation measure for these habitats is considered moderate (ie there will be permanent localised environmental damage); the likelihood of such an event is also considered to be moderate (ie might occur at some time), giving a risk ranking of high.

Sensitive Habitats Risk Mitigation

Mitigation of impacts during the construction phase is primarily around avoiding them during construction and, for the wetlands, ensuring that construction does not interfere with hydrological connectivity. Appendix D outlines the process of identification and mapping of sensitive habitats. This mapping helped determine potential threats to each occurrence, these included:

- Rock piles along the haul road there was the potential for clearing;
- Mapping along the haul road has shown that there is no substantial impact on riparian vegetation (Appendix D) and adherence to clearing guidelines will ensure that creeks and streams on the mining lease will retain a buffer of vegetation where they need to be cleared; and
- Some wetlands along the haul road may require wet season surface flows to fill them; there is the potential for the haul road to impact on this drainage.

For the two sensitive habitats that may be impacted by this development (rock piles and wetlands) the following mitigation measures will be put into place:

i. Using the rock pile mapping ensure that these are avoided during road construction; and

ii. Using wetland mapping and contour data ensure that culverts are installed above these ephemeral wetlands.

Sensitive Habitats Residual Risk

By avoiding impact to these sensitive habitats by physically avoiding impact and retaining hydrological connectivity the consequence would be unchanged as moderate but the likelihood has been reduced to unlikely giving a risk profile of medium risk.

9.3.5 Vegetation Communities

The EIS Guidelines identify concerns around vegetation clearance, rehabilitation and the spreading of weed species. The rehabilitation and weeds are dealt with elsewhere within this risk chapter, here vegetation clearance is considered. Important considerations for vegetation clearance include the type of vegetation cleared (i.e. restricted or rare vegetation communities), the extent of the clearance (including implications on connectivity as well as buffering for creek side vegetation), how it is cleared (including blade depth) and the stability of the soils of the cleared site (this has implications for erosion).

Vegetation communities of the development area have been mapped (Appendix D). That Appendix concludes that there is no vegetation or ecological community of national or Territory significance within the clearing envelope and that the existing vegetation communities are common throughout the region.

Vegetation Inherent Risk Profile

The inherent risk to vegetation relates to inappropriate clearing as described above. Without a proper clearing planning framework supported by relevant knowledge and information over-clearing, clearing of the wrong type of vegetation and not considering ongoing erosion issues might result. For this development, after considering the clearing profile the consequence is moderate (3) and the likelihood is moderate (C) giving a risk rating of 13 (high risk).

Vegetation Risk Mitigation

The issues outlined above are mitigated by:

i. Using existing Northern Territory Land Clearing Guidelines (NRETAS 2010) to inform clearing procedures and processes;

ii. Vegetation clearance planning will aim to clear the least about of vegetation as possible;

iii. All approved clearing boundaries to be shown on maps;

iv. Ensuring no clearing occurs in rare, restricted or sensitive vegetation communities; and

v. Utilising best practice when clearing vegetation in the context of retaining buffers for riparian vegetation.

vi. Ensuring that the above commitments are incorporated into the MMP auditing process.

Vegetation Residual Risk Profile

With these mitigation strategies in place the residual risk profile has a consequence of minor (2) and a likelihood of moderate (C) giving a medium risk (8)

9.3.6 Weeds and Pests

The weeds and pests discussed here are aquatic and terrestrial; marine pests are discussed in the marine risks section (Section 9.4).

Weeds are serious issue as they reduce habitat quality and adversely affect rehabilitation programs. While no weeds have been recorded in the exploration area, weeds have been recorded within the future development area, among them Weeds of National Significance (WONS). For instance the WONS Parkinsonia (*Parkinsonia aculeata*) has been recorded near to the proposed loading facility.

This development can allow for wider establishment of existing weeds as well as facilitate the introduction of new weeds. The activities that could lead to this includes:

i. Clearing and disturbing vegetation;

ii. Installing the haul road; and

iii. Vehicle movement.

Pest animals are also of concern. Pests can aid in the spread of weeds, lead to a decrease in populations of native species, increase erosion and be a hazard for vehicles. There are a number of pests known from the development area.

Weeds and Pests Inherent Risk

Without a strategic program to mitigate the further spread of existing weeds or the importation of new weeds it is expected that the consequence will be moderate (3) with a likelihood of likely (D) giving a risk ranking of 17 (high risk).

Pest animals may also benefit from this development without mitigation activities, specifically poor waste management will lead to an increase in population of existing pests (for instance cats, pigs and rats).

Weeds and Pests Risk Mitigation

WDRL has developed a Weed and Pest Management Plan (WPMP, Appendix F) for this development. To support the development of the WPMP a desktop survey of known weeds was performed, this identified 75 regional exotic plants. Weed mitigation strategies will focus on Class A weeds. WDRL has committed to fund a weed survey along the proposed haul road route to determine current weed extent to support weed control and containment strategies. These strategies include control of existing weeds along the haul road route, implementing hygiene protocols (including wash down bays) located to limit weed spread and auditing effectiveness of these strategies by follow up weed survey.

For pests the WDRL commitment is to limit the availability of food and water resources by burning and burying rubbish and by avoiding the creation of artificial water points that could provide a source of drinking water to vertebrate pests or breeding habitat for invertebrate pests.

The WPMP provides further details of these commitments.

Weeds and Pest Residual Risk

It is thought that the weed management strategy outlined in the WPMP will have an impact on the likelihood of Class A weeds spreading as a consequence of this develop. The risk residual profile has a moderate (3) consequence, but a reduced likelihood of moderate (C) giving a risk ranking of 13 (high).

9.3.7 Loss of connectivity along realigned channel

An identified key risk to biodiversity by this development is loss of the riparian corridor, and subsequent connectivity at the river realignment due to mortality of existing riparian vegetation. It is thought that connectivity of the riparian corridor is likely to be lost between the upstream and downstream sections of the river before the realigned channel is fully established, with consequential ecological impacts.

Realigned Channel Connectivity Inherent Risk Profile

Section 6.3 describes the river channel at the realigned section and describes the stream side vegetation not as a distinct and identifiable riparian strip but rather the vegetation abutting the stream is frequently the same as that distant from the stream: open-eucalypt communities and, more frequently, floodplain Melaleuca communities. Consequently, this discussion will focus on the fate of the Melaleuca floodplain communities as the open-eucalypt communities will not be affected by changes in the groundwater regime.

These Melaleuca communities were developed and maintained by frequent inundation. Hydrological modelling (Appendix N,) along the realigned section of river shows that there will not be a substantial change in inundation frequency. Consequently this development will not alter the hydrology supporting this vegetation thus not affect connectivity.

Because of this the risk score is considered to be low as the consequence of the realignment on these vegetation communities will be insignificant with the likelihood considered unlikely.

Realigned Channel Connectivity Mitigation and Residual Risk

As there is no perceived risk to these vegetation communities there are no mitigation strategies and the risk scoring remains low as per the inherent risk.

WDRL commits to monitoring these vegetation communities to ensure that they do not in form as a consequence of this development.

9.4 Marine Environment

This section examines the potential impact that this development will have on the marine environment and is based on the information contained within Chapter 5 – Marine Environment.

The study area which has been used to describe baseline conditions of the marine environments includes the coastal zone and marine waters in proximity to the existing Bing Bong loadout facility:

situated on the south-western coast of the Gulf of Carpentaria near the Sir Edward Pellew group of islands. All coastal and marine infrastructure is proposed to be located at this existing facility.

The marine environment at the mouth of the Towns River is not considered here, the risks to the marine environment are the same as those for surface water quality and hydrology (Section 9) approximately 80 kilometres upstream from the mouth of the Towns River.

For the purpose of this report, the marine environment is inclusive of the intertidal zone, and both Northern Territory waters (three nautical miles seaward of the Mean Low Water Springs and offshore islands) and Commonwealth marine waters (three to 200 nautical miles from the coast).

The study area includes all marine components of the proposal, specifically the Barge Loading structure, transhipment anchorages and existing loadout facilities.

The development of this section has been is supported by a desktop literature review and includes the results of previous research carried out in the vicinity of the subject site, specifically studies undertaken for the McArthur River Mine Bing Bong loading facility, and other environmental investigations in the region.

For this discussion the potential risks to the marine environment have been grouped by theme, specifically:

(i) Habitat degradation;

(ii) Species level impacts;

(iii) Coastal and marine processes; and

(iv) Socio-economic impacts.

Cumulative impacts from the expansion of Xstrata operations have been considered.

The potential impacts upon the marine environment are reviewed with respect to coastal and marine values, risk determined and mitigation measures identified. For each of these themes the status, supporting data, inherent risks, mitigation strategies and residual risks will be identified. A summary of this discussion will be in Table 9-5.

9.4.1 Habitat degradation

Coastal and marine habitats present at the Bing Bong loadout facility and adjacent waters include seagrass and macro-algal communities, intertidal banks, sandy beaches, mangrove forests, salt flats, open waters, inshore rocky reefs, and freshwater wetlands.

There are a number of potential impacts associated with the project that have the potential to degrade coastal and marine habitats, in particular sensitive marine ecological communities such as seagrass beds and soft sediment communities.

Significant marine communities immediately adjacent to the loading facility include extensive seagrass beds, found along the coast between the Roper and McArthur Rivers, and subtidal soft sediment communities. These communities support a number of fauna species of conservation significance, including dugong, a number of cetacean species, marine turtles, migratory seabirds and shorebirds, and fish. Conservation values of the marine environment are described in detail in Chapter 5.

Habitat Degradation Inherent Risk Profile

There are several potential impacts which have the potential to degrade marine ecological communities, and consequently the fauna species that are dependent upon them through:

i. Direct impacts including seabed disturbance from construction and operation including construction of the combi-pile wall, Barge Landing Facility, and maintenance dredging and associated impacts on water quality and soft sediment biota;

ii. The introduction of artificial habitat associated with the Barge Landing Structure and combi-pile wall, transhipment anchorages etc.;

iii. Acoustic and physical disturbance; and

iv. Potential impacts including:

- Spill of hydrocarbon or Direct Shipping Ore (DSO);
- Failure of the Towns River tributary realignment (though considered unlikely); and
- Introduction of invasive marine species; and
- Introduction of rubbish and waste into the marine environment (i.e. marine debris, sewage).

Potential consequences of these impacts occurring are expected to be generally localised, minor to moderate in nature and short-lived, with the exception of ongoing acoustic disturbance, and the potential for a major hydrocarbon spill. This conclusion has been based on a number of factors, including but not limited to:

i. That no critical habitat is affected by the development;

ii. That ranges of affected species are much wider than the spatial extent of the development; and

iii. Suitability of other habitat external to the affected areas.

The consequence of an unmitigated, major hydrocarbon spill would result in significant habitat degradation, likely injury or mortality for a number of species of conservation concern, and sediment and sea water contamination.

The consequences of unmitigated acoustic disturbance could result in a number of impacts to several marine taxa in proximity of the swing basin, entrance channel and navigation routes, including potential injury or death, disturbance to normal behaviours, and temporary avoidance or permanent displacement for some noise sensitive species. These impacts are considered to range from minor to major.

Habitat Degradation Risk Mitigation

Management of these direct and potential impacts is multi-faceted and involves quantification of the likelihood of risks occurring, as well as the scale and magnitude of mitigation measures required, particularly given that the proposed Barge Landing Facility is to be located within an operational loading facility.

Mitigation of potential impacts on habitats includes but is not limited to:

i. Timing of construction works to take into account seasonal and tidal variation;

ii. Physical mitigation measures including sediment and erosion control barriers and silt curtains as per best practice guidelines;

iii. Acoustic controls including observers prior to and during construction, soft start procedures, and speed restrictions;

iv. Dust suppression measures;

v. Design controls to prevent spills including covered conveyors and loading chutes, automatic cut-off valves on fuel hoses, standard operating procedures and clean up procedures;

vi. Management of rubbish and waste including licenced sewage disposal facilities onshore; and

vii. Monitoring of water and sediment quality, presence of invasive marine pest species and other marine biota.

Habitat Degradation Residual Risk

With the risk mitigation outlined above, it is expected that for the majority of impacts, the consequence of occurrence is low risk, with the exception of acoustic disturbance for which the consequence is considered medium risk.

9.4.2 Species Level Impacts

Subtidal zone surveys (i.e. sediment sampling or inshore fish surveys) have not been undertaken by EcOz Ecologists given that the majority of marine infrastructure is to be located within an existing operational loading facility. However, to understand the regional assemblage of threatened species literature reviews and desktop studies were undertaken. This enabled identification of the likely species present in the development area, their ecology and the likely threats that this development will have on these species as well as the likely risk profile and required mitigation measures for these species.

A review of marine species considered to be potentially occurring within the study area based on published data, database searches, general distributions and habitat requirements, and sightings from other more populated areas of the Gulf is outlined in Chapter 5; including their probability of occurrence, conservation status, and impacts that this development will have on these species. The assessment has focused on conservation-dependent and migratory marine species in accordance with the requirements of the EIS guidelines.

Based on the assessment contained within Chapter 5; there are a number of marine taxa that may be subject to species level impacts; significantly dugong, marine turtles, three inshore cetacean species, and a number of bony and cartilaginous fish species. Impacts in this instance do not include those previously described in habitat degradation i.e. underwater noise impacts.

Species Risk Profile

The potential impacts to marine fauna species due to this development include:

i. Direct mortality or injury;

ii. Changes in habitat quality (including physical disturbance, light and noise); and

iii. Behavioural impacts associated with risk or perceived risk to impacts such as boat strike, and artificial lighting.

Direct mortality or injury refers to an immediate impact from this development such as boat strike, and behavioural impacts associated with factors such as artificial lighting including disruption of critical behaviours such as nest selection and sea-finding behaviour.

With respect to boat strike, this is known to cause direct mortality of several marine species of conservation concern, in particular marine turtles, and also dugong and cetacean species. Artificial lighting sources associated with onshore infrastructure, and potentially offshore sources such as ships also have the potential to indirectly cause mortality.

Without any management intervention to mitigate hazards and subsequently risks the risk profile of the development is considered to be medium.

Species Risk Mitigation

Risks are mitigated by the following:

i. Mandatory speed restrictions within the entrance channel and swing basin;

ii. Personnel aboard all vessels will be responsible for remaining vigilant and avoiding cetaceans, dugong and turtles. Furthermore, strict marine megafauna interaction procedures are to be implemented (assuming that these do not presently exist for current loading operations) – approach distances are 50 m (dolphins and turtles) and 100 m (whales and dugongs) – i.e. no vessel must approach closer than these distances;

iii. Marine turtle nesting monitoring (see next point) in the vicinity of the loading facility including West Island will be undertaken, and lighting controls are proposed to minimise cumulative light emissions from the Bing Bong Loading Facility (noting that no nesting is known to be occurring on the mainland coast in proximity to Bing Bong).

iv. A strategic assessment of proposed mitigation measures and the current Xstrata marine monitoring program will be undertaken. This will investigate the requirement for additional monitoring, and the suitability of mitigation measures given the cumulative impact of both Xstrata's expansion and WDRL's proposal. The outcomes of this strategic assessment will be used to verify the proposed mitigation measures within this document (or provide alternative measures), and to determine an appropriate monitoring regime at the loading facility; and

v. Monitoring and reporting as determined by the outcomes of the strategic assessment will be undertaken.

Species Residual Risk

With the risk mitigation outlined above, it is expected that there is a low risk to marine megafauna specifically dugong, marine turtles, and Australian Snubfin, Indo-Pacific Humpback Dolphin, and Indo-Pacific Bottlenose Dolphin, as well as other marine taxa that may be vulnerable to boat strike. Whilst turtle nesting is not thought to be occurring adjacent to or within close proximity to the loading facility, cumulative light emissions may still serve to disorientate nesting females, as well as acting as a form of habitat degradation to nesting beaches in the nearby Pellew Island group. Consequently mitigation and monitoring measures are proposed to ensure the risk to marine turtles are minimised.

9.4.3 Coastal and Marine Processes

Potential impacts upon coastal and marine processes has been informed by a literature review of potential impacts associated with similar projects, prevailing climatic and weather conditions, and information on existing coastal morphology, bathymetry and sediment regimes.

Coastal process modelling has not been undertaken to inform this study, however will be undertaken at the Detailed Design stage as required to ensure that the proposed Barge Landing Facility does not impact upon coastal processes.

Coastal and Marine Processes Inherent Risk Profile

Potential impacts associated with tidal and near shore structures generally relate to potential for erosion and slumping as a result of coastal hazards such as storm bite, changed sedimentation regimes, and other coastal processes.

The detailed design of Infrastructure is incomplete however the Barge Loading Facility is unlikely to interfere significantly with active sediment transport given the low energy environment of the site and position within an operational loading facility. A causeway structure may potentially cause accretion on the updrift side and erosion on the downdrift side however given the low net rates of sediment transport; this is likely only in storm events.

Additional, shallow excavation in the swing basin is unlikely to have any significant effect on the wave climate of the loading facility or sediment regimes and therefore should not result in any significant effect on the existing loading facility or surrounding shoreline. Without any management intervention to mitigate hazards and subsequently risks the risk profile of the development is considered to be medium.

Coastal and Marine Processes Risk Mitigation

It is anticipated that even in the case of a storm event, that erosion is unlikely to be extensive, and any erosion scarps may be backfilled from the zone of accretion, using conventional earthmoving equipment. Coastal process modelling will be undertaken if required at the Detailed Design stage to ensure that the proposed Barge Landing Facility does not impact upon coastal processes.

Coastal and Marine Processes Residual Risk

With the risk mitigation outlined above, it is expected that for the majority of impacts, the likelihood of occurrence is low as is the consequence of occurrence. Therefore the residual risk profile is considered to be low.

9.4.4 Socio-economic Impacts

Potential impacts upon socio-economic values associated with the marine environment has been informed by a literature review of potential impacts associated with similar projects, as well as consultation and socio-economic assessment of the proposal, undertaken in support of preparation of this EIS (Chapter 8 and Appendix G).

Socio-economic Inherent Risk Profile

Potential socio-economic impacts associated with marine resources of the study area include:

i. Restriction of access to a popular recreational fishing site at the proposed Barge Landing Area;

ii. Potential interactions with commercial and Indigenous fishers;

iii. Impacts of cyclones and heavy storms on life and property including infrastructure and equipment damage and destruction, injury and mortality to personnel and or visitors; and

iv. The potential for barge groundings and collisions.

Without any management intervention to mitigate hazards and subsequently risks the risk profile of the development is considered to be high.

Socio-economic Risk Mitigation

Proposed mitigation measures will include:

i. Relocation of the existing viewing platform, access track and informal car parking area with appropriate signage installed as required;

ii. Ongoing consultation with both Traditional Owners and the fishing industry will take place to ensure that any potential negative interactions between commercial and Indigenous fishing and hunting can be prevented;

iii. Design of all facilities will be in accordance with relevant standards to withstand cyclones, and cyclone moorings for all barges and floating plant will be provided, as well as cyclone shelters for personnel and visitors and emergency procedures and planning implemented; and

iv. Development of a set of Operating rules; emergency response procedures; safety and security procedures; and the potential creation of shipping officer positions to manage traffic into and out of the loading facility.

Socio-economic Residual Risk

With the risk mitigation outlined above, it is expected that the residual risk of socio-economic aspects of the proposal is low.

9.5 Rehabilitation and Mine Closure

This section examines the potential impact risk associate with the rehabilitation and closure of the project and is based on the information contained within the Decommissioning and Closure section of Chapter 2.

The project draft Rehabilitation and Closure Plan is presented as Appendix P and has been developed in accordance with the document *Leading Practice Sustainable Development in Mining – Mine Rehabilitation* (DITR 2006), and the West Australian Environment Protection Authority and Department of Mines and Petroleum *Guidelines for Preparing Mine Closure Plans*. The key message and goals associated with this Rehabilitation and Closure Planning document include:

- The development of a rehabilitation plan during the planning phase which will evolve as results from research and on-site trials become available;
- Ensuring early characterisation of the materials to be rehabilitated to identify potential issues in time for them to be resolved;

- The understanding of the environmental externalities which have the potential to constrain rehabilitation success; and
- The setting of realistic rehabilitation objectives.

This EIS or associated documents do not detail the aspects of closure that involve the removal of plant, equipment, structures, hardstand and concrete footings, buildings or water storages. These are simple mechanical processes that are easily achieved and expected, it is the stabilisation and rehabilitation of the site that requires the most detail at this stage of the process so that investigations into the rehabilitation methods can begin immediately the project commences.

As no mining has yet occurred, no rehabilitation trials have commenced, it is premature to begin to develop contingency management measures against rehabilitation failure. As the site will be managed so that it can be progressively rehabilitated, there will be site undergoing several different stages of rehabilitation during the projects operational stage. This will allow for research and trials of the techniques used and these should inform the need for contingency measures. As a worst case scenario contingency, the NT Government holds an independently agreed rehabilitation security bond to the value of 100% of the potential cost of closing and rehabilitating the site as a precaution against the Company being unable to fund the activities.

For this discussion the potential risks associated with rehabilitation and mine closure are related to poor implementation or failed activities associated with this requirement. The overall objective of WDRL's rehabilitation plan is to mitigate all potential risks and in line with views expressed during stakeholder consultation, create a stable final landform, returning as much of the Project area as practicable to a similar landscape and ecosystem to what was the pre-mining land use. The rehabilitation strategy will remain flexible and will be amended as new rehabilitation techniques emerge and as environmental investigations progress.

The key aspects of such a strategy involve the proper design, prevention and/or management of:

i. Surface water impacts via prevention of erosion and sedimentation;

ii. Surface water impacts via prevention of acid or metalliferous drainage;

iii. Ground water impacts via prevention of acid or metalliferous drainage;

iv. Self-sustaining endemic vegetation;

v. A safe and contamination free environment for people and biota; and

vi. General 'off site' impacts.

Identification of major risks and the present level of understanding of the required management are identified in Chapter 2 as environmental issues. They are repeated here.

During operations, the progressively rehabilitated areas will be subject to management so that they are excluded from any bushfires or intentional burning activities.

Operations are expected to be a sufficient enough deterrent to feral animals. The feral animal density in the region is currently low and mining operations are not expected to result in this increasing, so if required feral animal impacts to rehabilitation will be investigated during operations.

The mine site is currently weed free and quarantine measures are in place in an attempt to maintain the site as weed free. This will impact rehabilitation activities in that no soils will be able to be imported to site, including soil for seedlings propagated for revegetation purposes.

The surface waters in the region are naturally turbid and sediment laden. WDRL do not intend to increase the sediment load of the surface waters and will be installing erosion and sediment control measures to manage this issue during vegetation establishment. The design and study and refinement of that design during progressive rehabilitation will allow for a greater understanding of long term erosion and sedimentation potential.

The prevention of impacts to surface and groundwater resources from potentially acid forming (PAF) materials is identified as a risk to rehabilitation success and study into these issues will continue as the project progresses. It is normal for PAF material to be significantly deep so as to allow for the further and longer term study of the materials, the study and design of placement areas and materials, the establishment of monitoring bores and other devices and the development of contingency plans. This is all part of the ongoing acid rock drainage (ARD) studies that are documented in Appendix K.

There is the potential for temporary and partial interruptions to stream flows during Haul Rd construction. No diversions or re-alignments are planned as it is expected that all crossings can be constructed without major interruptions to the stream flow. Construction activities are planned for late in the dry season when flows are at their lowest or have ceased. The Construction EMP includes details of management measures, however the selected contractor will also be required to finalise such measures prior to construction.

One re-alignment within the mine site is required, as the stream traverses pit F. This re-alignment will be planned and designed to be a permanent feature in the landscape. The conceptual design is in the surface water section of the EIS and at Appendix N. A permanent stream re-alignment will be designed and constructed to a greater level of detail than would be required for a temporary re-alignment. It will be established very early in the project development and be operational for the life of the project. This will allow for at least eight years of monitoring and management, to ensure its stability and functionality.

9.6 Social and Cultural Impacts

This section examines the impacts that this development could potentially have on the social and cultural aspects of the region. There are two broad themes within this section: heritage and socioeconomic.

Sites of indigenous and non-indigenous importance have been determined from archaeological reports on the haul road (see Appendix I) and mine site (see Appendix J) specifically done for this EIS. An Aboriginal Areas Protection Authority (AAPA) register search, which gives the location of known sacred sites, has also been performed. To further mitigate any impacts to these values WDRL is in a process with Traditional owners and the NLC to get certification.

The socioeconomic work examines the impacts that this development could potentially have on the social and cultural aspects of the region with a particular focus on the four communities affected or affecting the development. These are:

- Borroloola;
- Minyerri;
- Ngukurr; and
- Numbulwar.

The information in this section is drawn from two primary documents that have been developed to support the submission of the EIS and each is included with the submission of the EIS as an Appendix. In summary these documents are:

1. *Roper Bar Iron Ore Project: Community Profiles for Borroloola, Minyerri, Ngukurr, Numbulwar* (Social Compass 2012)

   This report is a detailed socio-economic study of each of the four communities. Information is sourced from significant desktop research inclusive of a review of public documents, research papers and other publication. The profiles are also inclusive of consultations that have taken place over the previous 12 months at the community, regional, local government and Territory Government levels.

   The report is included as Appendix G with this EIS.

2. *Roper Bar Iron Ore Project: Consultation Report* (Rowland 2012)

This report provides a detailed overview of the results collected during consultation with the four communities and key stakeholders. The consultations were undertaken as part of the Social Impact Assessment (SIA) for the EIS. Consultation was undertaken in accordance with the requirements and objectives stated in the NRETAS Guidelines issued in February for the Roper Bar Iron Ore Project.

The report is included as Appendix H with this EIS.

In terms of articulating the potential benefits or negative impacts that the development could bring, consultations across the four communities demonstrated that with 15 years exposure to other resource projects, the community of Borroloola has become more acutely aware of the benefits, opportunities, issues and potential threats of mining projects. However, all communities were clear in terms of detailing their aspirations.

Employment training and youth opportunities were the key areas where people felt the project could deliver the most positive contribution. The topics of traffic, roads and cultural heritage were the key areas of focus to ensure potential negative impacts were mitigated/managed.

For the following discussion social and cultural aspects have been subdivided into the following primary focus areas (under which the Community Profiles are mostly structured):

i. Assets and Infrastructure – including any impacts of construction;
ii. Education – Early Years to Adulthood;
iii. Economic Participation and Development – including employment and training;
iv. Youth Opportunities;
v. Health – including accommodation and housing; and
vi. Cultural Heritage – including effects on cultural practices and traditions (e.g. language).

The principle mitigation strategy for socioeconomic risks is included in the offsets package which addresses concerns and desires for outcomes as identified in the Consultation Report (Appendix H). The key component of the offsets package are the youth and health programs and a social enterprise mechanism to support community development outcomes. For full detail see Offsets Chapter 6.

Future stakeholder engagement will use the principles, procedures and processes used to date for community consultation as described in Consultation Report (Appendix H). WDRL has committed to ongoing social impact assessments to monitor changes over time, with community and stakeholder consultation playing a key role in this unique approach.

For each of these focus areas the status, inherent risks, mitigation strategies and residual risks will be identified. Notably, some of the risks have a heavier characterisation for some communities than others - though all those identified have some level of risk in each community. Where appropriate the salience of the risk for each community is assessed.

A summary of this discussion will be in Table 9-5.

9.6.1 Assets and Infrastructure

The capacity of a community to manage change and take control and ownership of community development is often dependent on the existing and future assets and infrastructure. This includes the ability within the community to manage such assets and infrastructure and the governance arrangements within the community to manage its own affairs.

To understand the strengths and challenges faced by each of the four community's significant desktop research and consultation was undertaken to assess the current assets and infrastructure and assess the future needs and concerns. Those consulted were Traditional Owners, Elders, community members, Aboriginal Community Controlled Organisations, service providers and wider stakeholders.

Collectively, this analysis identified a number of areas where the communities felt that the development might impact negatively or where the communities felt the development could enhance future asset and infrastructure needs.

The major concerns and therefore risks identified in relation to assets and infrastructure were in the following areas of interest:

(i) Traffic and Roads

Community members across all communities raised concerns about the existing conditions of the main roads within the region. The majority of stakeholders specifically raised concerns about the conditions of the roads during the wet season, which has implications for both access for the community, safety of the community and the delivery of goods and services to support the mine and the community. Isolation during the wet season was viewed as a negative impact. Most stakeholders acknowledged that it is the government that has the primary responsibility for roads maintenance but that this did not resolve the traffic and road issues of safety and access. There is some aspiration that WDRL could assist with the facilitation of community to government dialogue to draw attention to the issue. From this emerges the risk of heightened and/or unrealistic expectations

One of the identified risks in relation to the haul road was the desire of/for community members to use the road for public access. This has more salience for the community located closest to the haul road being Borroloola but is a potential risk for any member of any of the communities who might want to have access to the haul road and not be aware that the road is for private use only due to occupational health and safety risks.

An associated risk with the establishment of the haul road is the potential for increased levels of conflict in relation to any landholder compensation paid for the proposed haul road.

(ii) Construction

The consultations with the community suggest that at the development stage the communities are overall positive about the construction of the mine and haul road – viewing the Project as providing the means for realising some goals and objectives for improved community development. As with traffic and roads the risk is that expectations are raised and then not met.

The topic of construction impacts at the community level carried little prevalence during the consultations and only in the community of Minyerri was it raised as even a ‘minor concern’. Concerns were related to the close connection the people of Minyerri have with their land – though this is not and should not be read as a reflection that other communities do not share that connection. In Minyerri, impacts related to damaged environments, sacred sites and cultural significance.

It should be noted that as the construction phase commences and the Project has increased visibility, the impact of construction becomes more real and concerning for communities with a likely focus in the areas of concern expressed by community members in Minyerri.

There are accordingly, two major risks in relation to construction:

- Raised expectations that are not met
- Increasing concerns in relation to construction processes for both the mine site and the haul road.

(iii) Demand on Local Services

Each of the four communities are relatively small with limited capacity to support a major influx of visitors, workers and construction machinery and equipment. The impact on local services and the ability for those services to support increased demand is a risk to both project delivery and relationships with local community members and organisations.

Inherent Risk Profile

Without any management intervention to mitigate the risks the risk profile of the development is considered to be medium to high and mostly tolerable.

Risk Mitigation

All risks within this aspect will be managed through the development of a Communications and Stakeholder Management Strategy within the Community liaison and Consultation Plan. Inclusive will be consultation measures, tools and timing to ensure the community is fully informed and consulted in relation to construction and access

Residual Risk

With the risk mitigation outlined above, it is expected that there is a low and acceptable level of residual risk.

9.6.2 Education – Early years to Adulthood

Across the four communities the levels of engagement in early childhood education, primary and high school attainment and non-schooling qualifications was relatively low. At the same time - as the next section highlights – expectations are high across the four communities that the Project will enhance educational outcomes and pathways will be created into meaningful, long-term employment.

There are risks that the positives outcomes being sought from the development and outlined in the next section will not be met due to the maintenance or decrease in current outcomes for children and students through to leaving high school. There are too few people in the community that have or are attaining school levels beyond Year 9 and most community members across the four communities have reached Year 8 or below as the highest level of school attainment or not attended school at all.

The risks of the Project negatively affecting already poor education outcomes relate to:

- Lower school attendance rates due to parental employment at the mine;
- Gaps between school courses and employment requirements that mean ongoing disengagement for Indigenous people in an expanding labour market;
- Poor literacy and numeracy skills that reduce long-term employability of young people;
- Loss of aspiration and interest of students at primary and secondary levels for industry and occupation learning outside of the mining sector as the development dominates the employment landscape across the communities; and
- Ignorance of the cultural barriers that inhibit children from attending school.

Inherent Risk Profile

Without any management intervention to mitigate risks the risk profile of the development is mostly medium to high across the five risk areas.

Risk Mitigation

Risks are mitigated by the following:

- WDRL will support programs (as appropriate) that work closely with parents, families and teachers to ensure support is provided;
- WDRL will support programs (as appropriate) that work with schools to assist with programs to support increased attendance;
- WDRL will support programs (as appropriate) that work with communities and local employers to build broader skills and experience to support cross industry occupation development; and
- WDRL can investigate the potential of providing assistance to schools with any programs that support higher school attendance (as appropriate).

Residual Risk

With the risk mitigation outlined above, it is expected that there is a low and acceptable level of residual risk.

9.6.3 Economic Participation and Development

In terms of social and cultural impacts, this is the area that has the highest potential to positively and/or negatively affect individuals, communities and organisations. It is clear that the communities have developed over recent years a vision for their communities including enhanced employment and training outcomes, with increased opportunities for young people.

For all communities there was an enormous focus on employment generation and training opportunities. There was a clear and determined sense of empowerment in these communities as they saw the proposed Project as an opportunity they should capitalise on – they want to drive and play a key role in their future and the future of their community. As strongly noted in the Community Profiles, engagement with the labour market generally is low and where there is engagement CDEP has a high representation in terms of overall employment.

Traditional Owners, community groups, community members and business owners are focussed on the associated positive impacts of increased local employment. Areas of potential positive impacts are self-pride, a feeling of self-worth and increased social cohesion. However, there were some concerns raised with employment (specifically) where the potential positive impact also attracted potential negative impacts. For example, there were concerns raised regarding the increased affordability of alcohol leading to social problems in town once workers are on days off. Humbugging was also raised as a concern which was closely linked to the issue of housing (i.e. overcrowding in existing houses and lack of alternative accommodation).

The topic of training, while closely linked to employment opportunities, is a focus for communities. There is a need for training that can build the sustainability and resilience of each community. However, with training there may be increased relocation of community members once they are sufficiently trained. Community members and stakeholders suggested that there is a high probability that once a person is trade qualified or sufficiently trained he/she will leave the community and move to another location. This might include Darwin, Katherine or Cairns where the ability to be self-sufficient and escape the issues of humbugging are removed or significantly reduced.

Despite these perceived negatives, all stakeholders agreed the increased employment and training opportunities were a good thing for the local people and the communities of Borroloola, Minyerri, Ngukurr and Numbulwar as a whole.

Accordingly, the risks associated with the development, in the area of economic participation and development includes:

- Increased opportunity for employment and training brings increased expectations. There is a risk some members of the community or even certain communities will feel disappointed. They may see the development as the hope for a different future for their family members and the major development on the horizon that can provide better employment and training outcomes for the next generation;

- Lack of knowledge in some communities of the opportunities for employment and training and perceived exclusion from the opportunities due to community isolation;
- While WDRL is currently identifying the potential areas for the development of local and regional business and employment opportunities, establishing and supporting newly established Indigenous Business Enterprises requires significant resources. The risk of new enterprises failing is real and could reflect poorly on all parties and heighten community disappointment;
- Cultural responsibilities may conflict with work schedules and therefore become impractical for community members and lead to termination of employment and reinforced disappointment;
- Work ethic and values of community members/employees does not align with that of WDRL and vice versa. That is there is poor cross-cultural understanding between the Company and the communities;
- Increasing presence and appropriation of 'Western culture' and therefore a subsequent loss of local cultures and traditions;
- Increased tension and an atrophy of relationships leading to conflict within and between communities as local employment is skewed to the communities closest to the mine site;
- Increased pressure on accommodation and housing where there is already overcrowding due to family moving closer to where there is a perception of increased employment opportunities;
- There is also the opposite risk of residents leaving the community and taking skills and knowledge with them to secure employment with project therefore contributing to reduced community capacity rather than increased community capacity and the loss of culture as people move away;
- Increased conflict and humbugging due to increased community income through increased employment in the community; and
- Increasing negative social impacts with potentially an increase in alcohol and substance use through increased disposable income coming into the community. There is already some community concern with regard to these social issues and tension could emerge.

Inherent Risk Profile

Without any management intervention across the impact areas, the risk profile of the development is considered to be high risk.

Risk Mitigation

Risks are mitigated by the following:

- The development of a Stakeholder Engagement Plan;
- WDRL will investigate the potential of supporting programs (as appropriate) that provide mentoring and capacity building to support start-up businesses/enterprises;
- WDRL will support programs (as appropriate) that develop strategies to support recruitment through an Indigenous Employment Strategy;
- WDRL will investigate the potential of developing mechanisms and strategies to assist employees to manage humbugging; and
- WDRL will investigate the potential of supporting programs (as appropriate) that work with communities to develop a financial literacy program and local agencies to support money management.

Residual Risk

With the risk mitigation outlined above, it is expected that there is a residual risk that is mostly low and acceptable.

9.6.4 Youth Opportunities

Each of the four communities has a very young population with a median age lower than 21 years for all communities excepting Borroloola (median age 25). Not surprisingly, there is a significant amount of concern and interest in the future of youth in the region. There is hope the proposed Project would present opportunities for young people, particularly relating to employment and training, but also linking with the potential provision of more services and social infrastructure for youth through the introduction of a social benefits scheme or the like. There was a high level of positivity about support for youth across the four communities, most notably from the Traditional Owners and Elders. At its most basic level, youth opportunities related to giving youth 'something to do' in town (sports or recreation activities).

Consultation revealed a strong sense of concern for the future of the youth in the four communities together with a vision for the types of additions to the areas needed to create a more positive outlook for youth. Some stakeholders saw the introduction of a social enterprise scheme as a long-term vehicle with which to create these outcomes, while others focussed on short-term options such as improvements to community sporting facilities. The end result desired by all communities is the same – they want their youth engaged in positive, productive and meaningful activities that will secure their future and that of their community.

At the core of discussions about youth opportunities were the social concerns of alcohol and substance abuse. Communities consulted saw a direct link between a lack of perceived youth opportunities and youth succumbing to these social issues. Consultation revealed that meaningful and gainful employment was viewed as a key component to addressing this issue.

Concern was also shown by stakeholders and community representatives regarding the education of young people about money management, particularly relating to avoidance of spending money on drugs and alcohol. Stakeholders also commented that young people needed encouragement to attend schooling for their long-term security.

The risks specific to young people and the lack of opportunities they currently have is that the Project:

- May increase anti-social behaviour through increased disposable incomes (leading to increased alcohol and substance use and abuse);
- fails to make any positive contribution to change and therefore reinforces young people's sense of lack of opportunities or aspiration for an improved outcome in the future; and
- Could expose young people to cultures different from their own and cause either dissonance with or alienation from their own culture.

Inherent Risk Profile

Without any management intervention to these impacts the risk profile of the development is considered to be medium to high.

Risk Mitigation

Risks are mitigated by the following:

- WDRL will investigate supporting programs (as appropriate) that work with communities to develop a financial literacy program and local agencies to support money management;
- Ensure the topic of youth is included as a focus area for any Social/Community Benefits scheme that is established; and
- Ensure culture is respected and recognised within the workplace and young people are provided with the means to maintain cultural responsibilities. As part of WDRL commitment, all staff will undertake a Cultural Heritage Training Program.

Residual Risk

With the risk mitigation outlined above, it is expected that there is a residual risk that is low to medium.

9.6.5 Health

While there was little available data to report on the health and wellbeing of community members, Traditional Owners, Elders and community members themselves reported significant health issues within each community. These were not significant areas of focus during the consultations, but it is clear that a development such as is being proposed can bring with it opportunities to positively contribute to improved health and wellbeing or risks that can have a negative impact on health.

- As mentioned previously with the development of the Project there is an influx of visitors and/or family members and therefore increased pressure on an already stretched housing and accommodation system. With increased household sizes comes an associated acute health and environment health issue.
- Poor nutrition and education leads to local people not qualified for employment and missing out.
- Inability of people with poor health due to alcohol and substance abuse passing mandatory drug and alcohol testing for work and therefore leading to increased stress and poor health.
- Strains placed on families and increased health issues due to the stress of family members being away from home (e.g. jealousy).

Inherent Risk Profile

Without any management intervention to mitigate these impacts and risks the risk profile of the development is considered to be medium.

Risk Mitigation

Risks are mitigated by the following:

- WDRL will support programs (as appropriate) that work with local communities to support healthy lifestyle and eating programs;
- WDRL will support programs (as appropriate) that assist local agencies with education programs and work with local communities to build education programs; and
- Work with communities to build working rosters (As applicable to the work requirements of the project) that support family and community wellbeing.

Residual Risk

With the risk mitigation outlined above, it is expected that there is a residual risk that is low to medium.

9.6.6 Cultural Heritage

For all communities, cultural heritage was of critical importance and of particular interest was the process of how WDRL would identify and preserve sacred sites (or sites of cultural significance) throughout the EIS process and beyond. Community members acknowledged the importance of working with WDRL to protect sacred sites, however did express concern over properly identifying where these sites are located.

Caring for country is of significant importance – both culturally and spiritually – as it provides an opportunity to be ‘hands on’ with country and share stories with the younger generation. Consultation revealed that ongoing involvement in cultural heritage management was very important to the communities.

Traditional Owner and Elder stakeholder groups expressed their concerns regarding the size of the proposed Project and the potential impact it could have on these sites. There was a strong need for the project team to clearly demonstrate and articulate their cultural heritage management processes to confirm sacred sites would not be impacted.

Within Traditional Owner and Elder stakeholder groups there was also discussion surrounding the intangible elements of the Indigenous culture, such as language, ceremony and traditions, and how the design of potential employment packages may work to support and sustain the Aboriginal culture.

It was evident through consultation that preserving ceremony and culture should be recognised throughout all aspects of the Project, including the development of employment programs and business dealings. This includes the recognition that taking people away from the community for work opportunities can also impact on culture, as people are no longer available able to participate in ceremony.

Traditional Owner and Elder stakeholder groups both expressed their concern at employment preventing their youth from being able to practice ceremony. That is, the demands of maintaining a strong culture have been known to conflict with employment activities, such as having to leave work on very short notice to attend funerals and family matters. However, it was acknowledged that their youth needed to travel and gain work experience, so they can (hopefully) one day return to the community, bringing new skills and social benefits with them.

Specific reference was made to Maria Island, as a place of great cultural significance and a sacred site that needed to be protected from potential construction impacts.

Further, enquires as to how people would like the proposed Project site rehabilitated once mining work was complete suggested there needed to be more importance placed on protecting sacred sites and song lines rather than the actual environmental rehabilitation of the area.

The following Project risks are identified:

- Sacred sites and/or sites of significance are not adequately identified and therefore disturbed or damaged during and/or beyond construction;
- Cultural heritage is not managed well or understood by WDRL and therefore diminished in policy and practice;
- Employment packages and conditions do not adequately account for matters of cultural importance for Indigenous employees and communities;
- People having to work and live away from the community breaks cultural ties and traditions;
- Young people employed at the mine or in support services are no longer able to adequately meet their cultural obligations and responsibilities and therefore there is a break in cultural ties and traditions;
- Maria Island becomes the preferred option for moving the product off-shore and causes disturbances to a heritage site; and
- Rehabilitation of the site does not adequately account for or protect sacred sites.

Inherent Risk Profile

Without any management intervention to mitigate these impacts and risks the risk profile of the development is considered to be high.

Risk Mitigation

Risks are mitigated by the following:

- Develop a Cultural Heritage Management Plan across the WDRL project with policies and procedures that support best practice for identification, preservation, monitoring and management of sacred sites and/or sites of significance;
- There are no heritage sites associated with the project area other than those identified in the AAPA Certificate. These sites have been avoided. Traditional Owners have been engaged for

the AAPA clearance and certificate surveys as well as for the haul road route survey so as to ensure the route does not impact sacred or heritage sites;

- The SIA (Appendix G) is tasked with attempting to understand the actual impact of this project on the Indigenous stakeholders, including the potential impact on cultural heritage. There have been consultations on this subject so as to identify potential issues and gain an understanding of the thoughts and concerns about these potential issues prior to the development. This process has resulted in a project development plan that avoids identified cultural sites and importantly undertakes to seek ongoing feedback throughout the project so as to determine if any actual issues arise as a result of the operations associated with the project;
- Develop HR policies and practices in consultation with the community (as appropriate) to ensure cultural obligations and responsibilities can be met;
- Protocols for engagement within the wider development of a Community Liaison and Consultation Plan; and
- Investigation of the development of a Cultural Heritage Management Plan within the broader Mine Closure (Exit) Strategy.

Residual Risk

With the risk mitigation outlined above, it is expected that there is a residual risk that is low.

9.7 Cumulative Impacts

Cumulative impacts are those impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project (European Commission 1999). The Guidelines specifically request that the EIS consider:

i. Impacts on regional ecosystems within the Roper region;

ii. Social impacts, including perception of the region as remote or wilderness;

iii. Key habitats (e.g. riparian, wetland, threatened species habitat) which retain connections with adjacent vegetation and habitat;

iv. Hydrologically connected surface water and groundwater systems that support wetlands and base flows in rivers and creeks; and

v. Cumulative impacts on the marine environment in association with existing and proposed future activities at the Bing Bong loading facility.

This risk section will focus on the contribution that this development will have on adversely affecting the aspects outlined above; many of these aspects, however, are not relevant to a study into cumulative impacts as the area is undeveloped.

9.7.1 Current and Future Developments of the Region

The regional economy is generally reliant on pastoralism and some tourism. The remoteness of the region, lack of infrastructure and strong seasonality has hampered economic development in the region.

Xstrata operates an existing mine, processing facility at their McArthur River mine with the zinc lead bulk concentrate exported through the loading facility at Bing Bong. This mine commenced operations commenced in 1995 and transitioned to an open pit development in 2006. The current expected life of mine is until 2027. The existing loading facility is intended to be used by WDRL proposed development and is located approximately 145km straight line from the mine.

There are also a number of proposed mining developments within the region. Sherwin Iron Ltd is developing an iron ore mine approximately 100 km to the west of this proposed development. Australia Ilmenite Resources Pty Ltd is at the Notice of Intent phase with its Ilmenite mine and processing facility approximately 100 km to the west of this proposed development (Figure 9-1).

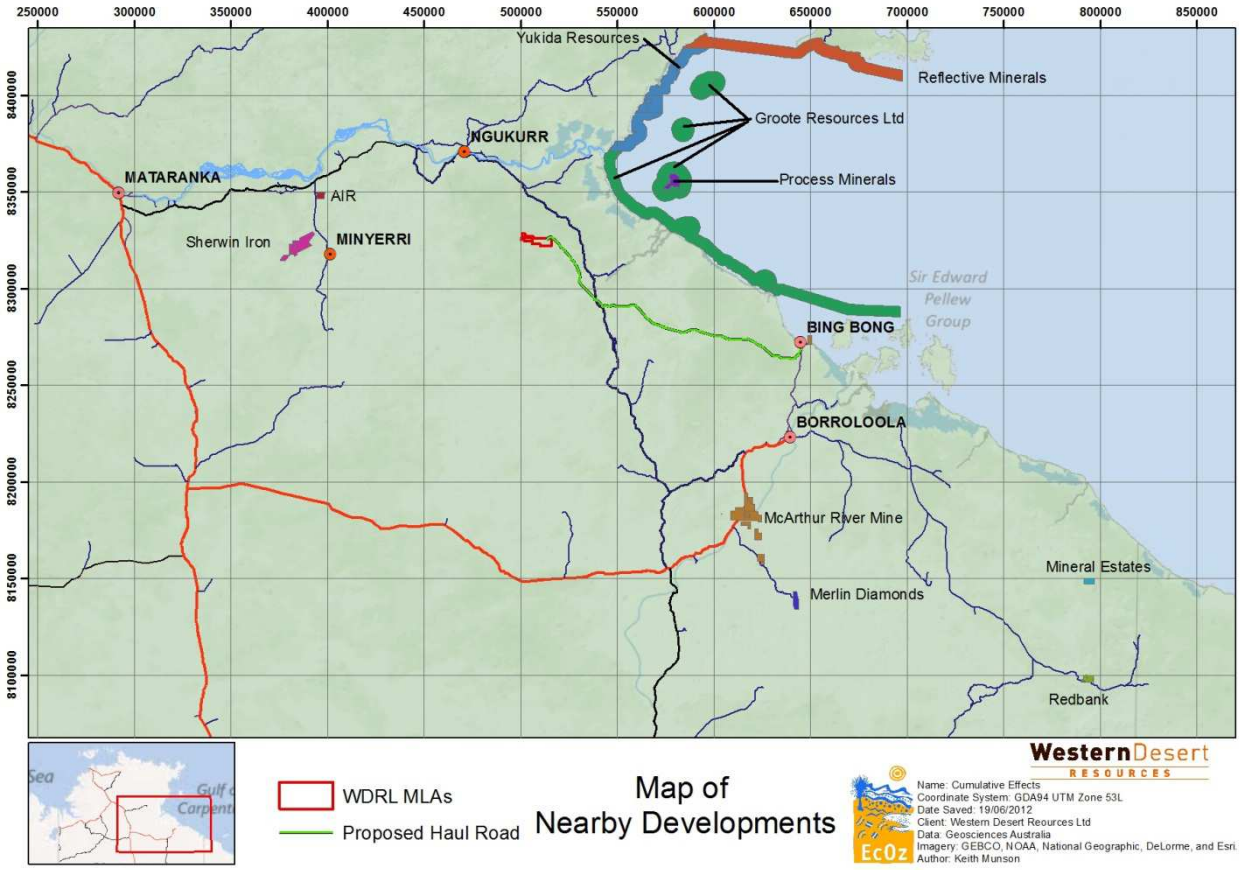


Figure 9-1: Map of Proposed developments in the region.

9.7.2 Impacts on Regional Ecosystems within the Roper Region

As discussed in Section 9.3 this development is not considered to have a substantial impact on regional ecosystems for two reasons. Firstly, the impact extent is relatively small and any off-site impacts are contained through mitigation measures. Secondly, even after considerations of known future developments there is no expected cumulative impact for regional ecosystems.

9.7.3 Social Impacts including remote perception

A development such as that proposed can have a substantial regional social impact. In regards to the regional aboriginal communities the issues of social impact are dealt with comprehensively in Section 9.6 (Social and Cultural Impacts). That section also makes reference to WDRL's current and ongoing work with these communities (see also Appendices G and H).

The proposed development is in the Gulf region of the Northern Territory in a region considered remote and this sense of remoteness is an appeal for tourists. The sense of remoteness will be affected by:

- The increase in road traffic (typically trucks) to the mine site;
- An increase in plane traffic taking workers to the mine site;
- The haul road crossing on the Savannah Way;
- Potential noise impacts on the Limmen Bight River campsite from the haul road; and
- Stockyards, conveyor belt and associated facilities at Bing Bong.

9.7.4 Key habitats

The risks to sensitive habitats and vegetation communities from this development are discussed in Section 9.3. Due to the remote nature of this project and limited existing and future developments it is considered unlikely that cumulative impacts in key habitats will be substantial.

9.7.5 Surface and Groundwater Systems

The rivers and streams of the region are considered near to pristine due to the limited regional development. The WDRL proposal will not impose substantial impacts on regional hydrology but any development in the region that adversely affects river hydrology (such as damming) needs to be considered in this context. Section 4.2 concludes that this development has little impact on hydrology (quantity or quality).

9.7.6 Marine Environment

The current proposal utilises the existing loading facilities at Bing Bong. This imposes a cumulative impact at the existing loading facility but reduces the need to duplicate the facility (along with inherent environmental consequences) elsewhere. The cumulative effect at the loading facility is discussed in detail in Section 9.4 and includes discussion on impacts at species, habitat and marine process level.

The impacts are associated with the construction and housing of staff at the Bing Bong facility and the increased shipping activity. For example, consequences of increased shipping activity include both the potential for higher rates of interactions between vessels and marine megafauna and increased likelihood of threats such as the introduction of invasive marine species on ships hulls or ballast water.

It is acknowledged that these affects are poorly understood, difficult to prioritise, manage and monitor. WDRL has made a commitment to undertaking a strategic assessment of proposed mitigation measures and the current Xstrata marine monitoring program to ensure that the cumulative impacts of both Xstrata's expansion and WDRL's proposal may be appropriately mitigated and monitored.

9.8 Other Risks

9.8.1 Bushfires

Bushfire can have serious impacts on people, the environment, and mine infrastructure. This development is within a contiguous area of Australian tropical savannahs an ecosystem that is known to be frequently burnt (Andersen et al 2005); consequently the likelihood of fire is D and the consequence is considered 4, giving a risk raking of 21 (extreme risk).

Bushfire Mitigation

Currently, WDRL has an Emergency Plan which incorporates, amongst other things, the processes during the outbreak of a fire. WDRL will update these procedures to capture the new mine site, campground, haul road and loading facility and associated infrastructure.

Broadly, WDRL has a twofold approach to managing fire:

i. To limit the opportunity for fire to start due to mining and associated activities; and

ii. To reduce the impact fire will have on people and infrastructure within the mining envelope.

WDRL aims to reduce the impact of fire on people and infrastructure through:

1. Reduce the opportunity for mining activities to start fire by:
   - fire being part of induction;
   - limiting smoking to defined areas;
   - maintaining a strict no-fire policy;

- ensure vehicles are maintained;
- Vehicle and machinery exhaust systems shall be inspected regularly for leaks; and
- All vehicles will be equipped with portable fire extinguishers.

2. Reduce the opportunity for fire to impact people or infrastructure by:
   - Installing firebreaks;
   - Updating fire planning procedures (such as muster points) for loading station, haul road and the mine site including the camp; and
   - Maintain, or update as required, existing Emergency Plan.

Residual Risk

After considering the mitigation measures above the likelihood of fire in the surrounding environment has not changed (D), but the likelihood of fire affecting people or infrastructure is reduced to C, with the consequence now Minor (2), giving a risk ranking of 8 (Medium Risk).

9.8.2 Biting Insects

Mine sites have the potential to create or exacerbate mosquito breeding, potentially from the site disturbance or the introduction of water holding receptacles. Also, any artificial receptacle sourced from North Queensland has the potential to introduce the exotic dengue mosquito *Aedes aegypti* into the Northern Territory.

Biting Insect Mitigation

Management of biting insects has two parts:

1. An initial 12 month biting insect baseline study to investigate actual and potential mosquito breeding sites; and
2. Based on the findings of the baseline study – implement biting insect management measures aimed to:
   (i) Reduce number of man-made breeding sites;
   (ii) Reduce biting incidents through insect screening of buildings; and
   (iii) Reduce incidence of exposure to biting insects, through staff training and availability of appropriate barriers and repellents.

Biting Insect Residual risk

While the amount of potential man-made breeding sites will be kept to a minimum, it is still likely that there will be high seasonal numbers of pest and potential disease carrying mosquitoes at the mine site. All areas of the mine are likely to be affected with the greatest risk period likely to be during the wet season and early dry season.

9.8.3 Noise and Vibration

The existing noise amenity at the Roper Bar region is likely to be dominated by natural noise sources as there are no urban, industrial and agricultural practices within close proximity which may influence the existing noise amenity.

The proposed iron ore extraction, processing and transport activities will introduce additional noise from the plant and equipment at the extraction site, the processing plant, haul road, Bing Bong loading facility and other ancillary infrastructure including the airstrip and mine camp.

Although cumulatively these noise emissions can be significant, the distance to the nearest sensitive receptors (in excess of 15 km) will mean that noise emissions will be inaudible beyond the immediate project area. However, the potential noise impact from power generators with respect to individual units

within the accommodation area and on the offices of the administration building at the processing area requires careful consideration.

The potential for the haul road traffic to impact upon the Limmen River Camp Ground has also been considered and it has been concluded that traffic will have a negligible effect on camp ground amenity.

The operation of the mobile (bulldozers, excavators and trucks) and static (power generators etc.) plant will be associated with localised ground vibration. However any ground vibration caused by the operation of the plant and equipment will be readily attenuated by the resilient properties of the soil.

Noise and Vibration Management

A number of mitigation measures have been specified to minimise potential noise and vibration impacts associated with discrete components of the project. These include strategic siting of buildings and infrastructure; the use of natural acoustic barriers (i.e. elevated terrain); acoustically attenuated generators; noise reduction systems on mobile or stationary plant and equipment; acoustic design of buildings; shock absorbing (vibration dampening) devices or materials around primary sources of vibration; and restricting the extent of the mine face and idle operation of plant and equipment.

Noise and Vibration Management Residual Risk

Provided the recommended noise control measures are fully implemented in the detailed design and operation of the mine, noise emissions will not impose any further constraints on the proposed Roper Bar Iron Mine Project.

9.8.4 Air Quality and Dust

The ambient air quality in the vicinity of the project is anticipated to be excellent given that there are no industrial or urban developments in the vicinity of the mine, except for dust generation in the vicinity of unsealed roads, and temporal impacts from bushfires.

Dust, odour and other gaseous emissions which are generated on a mine site have the potential to affect air quality in the vicinity of the mine site and potentially nearby sensitive receptors. Dust emissions during establishment, operation and rehabilitation of the proposed Roper River Iron Ore project are of primary concern in regards to the potential air quality impacts. However, due to the significant distance (minimum of 15 km) to the nearest sensitive receptors, the ground level concentrations attributed to the project's construction, operation and decommissioning are considered to be negligible.

The potential greenhouse gas (GHG) emissions were estimated using the National Greenhouse Accounts (NGA) Factors as prepared by the Department of Climate Change and Energy Efficiency. The proposed operations are mainly associated with direct (point-source) GHG emissions. There are no indirect emissions of GHG, as the proposed mineral sands mine will not purchase any electricity from external sources.

Air Quality Management

The potential air quality impacts are expected to be limited to localised areas in the vicinity of the mining face and the stockyard, as well as loading areas. Dust may impact upon the mine camp (the nearest sensitive receptor) however impacts are considered unlikely given that extensive management and mitigation measures are proposed.

Similarly, ground level concentrations of SO_2 and NO_2 are expected to be negligible and localised to the point source.

The dust deposited at close proximity to the mining face is of primary concern because of its potential to increase sediment loads in receiving waterways. The sediment control measures presented in Appendix L (Erosion and Sediment Control Plan) are designed to control the surface runoff sediment as well as any additional sediment load due to fugitive dust emissions from the proposed mineral sands mining activities. A number of other extensive air quality mitigation and management measures are proposed associated with the construction corridor and transport routes; mine pits; handling, storage, and transfer of material; barge loading; vehicle and plant and odour.

A number of proposed greenhouse gas reduction strategies are also proposed.

Whilst air quality impacts are expected to be minor, WDRL commit to undertake baseline surveys of air quality at the mine site and mine camp using dust deposition gauges during the dry season. This order will provide a baseline against which expected and actual dust nuisance can be measured against.

Air Quality Management Residual Risk

Provided the recommended air quality monitoring and control measures are fully implemented in the detailed design and operation of the mine, particulate emissions will not impose any further constraints on the proposed Roper Bar Iron Mine Project.

9.8.5 Visual Amenity

Due to the remoteness and that the majority of this development is not accessible to the public there are few expected visual amenity issues. The exceptions being the haul road crossing of the Savannah Way and the end of the haul road and loading facility at Bing Bong. Of these the former is considered to be the most substantial as there is already development at the Bing Bong end of the development. However, there is only a single crossing and at one location on the Savannah Way so this is not considered substantial.

9.8.6 Transport

WDRL's Roper Bar Iron Ore Project will result in increased traffic for both public roads and WDRL constructed and maintained private roads. Mine related traffic movements are assumed to be greatest during the construction phase of the project – with continued utilisation of public and private road network throughout the life of the mine. During operation of the mine all ore will be transported via a purpose built private haul road.

Transport Inherent Risk

Transport risks relate to injury or death of personnel due vehicle accidents. There are numerous existing legislative safeguards including maintaining roadworthiness of vehicles, breaks for drivers that mitigate vehicle and operator hazards. Some hazards remain including animals on the roads leading to vehicle accidents; there is little opportunity to reduce this hazard. Consequently, the inherent risk profile for transport has a consequence of 4 (major), a likelihood of C (moderate) giving a risk ranking of 18 (high).

Transport Management

Transport Management is discussed within the WDRL Draft Environmental Management Plan (Appendix C). This details how WDRL will mitigate risks concerning vehicle movements throughout the life of the project, including:

- Complying with any relevant road vehicle axle limits;
- Securing loads;
- Measures to reduce any road traffic noise impacts;
- Consultation with local communities affected by transport impacts;
- Traffic management;
- Management of driver fatigue;
- Ensuring all drivers and operators are adequately licensed/trained;
- Develop a Drivers Code of Conduct;
- Educate drivers through on-site Inductions; and
- Regularly perform routine inspections/maintenance on all vehicles.

Transport Management Residual Risk

The above mitigation strategies will not improve the consequence of a potential transport incident (which remains at 4 (major) or the likelihood of such an event.

Transport incidents remain a high risk for WDRL.

Table 9-5: The risk assessment for the WDRL Roper Bar Iron Ore Project.

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Surface Water Hydrology	Road crossings - permanent	• Permanent changes to hydrological conditions associated with road crossings (e.g. bridges, culverts) with subsequent impact on ecology (e.g. fish migration).	4	C	18 (H)	• Monitoring and management of runoff in accordance with Erosion and Sediment Control Plan and Water Management Plan. • Appropriate design of road crossings to avoid significant alteration to existing hydrological conditions. • Paving of haul road likely to reduce risk of erosion and extent of turbid run-off.	3	B	9 (M)
Surface Water Hydrology	Road crossings – during construction	• Temporary changes to hydrological conditions associated with construction of road crossings (e.g. blocking flows) with subsequent impact on ecology (e.g. fish migration).	2	C	8 (M)	• Ensure that stream flows are maintained at all times. • Undertake any in-stream works at a time when natural flows are absent or minimal.	2	B	5 (L)
Surface Water Hydrology	Stream realignment	• Loss of existing natural stream habitats. • Erosion resulting in impact on downstream surface water quality (e.g. increased suspended solids). • Changes to stream hydrology and habitats resulting in possible	4	C	18 (H)	• Appropriate design of stream realignment to avoid erosion and ensure long term sustainability, including development of a near-natural system. • Construction and revegetation of stream realignment to create appropriate riparian and in-stream habitats. • Monitoring for signs of erosion and remedial works if required.	3	B	9 (M)

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		effects on ecological processes (e.g. fish migration)							
Surface & Ground-water Quality	Storage of ore and/or waste rock	• Contamination of downstream surface and/or groundwaters associated with acid mine drainage (i.e. acid and/or heavy metal contamination).	4	D	21 (E)	• Management of potentially acid forming (PAF) materials through appropriate design of storage facilities and in accordance with PAF Management Plan. (Appendix K) • Management and treatment of any captured seepage water in accordance with Water Management Plan (Appendix R). • Ongoing characterisation of materials and storage and management methods.	4	C	13 (H)
Surface Water Quality	Land disturbance	• Erosion leading to transport of sediments in run-off, resulting in impact on downstream surface water quality (e.g. increased suspended solids, turbidity).	4	C	18 (H)	• Management of runoff in accordance with Erosion and Sediment Control Plan (Appendix L) and Water Management Plan (Appendix R).	3	B	9 (M)
Surface & Ground-water Quality	Storage & handling of hazardous materials (e.g. hydrocarbons)	• Spill or leak to environment with potential to contaminate downstream surface and/or groundwaters.	4	C	18 (H)	• Appropriate storage of hazardous materials and monitoring of storage facilities, in accordance with Standard Operating Procedures, Environmental Management Plan and relevant standards/guidelines. • Adequate training (e.g. inductions).	3	B	9 (M)

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Surface & Ground-water Quality	Disposal of sewage & other waste	• Contamination of downstream surface and/or groundwaters.	3	C	13	• Appropriate design, location and operation of waste facilities, in accordance with operational procedures and Environmental Management Plans.	2	B	5
Ground-water Levels	Groundwater abstraction (e.g. pit dewatering)	• Alteration to local or regional groundwater levels and availability, potentially affecting GDE's.	3	C	13	• Undertake modelling assess extent of impact on any GDE's (i.e. localised vs. regional). • If modelling indicates likely regional impact and/or impact on significant GDE's, consider alternative pit dewatering strategies. • Monitoring of groundwater levels and if required, surface flows to any GDE's.	3	B	9
Terrestrial and aquatic biodiversity	Terrestrial Threatened Species (Northern Quoll and Thorny Solanum)	Direct Mortality: Construction	2	C	8 (M)	• Mapping of preferred habitat of the quoll and ensuring construction avoids these areas. • Keeping vegetation clearing and disturbance to a minimum by adhering to approved vegetation management plans.	2	B	5 (L)
Terrestrial and aquatic biodiversity	Terrestrial Threatened Species (Northern Quoll and Thorny Solanum)	Direct Mortality: Operations	2	B	5 (L)	• Avoiding rocky areas during construction will reduce potential for quoll road kill.	2	A	3 (L)
Terrestrial and aquatic biodiversity	Terrestrial Threatened Species (Northern Quoll and Thorny Solanum)	Reduction in Habitat Quantity	3	C	13 (M)	• Mapping of preferred habitat of the quoll and ensuring construction avoids these areas. • Keeping vegetation clearing and disturbance to a minimum by adhering to approved vegetation management plans.	2	B	5 (L)

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Terrestrial and aquatic biodiversity	Terrestrial Threatened Species (Northern Quoll and Thorny Solanum)	Reduction in Habitat Quality: Noise	2	B	5 (L)	• No specific management responses	2	B	5 (L)
Terrestrial and aquatic biodiversity	Terrestrial Threatened Species (Northern Quoll and Thorny Solanum)	Reduction in Habitat Quality: Weed invasion	2	B	5 (L)	• Weed and Pest Management Plan (Appendix F)	2	B	5 (L)
Terrestrial and aquatic biodiversity	Aquatic threatened species	Changes in water quality and quality				Refer to Section 9.2			
Terrestrial and aquatic biodiversity	Migratory Shorebirds	Changes in habitat due to changes in water quality and quantity from the Towns and Limmen Bight Rivers.				Numerous relevant risks			
Terrestrial and aquatic biodiversity	Sensitive Habitats	Mining activity can deleteriously affect these important areas compromising their values.	3	C	13 (H)	• The location and extent of these habitats has been mapped. • Two of these sensitive habitats are considered to be of risk due to mining activities: rock piles and wetlands down slope of the haul road. • Threats to these will be mitigated by avoiding rock piles and ensuring hydrology of wetlands in considered during haul road construction.	3	B	9 (M)

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Terrestrial and aquatic biodiversity	Vegetation Communities	Poor clearing practices and processes can have immediate adverse effects such as erosion and also affect the capacity to rehabilitate land after mining.	3	C	13 (H)	• Minimise area required to be cleared through good planning processes. • Use Northern Territory Land Clearing Guidelines (NRETAS 2010) to inform clearing procedures and processes. • All approved clearing boundaries to be shown on maps.	2	C	8
Terrestrial and aquatic biodiversity	Weeds	Mining activities may lead to: • Increased weed extent • Increased weed species	3	D	17 (H)	Contain and control existing weed populations. • Stopping the introduction of new weeds. • Controlling the spread of existing weeds. • Auditing the effectiveness of the above strategy as outlined in the Weed and Pest Management Plan.	3	C	13 (H)
Terrestrial and aquatic biodiversity	Pests	Pests can increase: spread of weeds, erosion, be a vehicle hazard, affect native species.	1	C	4	WDRL will not contribute to pest animal populations by: • Ensuring mine waste does not end up as food for pests • Ensuring that no artificial water pools are created.	1	C	4
Terrestrial and aquatic biodiversity	Connectivity due to stream realignment	Loss of riparian connectivity due to mortality of riparian vegetation.	1	B	2 (L)	No management required as modelling infers no changes in hydrology.	1	B	2 (L)
Marine Environment	Habitat Quality	• Spills (ore and hydrocarbon) • Underwater noise • Seabed disturbance (water quality and soft	3	D	H	Management and mitigation strategies are: • A strategic assessment of proposed mitigation measures and the current Xstrata marine monitoring program will be undertaken. • Timing of construction works to take into account seasonal and tidal variation;	3	B	M

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		sediment community impacts) • Introduction of artificial habitat • Introduction of invasive marine species • Introduction of rubbish and waste into the marine environment				• Physical mitigation measures including sediment and erosion control barriers and silt curtains; • Acoustic controls including observers prior to and during construction, soft start procedures, and speed restrictions; • Dust suppression measures; • Design controls to prevent spills including covered conveyors and loading chutes, automatic cut-off valves on fuel hoses, standard operating procedures and clean up procedures; • Management of rubbish and waste including licenced sewage disposal facilities onshore; and • Monitoring of water and sediment quality, presence of invasive marine pest species and other marine biota.			
Marine Environment	Species impacts	Mining and associated activities can have a deleterious effect on marine biodiversity through: • Increase in boat strike • Light pollution	2	C	M	Management and mitigation strategies are: • Mandatory speed restrictions within the entrance channel and swing basin (mandatory go-slow zone of 6 knots); • Lighting controls; and • Mandatory reporting and monitoring.	2	B	L
Marine Environment	Coastal and Marine processes	• Coastal erosion associated with Barge Landing Facility • Changed sedimentation regimes. • Impacts on other coastal processes.	2	C	M	Management and mitigation strategies are: • Coastal process modelling will be undertaken if required at the Detailed Design stage to inform project design • Reactive erosion control as required.	1	B	L
Marine	Socio-economic	• Restriction of access to	5	B	H	Management and mitigation strategies are:	3	B	M

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Environment	impacts	popular recreational fishing location. • Interactions with commercial and Indigenous fisheries. • Impacts of cyclones and heavy storms.				• Relocation of the existing viewing platform, access track and informal car parking area with appropriate signage installed as required. • Ongoing consultation with both Traditional Owners and the fishing industry will take place to ensure that any potential negative interactions between commercial and Indigenous fishing and hunting can be prevented. • Design of all facilities will be in accordance with relevant standards to withstand cyclones, and cyclone moorings for all barges and floating plant will be provided, as well as cyclone shelters for personnel and visitors and emergency procedures and planning implemented; and • Development of a set of Operating rules; emergency response procedures; safety and security procedures; and the potential creation of shipping officer positions to manage traffic into and out of the loading facility.			
Rehab-ilitation and Mine Closure		Poorly designed rehab can lead to: • ongoing erosion and sedimentation • Uncover PAF materials over timeframes beyond that of the mining. • Weed establishment	3 4 2	C C C	13 18 8	Management and mitigation strategies are: • Progressive rehabilitation will provide the rehabilitation staff with the opportunity to trial methods and monitor these methods. • Erosion and sediment control plans will be in place and updated regularly • Weed quarantine and management policies and procedures are in place and will be regularly monitored • AMD management plans to ensure appropriate management of PAF materials. (see surface and groundwater quality risks above)	2 3 2	B C C	5 13 8

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Social and Cultural	Assets and Infrastructure	1. Road safety reduced	4	C	18	• All risks within this aspect will be managed through the Community Liaison and Consultation Plan (Appendix H). The plan will include consultation measures, tools and timing to ensure the community is fully informed and consulted in relation to construction and access	4	A	10
		2. Construction disruptions to community	3	C	13		2	A	3
		3. Pressure on services	3	B	9		2	B	5
Social and Cultural	Education – Early Years to Adulthood	1. Decline in school attendance due to parents working	2	C	8	• WDRL will support programs (as appropriate) that work closely with parents, families and teachers to ensure support is provided • WDRL will support programs(as appropriate) that work with schools to assist with programs to support increased attendance • WDRL will support programs (as appropriate) that work with communities and local employers to build broader skills and experience to support cross industry occupation development • WDRL can investigate the potential of providing assistance to schools with any programs that support higher school attendance (as appropriate).	2	B	5
		2. Poor literacy and numeracy affects ability to be employed	2	E	16		2	C	8
		3. Loss of aspiration for learning beyond mining sector	2	C	2		1	B	2
		4. Cultural barriers not addressed leading to ongoing disengagement from education	1	C	4		1	B	2

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
Social and Cultural	Economic Participation and Development	1. Expectations high and outcomes low leading to disappointment	3	D	17	• Managed through the Community Liaison and Consultation Plan (Appendix H). • Managed through the Community Liaison and Consultation Plan (Appendix H).	2	C	8
		2. Poor communication and planning means communities do not know when vacancies arise	3	C	13	• WDRL will investigate the potential of supporting programs (as appropriate) that provide mentoring and capacity building to support start-up businesses/enterprises • WDRL will support programs (as appropriate) that develop strategies to support recruitment through an Indigenous Employment Strategy	2	B	5
		3. Local Indigenous business enterprises fail	3	D	17		2	B	5
		4. Conflicting traditional and business values lead to poor retention of Indigenous employees	3	D	17	• Managed through the Community Liaison and Consultation Plan (Appendix H) that ensures recruitment communicated. Further the Indigenous Employment Strategy (Appendix H4)ensures recruitment is structured and not ad hoc • Managed through the Community Liaison and Consultation Plan (Appendix H). • WDRL will investigate the potential of developing mechanisms and strategies to assist employees manage humbugging • WDRL will support programs (as appropriate) that develop strategies to support recruitment through an Indigenous Employment Strategy • WDRL will investigate the potential of supporting programs (as appropriate) that work with communities to develop a financial literacy program and local agencies to support money management.	2	C	8
		5. Increased pressure on household through increased visitors looking for employment	3	C	13		2	C	8
		6. Tension between and within	3	C	13		2	C	8
			3	D	17		2	C	8
			3	C	13		2	B	5

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		communities competing for employment	3	C	13		2	B	5
		7. Increase in tension within families due to humbug							
		8. Reduce community capacity as people move away with new skills							
		9. Increased social problems due to increased disposable income							
Social and Cultural	Youth Opportunities	1. Increased anti-social behaviour through increased disposable income	3	C	13	• WDRL will investigate supporting programs (as appropriate) that work with communities to develop a financial literacy program and local agencies to support money management • Ensure the topic of youth is included as a focus area for any Social/Community Benefits scheme that is established • Ensure culture is respected and recognised within the workplace and young people are provided with the means to maintain cultural responsibilities. As part of WDRL commitment, all staff will undertake a Cultural Heritage Training Program.	2	B	5
		2. Failure to make positive contribution to change	2	B	5		1	B	2
		3. Expose young people to cultures	2	D	12		2	C	8

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		different from their own							
Social and Cultural	Health	1. Increased pressure on housing and associated health risks 2. Poor nutrition leads to unemployment 3. Failing mandatory drug and alcohol testing 4. Stress on families with members living away from home	2 1 3 3	C A C C	8 1 13 13	• Managed through the Community Liaison and Consultation Plan (Appendix H). • WDRL will support programs (as appropriate) that work with local communities to support healthy lifestyle and eating programs • WDRL will support programs (as appropriate) that assist local agencies with education programs and work with local communities to build education programs • Work with communities to build working rosters (as applicable to the work requirements of the project) that support family and community wellbeing	**1** **1** **2** **2**	**B** **A** **B** **B**	**2** **1** **5** **5**
Social and Cultural	Cultural Heritage	1. Failure to protect sacred sites and/or sites of significance 2. Cultural heritage not well managed 3. HR polices do not adequately account for cultural obligations and	4 4 3	B B C	14 14 13	• Results of survey work show that there are no heritage sites within the project area besides those identified in the AAPA search (these will be avoided). • Develop HR policies and practices in consultation with the community to ensure cultural obligations and responsibilities can be met [3,4] • Develop a Cultural Heritage Management Plan within the broader Mine Closure (Exit) Strategy	3 3 2	B B B	9 9 5

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
		responsibilities 4. Young people cannot meet cultural requirements and obligations 5. Rehabilitation does not account for protection of sacred sites	3 4	C B	13 14		2 2	A B	3 5
Cumulative Impacts	Impacts from this and other developments having a deleterious impact on regional values	Impacts on society, amenity, ecosystems and habitats	2	B	5	Of all the aspects mentioned in Section 9.7, only the sense of remoteness will be affected.	2	B	5
Bushfire	Bushfire encroaching on mining activities, process plant or mine camp	Loss or impact to: • Human health • Infrastructure	4	D	21	WDRL will: Reduce the opportunity for mining activities to start fire by: • fire being part of induction • limiting smoking to defined areas • maintaining a strict no-fire policy • ensure vehicles are maintained • Vehicle and machinery exhaust systems shall be inspected regularly for leaks • All vehicles will be equipped with portable fire extinguishers. Reduce the opportunity for fire to impact people or infrastructure	2	C	8

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
						by: • Installing firebreaks, • Updating fire planning procedures (such as muster points) for loading station, haul road and the mine site including the camp. • Maintain or update as required, existing Emergency Plan			
Human Health	Biting Insects	Personnel exposed to mosquito borne diseases	3	C	13	• Implementation of Biting Insect Management Plan, reducing potential biting insect breeding sites • Inform personnel of peak biting insect risk periods as determined by 12 month baseline biting insect study • Minimise personnel exposure to biting insects trough provision of appropriate clothing, insect repellent, utilising yellow external lights to prevent mosquito attraction and appropriately screened buildings.	3	B	9
Noise	Noise and Vibration	Impact visitors remote experience	3	C	13	• Careful consideration of location of receptors and plant and equipment and implementing known strategies to reduce.	2	B	5
Air Quality	Air Quality and Dust	Amenity Increase in sediment loads to nearby creeks	3	C	13	• Erosion and Sediment Control Plan	2	B	5
Transport	Traffic accident on mine site, haul road or transporting equipment to/from mine site	Potential injury or death of persons involved. Risk to humans and/or facilities	4	C	18	• All operators to be suitably licensed and trained for specific tasks • All personnel to receive site specific training through induction process • All personnel to adhere to WDRL's Traffic Safety Management System	4	C	18

Risk	Aspect	Potential Impact/Hazard	Inherent Risk (C=Consequence; L=Likelihood; RS=Risk Score)			Management Measures	Residual Risk (C=Consequence; L=Likelihood; RR=Residual Risk)		
			C	L	RS		C	L	RR
						• Transport operations to be carried out by experienced personnel only. • Transport using public roads to be performed in line with the Traffic Act and Motor Vehicles Act.			