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Balla Balla Magnetite Project

Environmental Protection Statement

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EXECUTIVE SUMMARY

INTRODUCTION

Ferro Metals Australia Pty Ltd (FMA), a 100% owned subsidiary of Aurox Resources Ltd (Aurox), proposes to develop the Balla Balla Magnetite Project (the Project), which comprises the mining and processing of up to 10.3 million tonnes per annum (Mtpa) of magnetite ore to produce 6Mtpa of magnetite concentrate over a 15 year mine life.

Aurox is a Perth-based Australian resource company first listed on the Australian Stock Exchange in October 2004. Since its incorporation in October 2003, Aurox has acquired a number of highly prospective tenements covering ground positions in the Yalgoo and West Pilbara mineral fields of Western Australia.

LOCATION

The Project mining area is located within the Sherlock and Mallina pastoral leases, in the Pilbara region of Western Australia, approximately 10km northwest of Whim Creek and midway between the regional centres of Karratha and Port Hedland (**Figure E1**). The Project's southern boundary of tenure is located approximately 6.5km to the north-west of Whim Creek. Pipelines to convey slurry and water between the mine and Port Hedland are set within a service corridor which lies within existing gas pipeline and power service corridors. Dewatering, storage and product loading facilities are located at Utah Point, within the Port Hedland Port Authority (PHPA) area. Mine tenure for the Project is shown on **Figure E2** and **Figure E3** and listed in **Table E1**.

Table E1 Balla Balla tenements

Mine Feature/Infrastructure	Tenement Numbers
Pits, waste landforms, low grade dumps, and borefields.	Mining leases M47/311, M47/312, M47/541, M47/360, M47/361, M47/297 M47/298 M47/514*. Miscellaneous Licence L 47/57, Prospecting Licence P47/1094 (M47/514).
Accommodation village, low grade dumps, processing plant and tailings storage facility (TSF).	General purpose lease G47/1229, Mining Lease M47/804.
Access road, water pipeline, slurry pipeline, Horizon power easement and gas pipeline.	Miscellaneous Leases L47/168, L47/171, L47/229, L47/230, L47/242, L47/243, L47/244, L47/245, L47/231.

Figure E1 Site location plan

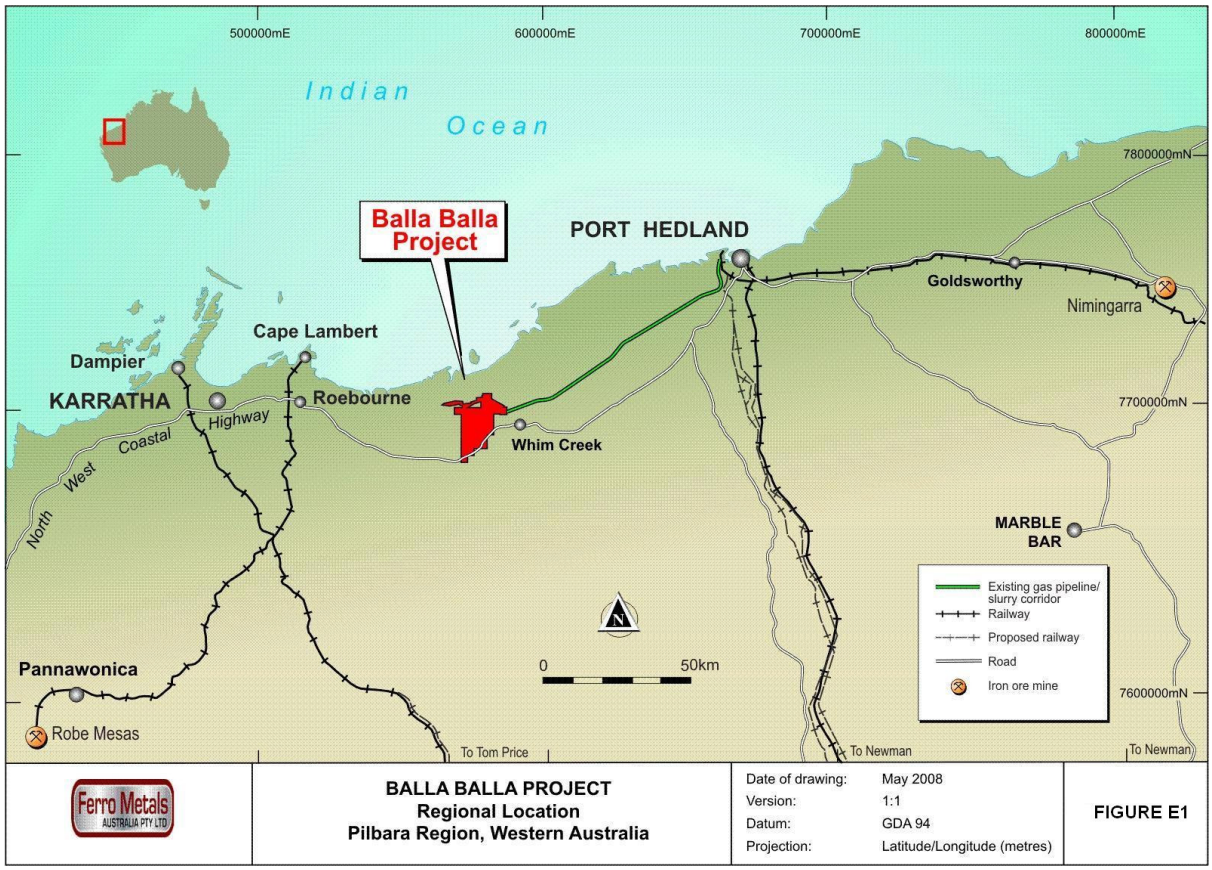


Figure E2 Land tenure

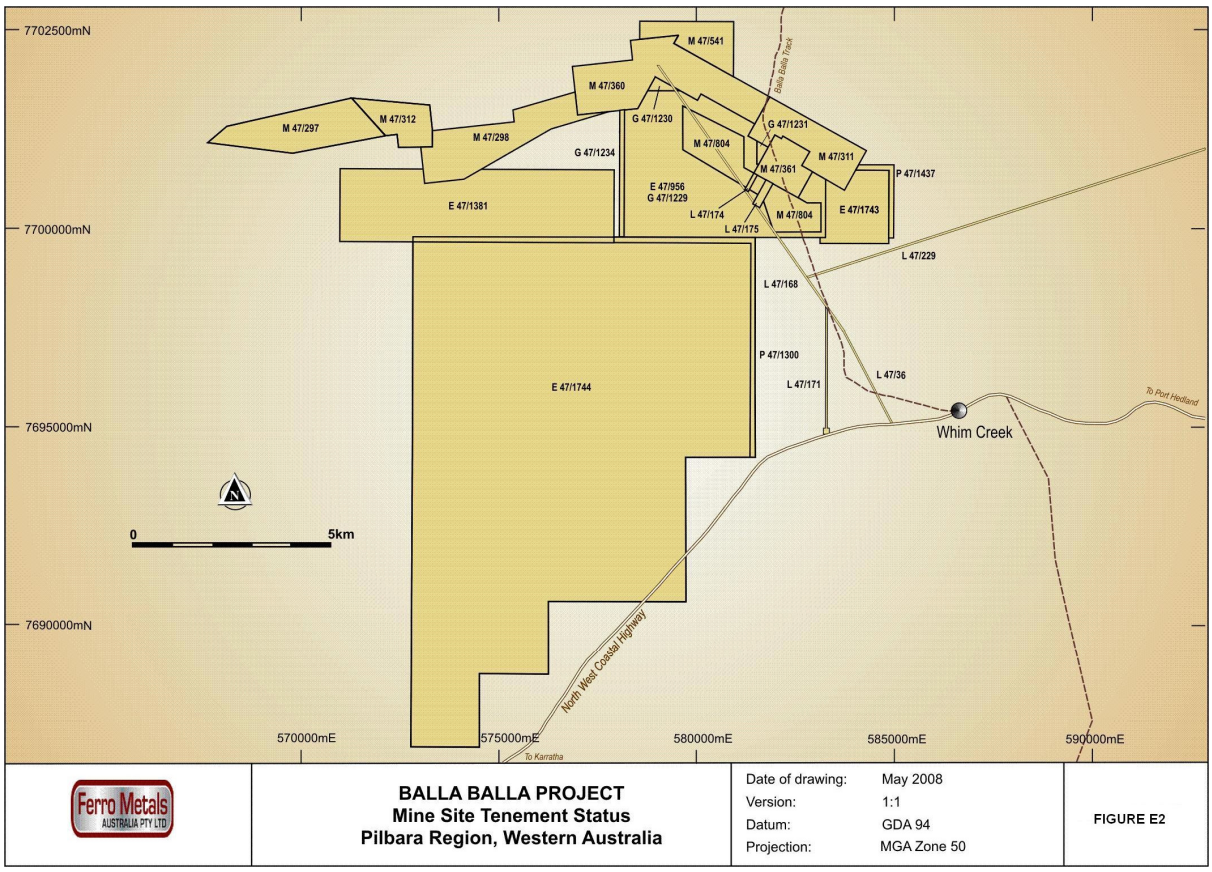
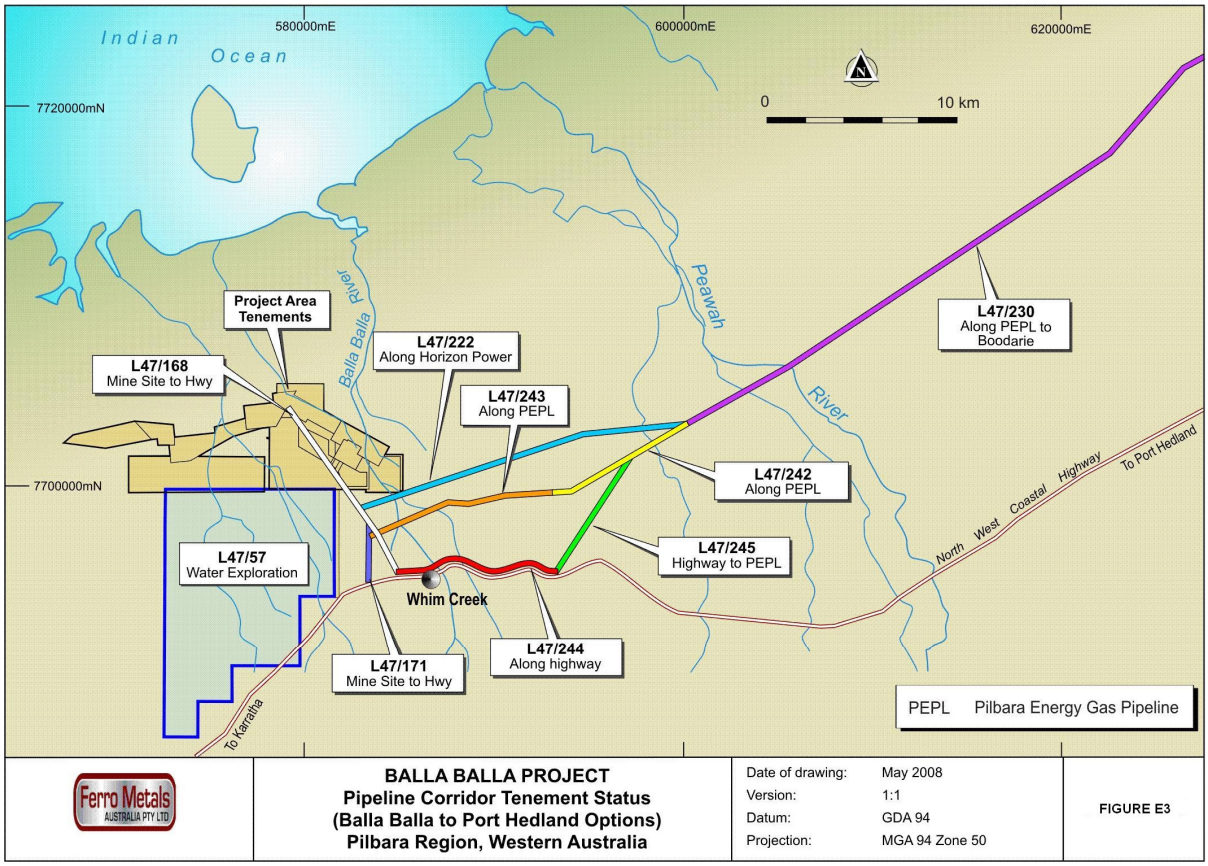


Figure E3 Land tenure including pipeline tenements



DESCRIPTION OF THE BALLA BALLA PROPOSAL

The Balla Balla Project involves the development of an open pit magnetite mine; a processing plant and associated support facilities near the mine; haul roads and access roads; above ground mine waste storage facilities; pipelines to convey magnetite slurry to Port Hedland and to return recovered water from Port Hedland to the mine; and a dewatering and loading facility at Utah Point in Port Hedland.

The scope of this report does not cover downstream processing of magnetite concentrate, impacts associated with shipping of concentrate overseas, or end use of the magnetite product. Also not covered in this report are the potential environmental impacts associated with the construction and operation of the port facilities at Port Hedland. These impacts are assessed under the Port Hedland Port Authority (PHPA) Utah Point Berth Project Public Environmental Review (SKM, June 2008).

Table E2 Summary of key project characteristics – Balla Balla Magnetite Project

Element	Description
Life of project (mine and ore processing)	15 years
Type of product	Magnetite (iron ore)
Quantity of ore to be mined over life of project, kilotonnes (kT)	129,332
Mining method	Open pit
Method of conveying product	Below ground slurry pipeline
Number of pits	2 – to be mined concurrently
Mine pit dimensions (length x width x depth, m)	Central pit (1800 x 300 x 135) Western pit (4000 x 200 x 165)
Number of people to be employed during operations	280
Size of residential accommodation facility (number of units)	Permanent 300 Construction 800
Employment roster	FIFO 8 on, 6 off
Pipeline corridor (length, km x width, m)	110 x 40
Area of disturbance (mine and pipeline, ha)	1515
Quantity of waste rock and overburden, kilotonnes (kT)	283,684
Quantity of tailings produced over life of mine, megatonnes (MT)	59
Maximum height of waste dumps (m)	55
Size of traditional TSF (ha and maximum height, m)	270 x 31
Size of concept TSF and Integrated Waste Landform (ha and maximum height, m)	174 x 45
Source of water	Groundwater, recycled water from processing plant, pit water
Estimated groundwater use (pit dewatering and borefields) over life of mine (GL)	98.4
Quantity of ore to be dewatered at port (Mtpa)	6
Quantity of ore to be stockpiled at port (maximum at any given time), tonnes (t)	500,000
Estimated CO_2 (equivalent) emissions, kilotonnes (kT) over life of project – AGO scopes 1, 2 and 3. Includes construction and operations phases of project. No allowance for sequestration.	5065
Additional vehicle movements on North West Coastal Highway, per week (road trains, light vehicles, buses)	16 x 15 x 10

STAKEHOLDER CONSULTATION

FMA commenced a stakeholder consultation programme in late 2005 during the early stages of Project design and development.

The following stakeholders have been consulted:

Government Agencies:

- Environmental Protection Authority Services Unit (EPASU);
- Department of Environment and Conservation (DEC);
- Department of Conservation and Land Management (now DEC);
- Department of Planning and Infrastructure (DPI);
- Department of Industry and Resources (DoIR);

- Department of Water (DoW);
- Department of Consumer Protection and Employment (DoCEP);
- Department of Indigenous Affairs (DIA);
- Office of Development Approvals Coordination (ODAC);
- Pilbara Development Commission;
- Port Hedland Port Authority (PHPA);
- Main Roads of Western Australia (MRWA);
- Horizon Power.

Local Government:

- Shire of Roebourne;
- Town of Port Hedland.

Indigenous:

- Ngarluma Yinjibandi Group;
- Karriyarra Group.

Other:

- Mallina Station;
- Sherlock Station;
- Straits Resources;
- Boodarie Station;
- Mundabullangana Station;
- Conservation Council of Western Australia Inc;
- Wildflower Society of WA;
- Adjoining Mining Tenement Holders;
- Karratha Tourist Bureau.

KEY AREAS OF INTEREST

The main aspects raised by stakeholders related to surface and groundwater management, potential impacts to flora and fauna (including stygofauna) and Aboriginal heritage.

The following scientific studies and investigations have been undertaken by FMA to identify possible conflicts or in response to the issues raised by stakeholders, which are included in the EPS as appendices:

- Vegetation and flora studies
- Terrestrial fauna studies
- Subterranean fauna studies
- Surface hydrology investigations
- Hydrogeological investigations
- Archaeological and ethnographical surveys
- Soils and geotechnical investigations

- Geochemical investigations
- Air quality investigations
- Noise modelling
- Tailings storage facility conceptual design

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

The following environmental factors were identified as relevant to this proposal:

- Vegetation and flora
- Terrestrial fauna
- Subterranean fauna
- Surface water
- Groundwater levels and quality
- Rehabilitation and closure

The following additional environmental factors were considered to be minor factors given the remoteness of the location or where existing management measures have been applied to these factors. Therefore, the following nine factors are addressed in less detail in the EPS.

- Aboriginal heritage
- European heritage
- Air quality and greenhouse gases
- Landforms, geology and soils
- Waste rock and tailings
- Noise
- Visual amenity
- Waste management
- Public risk and safety

VEGETATION AND FLORA

The proposal will result in clearing of a maximum 1010ha from a total of 3594ha within the mine-site. This represents 28% of the mine-site area. A further 505ha will be cleared for the slurry pipeline. 31 vegetation communities (and five mosaic communities) have been mapped within the Project Area. All vegetation communities in the mine-site area are well represented in either the Horseflat land system or the Pilbara region generally. The Clay Plains communities located in the Project Area (designated by CP prefix) support a few species in common with the Priority Ecological Community of Roebourne Plains coastal grassland. The species in common include *Eragrostis xerophla* (CP2, CP3, CP4 and CP6) (Mattiske, a2008). However, these communities are tussock grasslands on gilgaied and non-gilgaied clay plains and are characteristic of the Horseflat land system. Three Priority

species have been located at different times within the Project Area. Of these, two Priority species could potentially be impacted by the mining footprint.

Three vegetation communities considered 'locally significant' have been identified within the mine-site area. The major channel community (MC1) which is present along the two watercourses that run through the Project Area (Balla Balla River and Salt Creek) could be considered as 'locally significant' because a small population of Priority species *Themeda* sp. Hamersley Station was recorded in this community. Similarly the MC1 community is poorly represented in the Horseflat land system (<1%) and provides habitat for fauna such as birds nesting in tree hollows. The watercourse vegetation will not be directly impacted by mining operations. The woodland communities (DZw4 and DZw8) are located in the drainage zones and could be considered locally significant as they provide significant fauna habitat.

TERRESTRIAL FAUNA

Impacts to fauna as a result of the Project are expected to be low. There are 20 fauna species that are of conservation significance and could occur in the mine-site area. Based on the habitats present, the area is unlikely to support large populations of these species except for the skink *Ctentotus rufescens*. However, there is extensive habitat available for *C.rufescens* both inside and outside the Project Area. Construction of the slurry pipeline is not expected to result in a high fauna mortality rate due to the management measures that will be implemented during construction.

Impacts upon fauna due to the construction and operation of the Project are likely to be from localised loss of habitat, with potential impacts from roadkill and changes in hydrology, the fire regime and the abundance of introduced predators. Riparian habitats along the Balla Balla River and Salt Creek are locally significant due to the high concentration of species they support and their restricted occurrences. These habitats will not be directly impacted by mining operations, and FMA have developed a monitoring programme to ensure that the riparian vegetation is not impacted from groundwater drawdown. The proposal will result in approximately 1515ha of vegetation clearing to accommodate the infrastructure footprint. Of this approximately 39ha will occur on the riparian systems, which is predominantly from TSF Creek and Marnipurl Creek, both of which are severely degraded small catchments, which are well represented elsewhere in the region.

SUBTERRANEAN FAUNA

From the 72 bores sampled in the Project Area, 56 stygal taxa were identieid which were typical of the Pilbara region. The connectivity of the subterranean habitat in and around the Project Area, the wide distribution of the majority of species found, the relatively small loss of habitat, and the management measures in place, it appears unlikely that either the direct impacts of mining or the effects of dewatering and water abstraction will result in unacceptable impacts on subterranean fauna. Although the groundwater system in the Project Area comprises a number of aquifers, i.e. there is no

single aquifer across the site, they are contiguous and interconnected. The area is not considered to be a suitable habitat for troglofauna, based upon the geomorphological characteristics of the area. The groundwater table rises to 7m in the area and the clayey nature of the surface layer does not support stable interstitial spaces. The magnetite exists at approximately 30m and is compact, lacking any suitable habitat for troglofauna.

SURFACE WATER

The Balla Balla Project is not expected to impact off-site surface water quality as there will be no discharge of excess or disturbed water from the mine. Run-off from undisturbed areas within the Project Area will be diverted around the facility via diversion drains into existing drainage features. Prior to development, the combined Marnipurl and unnamed drainage line subcatchment area is approximately 16.4km^2. An estimated 13.3km^2 of this catchment will be impacted. The pre-development flow regime of both the Marnipurl and unnamed drainage line will therefore be significantly modified. Given the relatively small contribution of the Marnipurl Creek to hydrological function in the Project Area, the reductions in streamflow is unlikely to significantly impact the receiving environment. For Salt Creek, the hydrological modelling predicts a small reduction in peak discharge from high frequency (1 in 2 year) storm events of up to about 3.3% (reduction from 90m^3/s to 87m^3/s). For low frequency (1 in 100 year storm events), the Salt Creek catchment peak discharge will be reduced by about 4.8%. The Balla Balla River catchment area will increase by approximately 0.9km^2 of additional catchment area (an increase of about 0.5%). There will be a minimal effect on streamflow in the Balla Balla River, given that the existing catchment area for this river is in the order of 164km^2. The minor reduction in disharge of the Salt Creek catchment is not expected to impact riparian vegetation in Salt Creek however, the health of the riparian vegetation will need to be regularily monitored to ensure the vegetation is protected.

GROUNDWATER

Approximately 7.80GLpa of fresh to brackish water is required for the processing plant operations on-site, reducing to 5.90GLpa as clarified water is returned from the dewatering operations at the port. An additional 0.56GLpa is required for dust suppression and for plant and mine equipment washdown. Process water will be sourced from a combination of mine dewatering and groundwater abstracted from bores. Groundwater in the Balla Balla Project Area is relatively shallow (typically less than 10m below surface). In the mine site area, the groundwater depth is around 7m below ground level, with water occurring in floodplain sediments, weathered rock and fractured rock zones. Two hydrogeological investigations have been undertaken in the Balla Balla Project Area based on data obtained from two exploration drilling programmes and one test pumping programme. Groundwater levels may be altered as a result of pit dewatering, abstraction of water from production bores and mounding of water beneath the tailings storage facility. Potential impacts of these changes include the reduction in quantity of water available to terrestrial vegetation communities, subterranean fauna, and to existing groundwater users; these impacts will be managed by establishing with relevant

agencies appropriate threshold drawdown levels, and the cessation of abstraction in affected areas or release of compensatory water from other areas.

REHABILITATION AND CLOSURE

Approximately 1430ha of disturbed land will be rehabilitated at the end of mining. FMA recognises that the environmental rehabilitation and closure of its mining sites is an essential requirement of mining and needs to be incorporated into the planning and operational phases of mining. FMA will ensure that public safety and key environmental values will be protected at closure, with disturbed areas being made safe, stable and non-polluting. FMA will ensure that the use of environmental resources will not result in public cost or liability or significantly constrain the agreed future uses of the land. FMA will minimise disturbance to biophysical systems and optimise use of valuable resources, including water, energy and topsoil.

ENVIRONMENTAL MANAGEMENT

Environmental management and monitoring will be carried out within the framework of an integrated environmental management system (EMS). The EMS used at Balla Balla will be compliant with the international standard ISO 14001:2006. The EMS and the plans and procedures that support it have been developed or are currently being developed by FMA and will be in place prior to the commencement of ground disturbing works.

The following environmental management plans have been developed and form part of the Project referral:

- Acid Sulphate Soil Management Strategy
- Waste Management Plan
- Emissions Control Plan (dust, noise, light)
- Fire Management Plan
- Water Management Plan
- Ground Disturbance and Rehabilitation Plan
- Emergency / Contingency Preparedness Plan
- Construction Environmental Management Plan

CONCLUSION

In summary, the potential environmental impacts of the proposal and corresponding management measures are:

- The potential impact of the direct clearing of 1010ha of vegetation to accommodate the mining and ore processing operations, and a further 505ha for the pipeline corridor. FMA has designed the location of key mining infrastructure to avoid significant local vegetation wherever feasible, predominantly major creek lines. FMA has developed a Ground Distrubance and Rehabilitation Management Plan to minimise the impacts of clearing and manage rehabilitation. FMA has developed a mine closure and rehabilitation strategy which will be refined throughout the life of the Project.

- The Project Area has a number of local surface water catchments that will be impacted by the Project. The range of catchment loss/modification varies from relatively minor in the case of Balla Balla River and Karinha/Salt Creek catchments, to quite significant in the case of Marnipurl Creek and the area collecting from the unnamed drainage line. However no significant riparian vegetation will be impacted.

- Groundwater drawdown from pit dewatering and process water supply has the potential to affect groundwater dependant River Red Gums (*Eucalyptus camaldulensis*) in Salt Creek and the Balla Balla River. A groundwater monitoring programme will be implemented to manage any potential impacts to groundwater dependent vegetation along the Balla Balla River, Coorinjinna Pool, or Salt Creek.

- Construction of the slurry pipeline has the potential to cause death or injury to fauna from entrapment in open trenches during construction of the pipeline. FMA has developed a management strategy, in the Construction Environmental Management Plan, to ensure impacts to fauna are minimised and will employ a specialised fauna clearing crew to manage fauna pitfall during the pipeline construction.

- The Project Area is rich in stygofauna, some of which were found in potential impact zones. A stygofauna monitoring programme has been developed and will be implemented to ensure that the impacts of mining do not result in unacceptable impacts to stygofauna.

- At cessation of mining, dewatering of mine pits will stop and groundwater will seep back into the pit voids. FMA will rehabilitate the site, based on FMA's overall closure and rehabilitation objectives to ensure that public safety and key environmental values are protected, ensure the use of environmental resources by FMA do not result in public cost or liability, minimise disturbance to biophysical systems, optimise the use of resources (water, energy, topsoil),

and attain closure and rehabilitation outcomes as agreed with government agencies and other stakeholders.

Table E3: Summary of key environmental issues, potential impacts and management

Factor	Environmental Objective	Existing Environment	Potential Outcomes	Management and Mitigation	Predicted Outcomes
Terrestrial Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of terrestrial flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	50 terrestrial vegetation communities within the proposed mine site Project Area. No threatened ecological communities (TECs) as defined by the EPBC Act or by the DEC. No declared rare flora ("DRF") species. No plant taxa listed under Section 179 of the EPBC Act. Potentially PEC Roebourne Plains Coastal Grasslands. Three Priority Flora species were recorded as being within or potentially within the Project Area.	Direct clearance or disturbance of vegetation and flora. Impacts to riparian vegetation associated with alterations to site hydrology. Impacts to vegetation from potential changes to groundwater levels due to pit de-watering, water abstraction and/or groundwater mounding around the tailings storage facility (TSF). Effects of dust. Introduction of weeds and exotic species. Secondary impacts, such as off-road traffic and increased fire. Reduction in grazing pressure.	Unnecessary clearing of vegetation beyond that strictly required will be avoided, particularly in sections where trees are present, as they provide habitats for many species. Further targeted surveys will be implemented to determine whether Priority species *Gomphrena* sp. and *Mimulus* sp. can be found within the Project Area. Disturbance to communities supporting habitat trees will be minimised wherever feasible (MCI, DZw4, DZw8). Viable seed of native species will be collected for future rehabilitation work. Topsoil, log debris and leaf litter will be salvaged for future use in rehabilitation programs. If possible, stockpiled topsoil will be directly replaced on disturbed areas. The risk of introducing and spreading invasive weeds will be minimised by maintaining vehicle hygiene or other suitable means of weed control in accordance with the Ground Disturbance and Rehabilitation Management Plan. Impacts and management associated with changes to groundwater levels from pit de-watering and/or groundwater will be monitored through the ground water monitoring programme to ensure there is no impact to groundwater dependant vegetation (River Red Gums).	1010ha of vegetation will be cleared in the mine-site area (28% of existing vegetation). Disturbance to locally significant communities are: 2.9% of MC1 will be impacted. 60% of DZw4 and 20% of DZw8 will be impacted by essential mining infrastructure. The impact of mining on Marnipurl Creek will result in a 66% loss of Dzg2 habitat and 100% loss of Dzg2 and CP3. The construction operations of the proposal will not significantly impact upon the significant flora or vegetation of flora or vegetation communities or their conservation status. Priority species *Themeda* and *Acacia glaucocaesia* will not be impacted by the Project. There willl be no long term impacts to groundwater dependant vegetation at Salt Creek, Balla Balla River or Coorinjinna Pool from groundwater drawdown.

				Surface water dependant species *Corymbia hamersleyana* at Salt Creek, Balla Balla and Coorinjinna Pool will be monitored throughout the life of the Project.	
Terrestrial Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of terrestrial flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Pipeline corridor: 14 plant communities along the pipeline corridor study area; none are Threatened Ecological Communities. Condition of vegetation varied from completely degraded (in previously cleared areas) to degraded (grazed areas and those affected by weed infestation) to very good. Regular fires have had adverse impacts on vegetation along the pipeline corridor. No Priority Flora species as listed by the DEC. No Declared Rare or Priority Flora species. No plant taxa pursuant to Section 179 of the EPBC Act. No threatened plant species listed under the EPBC.	Direct clearance or disturbance of vegetation and flora. Impacts to riparian vegetation during construction. Effects of dust. Introduction of weeds and exotic species. Secondary impacts, such as off-road traffic and increased fire.	FMA pipeline corridor to be located in proximity to existing previously disturbed infrastructure corridor. Unnecessary clearing of vegetation beyond that strictly required is avoided, particularly in sections where trees are present, as they provide habitats for many species. Disturbance to communities supporting habitat trees will be minimised. Viable seed of native species will be collected for future rehabilitation work. Topsoil, log debris and leaf litter will be salvaged for future use in rehabilitation programs. If possible, stockpiled topsoil will be directly replaced on disturbed areas. The risk of introducing and spreading invasive weeds will be minimised by maintaining vehicle hygiene or other suitable means of weed control. Clearing of creek line systems will be avoided where feasible. Reconfirm specimen of *Olearia dampieri* held at Mattiske and undertake further targeted studies in the field (northern flowline of the Yule River pipeline crossing) following seasonal rains.	Construction of the pipeline will result in 505ha of clearing. The construction and/or operations of the pipelines will not significantly impact upon the conservation status of flora or vegetation communities.

Terrestrial Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Mine site: 20 vertebrate fauna species that are of conservation significance may live in or visit the general Project Area. The area is unlikely to support large populations of any significant species, except perhaps for the skink *Ctenotus rufescens* (Conservation Significance 3). Extensive habitat for *C. rufescens* is available both within and outside the study area.	Death/injury of fauna during clearing, grading and construction. Entrapment of fauna in boreholes, water storages and TSF. Fauna injury and mortality as a result of impacts with vehicles/machinery. Obstruction (e.g. pipes on ground, roads) to the movements of terrestrial fauna. Loss or fragmentation of habitat (clearing). Impacts to riparian and aquatic habitats as a result of altered hydrology. Increased predation or competition as a result of increase in the abundance of exotic species. Loss of habitat or direct mortality as a result of increase in the frequency of fire.	Clearing of vegetation will be kept to a minimum. Disturbance of riparian systems that are significant fauna habitats (major creek lines and drainage lines) will be particularly avoided where possible. Where drainage diversion works are required, sufficient culverting will be installed to maintain surface water flows. Drill holes will be temporarily capped on completion of drilling and permanently capped as soon as possible. Off-road vehicle use will be strictly controlled over the Project Area with no driving permitted off designated routes. Strict speed limits will apply over the Project Area and on all haul roads. All vertebrate fauna injuries or death will be reported annually. Residential and plant areas of the mine site will be designed to minimise light spill. Progressive rehabilitation of disturbed areas will be implemented with the aim of reflecting the pre-disturbance state as closely as possible. Fire management will be addressed in the Project's Environmental Management System and will be based upon fire exclusion within the Project Area. Management over the Project Area will ensure that feral animals, as well as native animals, cannot access food scraps. No pets will be allowed in the	Impacts on terrestrial fauna and the habitats that support them are expected to be minimal. Any species recovered during pipeline trench clearing will be recorded.

				mining accommodation areas. FMA will cooperate with other land managers in the implementation of feral/introduced animal control measures in the Project Area.	

Terrestrial Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Pipeline corridor: Up to 27 significant taxa may visit or live in or near the pipeline corridor. The significant species which may occur in the Project Area include: 4 reptiles, 14 birds and 9 mammals. No fish or amphibians of conservation significance are expected to occur in the area. The most significant fauna habitats along the pipeline corridor are riparian habitats along major watercourses and dense Acacia shrublands on sandy plains.	Death/injury of fauna during clearing, grading and construction. Entrapment of fauna in trenches. Fauna injury and mortality as a result of impacts with vehicles/machinery. Obstruction (e.g. pipes on ground, roads) to the movements of terrestrial fauna. Disturbance associated with light, blasting vibrations and noise. Loss or fragmentation of habitat (clearing). Increased predation or competition. Loss of habitat or direct mortality as a result of increase in the frequency of fire.	Construction of the 110km pipeline will not occur during the summer months from November to March (inclusive). The length of open trench will not be greater than 20 km at any one time. The entire length of trench will be inspected by a specific fauna team within 3 hours of sunrise. Fauna shelter boxes and soil plugs will be placed in trenches at regular intervals to allow an escape for fauna. FMA will report the fauna species collected to DEC on a regular basis. Clearing of vegetation will be kept to a minimum. Disturbance of riparian systems will be particularly avoided where possible. Off-road vehicle use will be strictly controlled over the Project Area with no driving permitted off designated routes. Progressive rehabilitation of disturbed areas will be implemented with the aim of reflecting the pre-disturbance state as closely as possible. Management over the Project Area will ensure that feral animals, as well as native animals, cannot access food scraps. No pets will be allowed in the mining accommodation areas. FMA will cooperate with other land managers in the implementation of feral/introduced animal control measures in the Project Area.	Impacts on terrestrial fauna and the habitats that support them are likely to be minimal.

Subterranean Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Rich and diverse stygyofauna. Most of the stygofauna from the Project Area are typical of the stygofauna of the immediate region and wider Pilbara region. Possible new species (not confirmed) in the Project Area are not limited to "impact areas". Area is not suitable for Troglofauna.	Loss of subterranean habitat as a result of mining and groundwater drawdown from dewatering or water abstraction. Alteration to groundwater quality as a result of seepage from the TSF or changes in pit void water chemistry.	Monitor groundwater drawdowns and water quality to validate hydrogeological model predictions. Implement the stygofauna monitoring programme.	Neither the direct impacts of mining, or the effects of dewatering and water abstraction are expected to result in unacceptable impacts on subterranean fauna populations. No impacts to Troglofauna are expected as the area is not a suitable habitat.
Surface Hydrology	Maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected.	The mine is located between the Whim Creek/Balla Balla River and the Salt Creek/Karinha Creek catchments. The Marnipurl Creek subcatchment lies within the mine-site area. The pipeline corridor traverses the Peawah River, Yule River, Yule River West, Turner River West and Turner River. Other smaller river crossings occur at the Balla Balla River, and Poverty and Whim Creeks.	Alteration of surface drainage networks and flow regimes. Contamination of surface water.	Surface water drainage has been designed to minimise alterations to hydrological flow regimes. Sediment control features and other contaminant removal controls (e.g oil/water separators) are included in mine drainage design. Pipeline construction will be scheduled to avoid the wet season. Directional drilling methods will be used near major river crossing to avoid disturbance to stream bed and banks during pipeline construction. Slurry pipeline includes automated leakage detection and control systems. Port site drainage design includes ample spill containment capacity and surface water treatment pond.	33% permanent reduction of flow in the Marnipurl Creek subcatchment is predicted as a result of surface water diversions required for flood protection. No significant adverse impacts on surface water quality or flow regimes are expected for the Balla Balla River, Coorinjinna Pool and Salt Creek.

Groundwater	Maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected.	Groundwater depth is ~7m below ground level. Water occurs in floodplain sediments, in weathered rock zones, and in fractured rock zones. The water table gradient is flat, with a low northerly hydraulic gradient towards the coast. Water quality is typically brackish and neutral to alkaline.	Changes in groundwater levels as result of pit dewatering, abstraction of water from production bores. Mounding or contamination of water beneath the TSF. Reduction in quantity of water available to terrestrial vegetation communities, subterranean fauna, and to existing groundwater users. Reduction in baseflow to the Balla Balla River and to the Coorinjinna Pool. Adverse impacts to groundwater quality as a result of spillage or poor management of hydrocarbons or reagents. Seepage of water containing elevated salts, metals or acidity from the TSF. Increased salinity, acidity or metals concentrations in water in the pit void as the pit re-fills at cessation of mining.	Routine monitoring of groundwater to confirm predictions of groundwater model. If defined trigger values is exceeded, FMA will implement contingency actions including, a reduction or cessation of pumping from production bores and augmentation of groundwater flows to the pool and upstream channel. Groundwater monitoring and contingency responses will be documented in a Groundwater Operations Strategy. A drainage management strategy has been developed to manage potential contamination issues associated with hydrocarbons, reagents and entrained sediment in the Project Area. All chemicals, oil and other hazardous materials will be stored in bunds in accordance with relevant standards and codes. Monitoring bores will be installed surrounding the TSF. If necessary, a seepage recovery system will be installed. A groundwater monitoring programme will be put in place to ensure that the TSF is performing as predicted.	No significant adverse impacts are expected to groundwater quality and the receptors potentially affected by groundwater drawdown or mounding as a result of the proposal. During operations and following mine closure a steep groundwater drawdown cone will develop in close proximity to the mine pits. Groundwater levels in the pits will not fully recover at mine closure. No discernible drawdown impacts to the Coorinjinna Pool and Balla Balla River or associated riparian vegetation. Trigger levels to be developed in consultation with DoW and DEC and drawdown levels to be monitored. Very localised impacts on stygofauna habitat – unlikely to affect stygal populations at local or regional level. Rate of seepage from the TSF during the operating life of the mine is unlikely to result in any discernible change to groundwater levels. The relatively benign chemical characteristics of the TSF leachate, coupled with the predicted slow rate of seepage, suggest that the TSF is unlikely to represent a significant source of groundwater contamination.

Table E4 Summary of commitments

Subject	No.	Commitment
Vegetation and Flora	1	All clearing of vegetation, in particular riparian systems, will be kept to a minimum over the Project Area.
	2	FMA will endeavour to avoid disturbance of the three Priority species communities relevant to the mine-site.
	3	Additional targeted work will be undertaken to locate *Mimulus* sp. *and Gromphrena* sp. post-cyclonic rains.
	4	A further targeted survey will be undertaken at the Yule River for *Olearia dampieri* post-cyclonic rains.
Terrestrial Fauna	5	Pipeline trenching for construction will not occur during the months of November to March (inclusive). No more than 20km of trench will be open at one time and the trench will be cleared within 3 hours of daylight everyday by a designated fauna pipeline clearing crew.
Short Range Endemics	6	A further short range endemic survey will be undertaken prior to any ground disturbing activity, before the next dry season.
Subterranean Fauna	7	FMA will implement the stygofauna monitoring programme in conjunction with the groundwater monitoring programme.
Surface Water	8	There will be no discharge of excess or disturbed water off-site and run-off from undisturbed areas within the Project Area will be diverted around the facility via diversion ditches.
Groundwater	9	A comprehensive surface and groundwater monitoring program will be finalised by FMA prior to the commencement of pit dewatering or bore field development or use. FMA will consult with DoW and DEC to determine groundwater trigger values indicative of excessive drawdowns and the management responses required should a trigger value be breached.

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Appendix F- Greenhouse

Appendix G – Terrestrial fauna and short range endemics

Appendix H – Subterranean fauna

Appendix I – Geochemistry

1. INTRODUCTION

1.1. The Proposal

Ferro Metals Australia Pty Ltd (FMA) proposes to develop the Balla Balla Magnetite Project (the Project), which comprises the mining and processing of up to 10.3 million tonnes per annum (Mtpa) of magnetite ore to produce 6Mtpa of magnetite concentrate over a 15 year mine life. Magnetite is a type of iron ore with strong magnetic properties. The Project is located approximately 10km northwest of Whim Creek on the North West Coastal Highway, midway between the regional centres of Karratha and Port Hedland (**Figure 1**). The magnetite concentrate will be sent to Port Hedland via a slurry pipeline.

Project construction is expected to commence during the first quarter of 2009 following the receipt of environmental and Ministerial approvals and permitting. Construction of the Project is expected to be completed during the forth quarter 2010. Operation of the Project will commence during the forth quarter of 2010 and will continue for approximately 15 years.

1.2. The Proponent

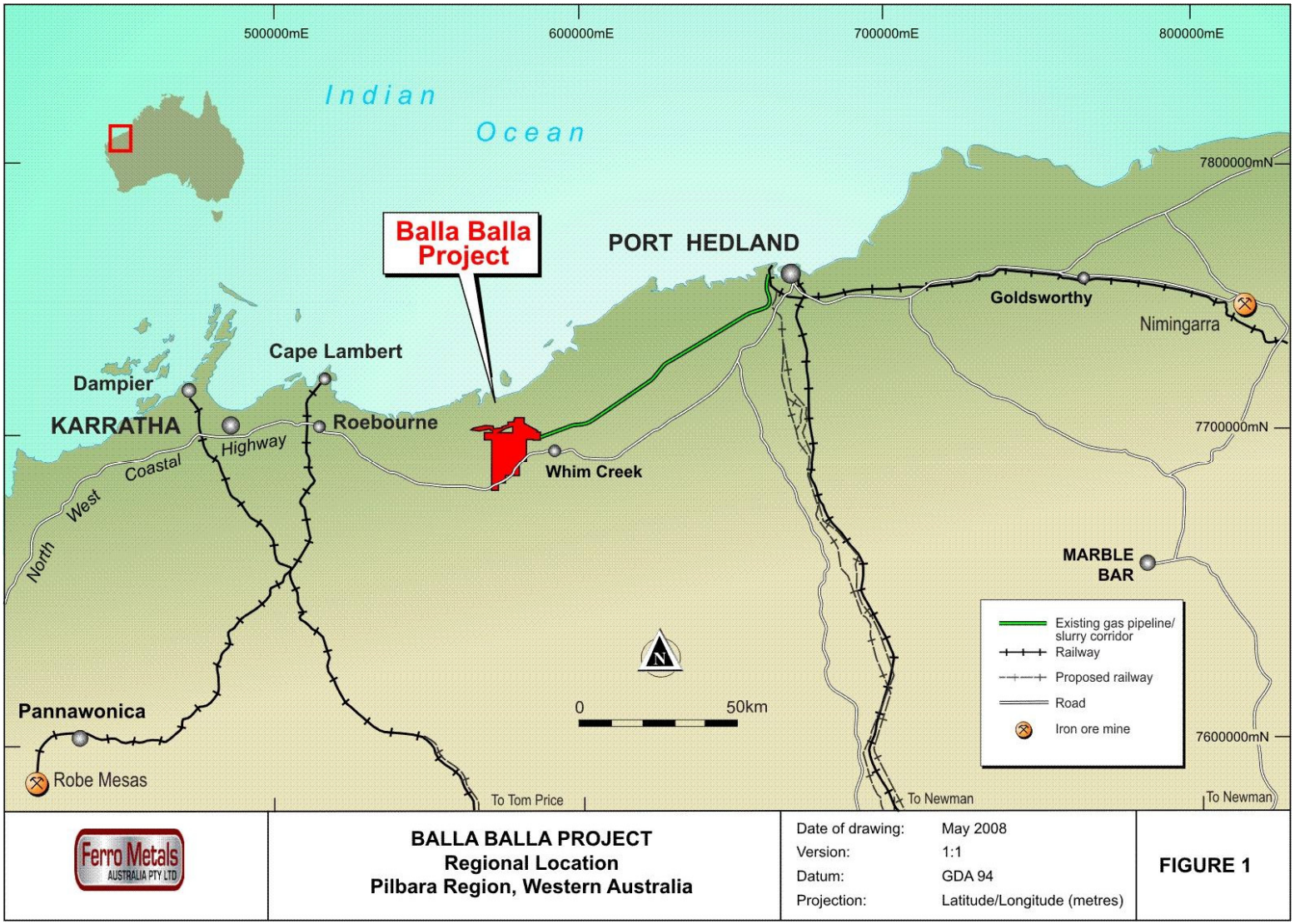
The proponent of the Balla Balla Magnetite Project is Ferro Metals Australia Pty Ltd (FMA), a 100% owned subsidiary of Aurox Resources Ltd (Aurox):

Aurox Resources Limited
Unit 1, 245 Churchill Avenue
Subiaco WA 6008
ABN: 32106793560

Aurox is a Perth-based Australian resource company, first listed on the Australian Stock Exchange in October 2004. Since its incorporation in October 2003, Aurox has acquired a number of highly prospective tenements covering ground positions in the Yalgoo and West Pilbara mineral fields of Western Australia. In April 2005, Aurox signed an option agreement to purchase 100% of the Balla Balla Project and is now focused on development of the Project.

The key contact for the Balla Balla Magnetite Project is:
Charles Schaus
Managing Director
Telephone: (08) 9382 4477
Facsimile: (08) 9382 2012
Email: charles.schaus@aurox.com.au

Figure 1 Regional location plan



1.3. Purpose and scope of this document

This document explains and describes the Project proposed by FMA and outlines the alternatives that were considered before arriving at the current proposal. The report provides a description of the environment in which the Project will be developed and identifies the key environmental issues that will need to be considered as part of the design and management of the Project. In discussing potential environmental impacts of the Project and the ways in which these will be avoided, minimised or managed, FMA has focussed on the most significant environmental aspects. Descriptions of more routine environmental aspects, and the arrangements proposed for managing these, will be provided at other stages of the environmental approvals process, for example in Works Approval applications and applications for water licences.

FMA has referred the Balla Balla Magnetite Project to the EPA under Section 38 of the *Environmental Protection Act 1986*. This report has been prepared to help the Environmental Protection Authority (EPA) and other stakeholders to form an opinion as to the environmental acceptability of the Project. The report seeks to demonstrate that the Project can be implemented in a way that is consistent with EPA policy objectives and with the environmental protection principles upon which EPA policies are based. Copies of field studies and other environmental investigations and analysis that have been completed as part of the Project planning and design are provided in a separate electronic document so that those interested in the technical detail of particular aspects of the environmental impact assessment may review all relevant information.

This report does not cover the detailed day-to-day procedures for environmental management and monitoring at the Balla Balla Project. Environmental management and monitoring will be carried out within the framework of an integrated environmental management system (EMS). The EMS used at Balla Balla will be compliant with the international standard ISO 14001:2006. The EMS and the plans and procedures that support it have been developed or are currently being developed by FMA and will be in place prior to the commencement of ground disturbing works.

The following environmental management plans have been developed and form part of the Project referral:

- Acid Sulphate Soil Management Strategy
- Waste Management Plan
- Emissions Control Plan (dust, noise, light)
- Fire Management Plan
- Water Management Plan
- Ground Disturbance and Rehabilitation Plan
- Emergency / Contingency Preparedness Plan
- Construction Environmental Management Plan

The scope of this report does not cover downstream processing of magnetite concentrate, impacts associated with shipping of concentrate overseas, or end use of the magnetite product. The potential environmental impacts associated with the construction and operation of the port facilities are described and identified in the Port Hedland Port Authority (PHPA) Utah Point Berth Project Public Environmental Review (SKM, June 2008).

1.4. Structure of this document

Section 1	Introduction
Section 2	Overview of Existing Environment
Section 3	Description of Proposal
Section 4	Stakeholder and Community Consultation
Section 5	Sustainability
Section 6	Assessment of Environmental Impacts
Section 7	Flora and Vegetation
Section 8	Terrestrial Fauna
Section 9	Subterranean Fauna
Section 10	Surface Water
Section 11	Groundwater
Section 12	Rehabilitation and Closure
Section 13	Environmental Management Commitments
Section 14	Conclusions
Section 15	References

1.5. Project benefits

1.5.1. Regional and State benefits

Balla Balla is the largest and highest grade titanomagnetite iron ore deposit in Australia. The Project is well situated, located in the West Pilbara mineral field adjacent to key infrastructure, including gas and grid power, and is within approximately 100kms of Australia's largest iron ore shipping facilities at Port Hedland and Karratha.

The Project will contribute to the WA and Australian economies through employment, and capital and operating expenditures, and through royalties paid to the State Government. Regionally it will assist in the development of the West Pilbara, providing long-term economic impetus through long-term and renewable contracts with Chinese steel companies. FMA is in a position to be WA's first magnetite producer.

The Balla Balla Project will generate in excess of A$400 million in sales revenue per annum, over a mine life of approximately fifteen years. Direct and indirect local contributions such as indigenous employment, support for local community activities, opportunities for local contractors, and on-going full-time employment for approximately 280 people are potential benefits to be generated from the Project. **Table 1** presents a summary of economic benefits for the State and the region.

Table 1 Economic benefits summary

Factor	Predicted Outcome
Direct employment (operations)	280 persons
Indirect employment	350 persons
Direct employment (construction)	800 persons
Sales revenue (annual average)	>$400 million pa
Total mine life revenue	>$5,000 million
Royalties and taxes (total mine life)	$759 million

1.5.2. Environmental and social benefits

FMA has funded a significant program of investigations since commencing its environmental studies of the Project Area. The studies have provided an understanding of the history and needs of the local and regional surroundings. A list of completed environmental and social studies includes:

- Flora and vegetation surveys;
- Fauna assessments;
- Stygofauna surveys;
- A non-marine molluscan fauna survey;
- Surface and groundwater investigations;
- Geochemical investigations; and
- Heritage surveys.

In addition to the above, there are a range of environmental and social benefits that would be realised if the Project receives Ministerial approval and is implemented by FMA. These include:

- Contribution to the local economy as a result of full-time employment for approximately 280 people, and flow-on affects to the local and wider community via indirect employment;
- Training and possible employment of local indigenous people from the Roebourne community;
- A heightened knowledge in regards to the extent of Aboriginal heritage items;
- Improved access to the area for pastoralists, external exploration projects and Indigenous people;

- Improvements to infrastructure, such as pastoralist water bores that will be replaced and upgraded where necessary.

1.5.3. Consequences of not proceeding

Loss of social, economic and employment opportunities, compounded by lost materials trade for Australia, would be the results of not proceeding with the Project. Specific losses include:

- royalties and taxes, and a source of export material for the State;
- local communities would lose financial injections and support;
- the loss of contractual opportunities to regional and indigenous groups;
- the loss of ongoing scientific investigations of the area, contributing to the Pilbara database; and
- the losses incurred by FMA in developing the Project to this stage.

1.5.4. Evaluation of alternatives

Below is a list of options and alternatives considered for the Project to minimise the environmental performance and impacts:

- The design of the waste rock dumps, in relation to:
    - The presence of Heritage sites;
    - Sustainable surface water management.
- The design and management of the TSF in relation to:
    - The evaluation of the feasibility of back-filling the pit void with the tailings on completion of mining. This option would render the Project uneconomic and would compromise blending requirements during the mining operations, hence the tailings will be stored in a designated storage facility designed to minimise environmental impacts;
    - The commitment to investigate the use of tailings in the TSF wall lift construction;
    - The design and management of the TSF to maximise water recycling, so as to minimise the need for groundwater make-up;
    - The TSF ‘domed’ cover design to encourage a sustainable revegetation environment and protect the embankment walls from water erosion;
    - Moving the footprint of the TSF east of the Karinha Creek to avoid interference with flows, to avoid creation of back water effects, and to reduce the risk of sediment release during extreme flow events.

- Processing plant options in relation to:
    - Plant designed to maximise gravity flow and minimise energy usage. Revisions of the design to minimise disturbance footprint.
    - The use of low toxicity flocculants.
    - Installation of flow meters to measure and manage water usage.
    - The design of containment facilities, such as concrete slabs and strategically located sump pumps, to minimise environmental impact.
    - Metallurgical investigations to obtain the coarsest grind sizings to minimise over-grinding and energy wastage.
    - The mills are fitted with gearless drive motors to enable variable speed control and low-stress start-ups to eliminate power surges and minimise operational energy requirements. The gearless drives remove the need for heavy lubricants.
    - Transport of the concentrate via a slurry pipeline eliminates trucking transport and associated greenhouse gas emissions and road traffic impacts.
    - Pressure indicators on the slurry pipeline to the Port Hedland port and the TSF pipeline to immediately identify the potential for spillage.
    - Harvesting of stormwater.
    - Installation of a return water line from the port back to Balla Balla.
- An on-site gas fired generator was considered for a potential power supply source, but found to be less desirable than utilising the regional electricity grid. A 220kV power line runs a few kilometres to the south of the Project area.
- In the absence of a regional reticulated water scheme, abstraction of groundwater in the immediate Project Area is considered to be the most sustainable means of providing water for the Project, minimising pumping power. The return to process of water used in the slurry pipeline to Port Hedland, and of water recovered from the TSF, will maximise water reuse.
- Positioning of the Balla Balla and site access roads to minimise disturbance to the environment, and alignment to avoid disturbance to heritage sites.

An undersea pipeline from the coast at Balla Balla to an offshore dewatering and shiploading facility (permanently moored) was judged to require more than a year of detailed biological and other studies to allow reliable assessment of potential impacts. The proposed development of a buried slurry pipeline and a return water pipeline, immediately adjacent to the existing Dampier-Port Hedland gas pipeline (PEPL) which runs several kilometres to the south of the Project area, is considered the most

sustainable concentrate transport option. It minimises the amount of land disturbance required, by taking advantage of the existing gas pipeline.

1.6. Responsible authorities

The Project will be assessed and monitored by the following agencies:

- The WA Environmental Protection Authority (EPA), which assesses environmentally significant proposals and provides overarching environmental advice to the Minister. The EPA also promulgates environmental protection policies and guidelines on a range of environmental protection matters.

- The Department of Environment and Conservation (DEC), which is responsible for administering the *Environmental Protection Act 1986*, the *Conservation and Land Management Act 1984* and *Wildlife Conservation Act 1950* on behalf of the Minister for the Environment; for considering and initiating measures for the conservation, protection and management of the environment; and for the prevention, control and abatement of pollution.

- The Department of Water (DoW), which is responsible for the administration of the *Rights in Water and Irrigation Act 1914, Water and Rivers Commission Act 1955* and *Country Areas Water Supply Act 1947* to ensure that the State's water resources are managed to support sustainable development and conservation of the environment for the long term benefit of the community.

- The Department of Industry and Resources (DoIR), which administers the *Mining Act 1978*, *Mines Safety and Inspection Act 1994* and the Mines Safety and Inspection Regulations 1995.

- The Department of Consumer and Employment Protection (DoCEP), which administers the *Dangerous Goods Safety Act 2004* and aspects of the *Mines Safety and Inspection Act 1994* and which generally has a role in the promotion of safe work practices and standards.

- The Department of Indigenous Affairs (DIA), which administers the *Aboriginal Heritage Act 1972* and supports the Aboriginal Land Trust.
- Main Roads WA (MRWA), which is the State road authority and manages the network of national highways and State roads.
- The Shire of Roebourne will administer local legislation, strategic plans and policies.

1.7. Relevant legislation, policies and guidelines

The EPA (2006) requires that Proponents identify Commonwealth and State legal framework and any standards, policies and guidelines that underpin the environmental assessment process relevant to

the Proposal and with which the Proponent will need to comply. The following Acts and Regulations are relevant to the assessment and implementation of the Balla Balla Magnetite Project:

- *Aboriginal Heritage Act 1972*;
- *Conservation and Land Management Act 1984*;
- *Contaminated Sites Act 2003*;
- *Country Areas Water Supply Act 1947*;
- Environmental Protection (Noise) Regulations 1997;
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004;
- *Environmental Protection Act 1986*;
- Environmental Protection Regulations 1987;
- *Explosives and Dangerous Goods Act 1961*;
- *Heritage of Western Australia Act 1990*;
- *Mining Act 1978;*
- Mines Safety and Inspection Regulations 1995;
- *Rights in Water and Irrigation Act 1914*;
- *Soil and Land Conservation Act 1945*;
- Soil and Land Conservation Regulations 1992;
- *Wildlife Conservation Act 1950*;
- *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth).

The following EPA position statements, environmental protection policies and guidelines are relevant to the design, assessment and implementation of the Balla Balla Project:

- Position Statement No 3 (March 2002) – Terrestrial Biological Surveys as an Element of Biodiversity Protection.
- Position Statement No 5 (November 2004) – Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia.
- Position Statement No 6 (August 2004) – Towards Sustainability.
- Position Statement No 7 (August 2004) – Principles of Environmental Protection.
- Position Statement No 8 (October 2005) – Environmental Protection in Natural Resource Management - Statewide Ambient Air Quality Environmental Protection Policy (currently in development).
- Guidance Statement No 8 (Draft, May 2007) – Environmental Noise.
- Guidance Statements No 54 (Dec, 2003) and 54a (Draft – August 2000) – Sampling for Subterranean Fauna.

- Guidance Statement No 3 (June 2005) Separation Distances between Industrial and Sensitive Land Uses.
- Guidance Statement No 6 (June 2006) – Rehabilitation of Terrestrial Ecosystems.
- Guidance Statement No 12 (Oct 2002) Minimising Greenhouse Gas Emissions.
- Guidance Statement No 18 (March 2000) Prevention of Air Quality Impacts from Land Development Sites.
- Guidance Statement No 41 (April 2004) Assessment of Aboriginal Heritage.
- Guidance Statement No 51 (June 2004) Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.
- Guidance Statement No 55 (Dec 2003) Implementing Best Practice in proposals submitted to the Environmental Impact Assessment Process.
- Guidance Statement No 56 (June 2004) Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.

2. OVERVIEW OF EXISTING ENVIRONMENT

2.1. Physical environment

2.1.1. Climate

The Balla Balla Project is located in the Australian Arid Zone and has a coastal tropical-arid climate that is characterised by low and erratic rainfall, extremes of temperature and high evaporation rates **(Table 2)**. Climatic conditions in the region are strongly influenced by tropical cyclones (Payne and Tille, 1992). On average, a cyclone is likely to pass within 250km of the mine-site area about once each year, and within approximately 50km of the mine-site about once every five to six years.

Table 2 Climatic conditions near Balla Balla Project Area

Month	Mean Monthly Rainfall[1] (mm)	Mean Monthly Evaporation[2] (mm)	Mean Relative Humidity[3] (%)	Mean Minimum Daily Temperature[4] (°C)	Mean Maximum Daily Temperature[5] (°C)
January	57.2	323.4	55.9	26.2	38.7
February	74.7	269.8	57.9	26.2	37.9
March	86.1	290.3	50.5	25.4	37.6
April	41.0	264.1	46.3	22.2	35.3
May	23.0	227.2	49.9	18.4	30.4
June	24.5	189.2	49.6	15.3	27.0
July	13.2	205.0	50.9	13.6	26.7
August	5.3	228.9	44.9	14.6	28.9
September	1.7	266.5	46.1	16.8	32.5
October	2.0	328.5	44.7	19.6	35.4
November	3.8	343.5	42.1	22.6	37.9
December	15.0	350.4	50.4	24.9	38.9

Source: BOM (2006).

1. Whim Creek, Station No.4042. Data recorded from December 1897 to June 2000 (excluding January 1943 to August 1943, August 1967 to December 1967 and March 1970 to November 1994);
2. Port Hedland, Station No.4032. Data recorded from June 1967 to October 2005;
3. Roebourne Airport, Station No.4090. Data recorded from June 2001 to January 2006;
4. Roebourne, Station No.4035. Data recorded from April 1990 to September 2005 (excluding October 1985 to December 1985 and March to December 1987);
5. Roebourne, Station No.4035. Data recorded from May 1990 to September 2005 (excluding October 1985 to December 1985 and March to December 1987).

Variable rainfall of around 340mm per year coincides primarily with the warmer summer months (December to March). Hot summer temperatures between 30ºC and 40ºC are typically accompanied by periods of high humidity during the wet season. The average daily maximum temperature during winter is around 27ºC. Temperatures along the coast are often moderated by afternoon sea breezes during the summer months. Coastal areas near the Project Area typically have morning easterly winds all year round, and afternoon wind conditions are variable in winter, with regular summer sea breezes.

2.1.2. Topography

The general topography of the area around the Project Area is related to the underlying geology and is characterised by gently undulating grassy coastal plains comprising red soils overlying fractured and oxidised volcanics. The majority of the mine-site area lies at an elevation of approximately 20m to 30 m above the Australian Height Datum (AHD). The pipeline corridor traverses undulating ground, with elevations ranging from 15m AHD to 30m AHD.

2.1.3. Geology

The region occurs within an area of late Archaean rocks, which form the Pilbara Craton (Myers and Hocking, 1988). The 1:250,000 scale Geological Survey of Western Australia 'Roebourne' map sheet shows that the superficial geology within the Project Area comprises Quaternary age alluvial silts, clays and sands overlying Archean age granites and granitoid gneisses. Surficial deposits in the mine-site area comprise an extensive cover of sediments, which occur mainly as floodplain alluvials from the Balla Balla River, Karinha Creek and Salt Creek (K.H. Morgan and Associates, 1999).

Subsurface geology in the immediate mine-site area consists of a shallow north declining (25° to 30°) vanadiferous mineralised zone within a titanomagnetic layered gabbro of the Archaean Sherlock Intrusion. Gabbro outcrops are found within the mine-site area and also occur at the transition of the Caines Well Granitoid Complex and the Whim Creek Group. The ore zone is in stratiform and strata-bound seams of magnetite with a strike length of about 18km.

2.1.4. Geomorphology

Mine site

Three main geomorphic units occur within the Balla Balla region. They are: the upland plateau, the coastal plain and a transition zone between the two (Williams, 1968). The upland plateau is a tableland formed on Proterozoic rocks of the Fortescue Group, consisting mainly of basalt with some siltstone, mudstone, shale, dolerite and jaspilite. The coastal plain, commonly referred to as the Roebourne Plains, is a broad, low lying plain that slopes gently seawards and is formed on Quaternary alluvium. The transition zone lies between the upland plateau and the coastal plains and is formed on Archaean rocks and consists of low lying hills and some gently undulating plains. Granitic tors and outcrops are occasionally present, and the geology is extremely complex, including

granitic gneiss and migmatite, metamorphosed mafic and ultramafic volcanic rocks as well as metamorphosed sedimentary rocks (Payne and Tille, 1992).

The majority of the mine-site area lies within the Horseflat land system, with only the southern section of the access road entering the Macroy land system. The Horseflat land system comprises extensive, weakly gilgaied clay plains with tussock grasslands. Parts of the system are prone to erosion, especially gullying on the sloping margins to major watercourses (Payne & Tille, 1992). The proposed water supply for the Project is groundwater supply from borefields. The borefields are located mainly within the Horseflat land system.

The Macroy land system comprises gently undulating stony plains which are generally not degraded or eroded. These land systems are characterised by hard spinifex pastures and contain hummock grasslands of hard spinifex (*Triodia wiseana, T. angusta, T. secunda)* with scattered shrubs and trees. The pastoral value of both land systems is considered low to very low (Payne & Tille 1992).

Pipeline corridor

The preferred pipeline corridor traverses broad, low lying plains that slope gently seawards, known as the Roebourne Plains (Van Vreeswyk et al, 2004). A total of 11 Land Systems are crossed by the 110km pipeline (**Table 3**).

The dominant land systems traversed by the pipeline corridor are the Mallina, Uaroo and River Land Systems. The Mallina Land system represents the fifth largest land system within the Roebourne Plains and comprises extensive sandy alluvial plains. The Uaroo Land system consists of broad sandy plains, and the River Land System consists of active floodplains and major rivers.

The condition of the Mallina Land system was described as generally good, with 77% of the land system assessed as being in either good or very good condition, and only 7% considered in poor condition (Payne & Tille, 1992). Moderate soil erosion occurs in 3% of the Mallina Land System.

Table 3 Land Systems traversed by the Balla Balla to Port Hedland pipeline

(Van Vreeswyk et al, 2004; modified from Payne & Tille, 1992)

Land System	Extent of Land System (in Roebourne Plains), km^2	Proportion of Roebourne Plains Survey Area, %	Description	Vegetation Condition	Soil Erosion
Horseflat	1,261	0.7	Gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands.	17% very good, 30% good, 22% fair, 23% poor and 8% very poor condition.	Nil 82%, slight 5%, minor 2%, moderate 5%, severe 3%, extreme 3%.
Mallina	2,557	1.4	Sandy surfaced alluvial plains, supporting soft spinifex (and occasional hard Spinifex) grasslands.	42% very good, 36% good, 15% fair and 7% poor condition.	Nil 87%, slight 6%, minor 4%, moderate 3%.
Macroy	13,095	7.2	Stony plains and occasional tor fields based on granite supporting hard and soft Spinifex grasslands.	85% very good condition, 9% good, 5% fair, 1% poor.	Nil 98%, slight 1%, minor 1%.
River	4,088	2.3	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft Spinifex grasslands.	56% very good condition, 26% good, 13% fair, 5% poor.	Nil 94%, slight 3%, minor 2%, moderate 1%.
Uaroo	7,681	4.2	Broad sandy plains supporting shrubby hard and soft Spinifex grasslands.	68% very good condition, good 24%, fair 7%, poor 1%.	Nil 99%, slight 1%.
Ruth	346	0.2	Hills and ridges of volcanic and other rocks supporting hard spinifex (occasionally soft Spinifex) grasslands.	72% very good condition, 11% good, 11% fair, 6% poor.	Nil 100%
Rocklea	22,993	12.7	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard Spinifex (and occasionally soft Spinifex grasslands.	89% very good condition, 7% good, 2% fair, 2% poor.	Nil 100%.
Littoral	1 577	0.9	Bare coastal mudflats with mangroves, samphire flats, sandy islands, coastal dunes and beaches	595 very good, 31% good, 10% fair	Nil 96%, slight 2%, minor 2%
Gregory	113	0.06	Linear dunes and restricted sandplains supporting shrubby hard Spinifex (and occasionally soft Spinifex) grasslands.	25% very good condition, 25% good, 50% fair.	Nil 100%.
Paradise	1,479	0.8	Alluvial plains supporting soft Spinifex grasslands and tussock grasslands.	23% very good condition, 31% good, 27% fair, 15% poor, 4% very poor.	Nil 53%, slight 12%, minor 20%, moderate 10%, severe 4%.
Yamerina	1,207	0.7	Flood plains and deltaic deposits supporting tussock grasslands, grassy woodlands and minor halophytic low shrublands	26% very good condition, 48% good, 14% fair, 6% poor, 6% very poor.	Nil 77%, slight 6%, minor 8%, moderate 4%, severe 3%.

2.1.5. Soils

Mapping by the WA Department of Agriculture and Food shows the Project Area and associated pipeline corridor intersect only two major soil-landscape units (P Tille, 2006). They are:

- The “De Grey-Roebourne Lowlands Zone” (Unit 281), and
- The “Harding Hills and Plains Zone” (Unit 289).

The former soil-landscape is by far the more common in both the Project Area and along the pipeline corridor. It comprises predominantly alluvial (and possibly some Aeolian) plains and sandplains, overlying alluvial or marine deposits. The alluvial deposits are, in turn, underlain by basement rocks of the Pilbara Craton. Soils in this soil-landscape unit include deep sandy duplex soils with red loamy earths and some red/brown non-cracking clays, cracking clays, red sandy earths and red deep loamy duplexes (Tille, 2006).

Soil-landscape unit 289 occurs predominantly in a hilly area which lies to the east of the Project Area. Soils in this area typically comprise stony red/brown non-cracking clays and red shallow loams and some hard cracking clays.

2.1.6. Surface hydrology

The Balla Balla Project mine and pipeline lies within the hydrological unit known as the Port Hedland Coastal Drainage Basin (drainage basin 709, Water and Rivers Commission, 2000). Surface water flow in the region occurs almost exclusively as a direct response to rainfall. Accordingly, flows are extremely variable and seasonal. None of the watercourses in the drainage basin flow throughout the year: most flow for less than half the year. Mean annual runoff rates typically amount to less than 20% of annual rainfall. The rivers within the Port Hedland Coastal Drainage Basin characteristically have dendritic drainage patterns which become less defined as they traverse the flat coastal plain.

Alluvial deposits along drainage lines are predominantly recharged by surface runoff in the river channels during significant rainfall events. However, some recharge may also originate from subsurface seepage. Some of the rivers in the drainage basin contribute significant recharge to groundwater through localized flow into the alluvial sediments that line the watercourses. This is particularly the case in those parts of the drainage basin where the depth to groundwater is in the order of 5m or less. However, where depths to groundwater are deeper (eg > 10m), surface water runoff only has a small effect on groundwater levels (Water and Rivers Commission, 2000).

Mine-site hydrology

The general topography of the region is related to the underlying geology and is characterised by gently undulating grassy coastal plains. The Project site is located in a low-lying broad valley that falls from a maximum elevation of approximately 200 m AHD in the headwaters of Balla Balla River to sea level over a 35km stream length (i.e. an average gradient of some 0.6%). The existing ground elevation in the vicinity of the Project site is in the order of 15 to 25m AHD.

The Balla Balla River and Whim Creek are located to the east, and Salt Creek and Karinha Creek (a tributary of Salt Creek) are located to the west of the mine-site area. Marnipurl Creek lies within the mine-site area **(Figure 2)**. With the exception of the spring-fed Corrinjinna Pool, located in the lower reaches of the Balla Balla River, approximately 10km northeast of the proposed mine, all of the local watercourses are ephemeral and are likely to carry runoff only following significant storm events during the summer months from January to March when the potential exposure to high intensity cyclonic rainfall is greatest. A review of the daily rainfall record for eight local rainfall stations found that some 90% of the wettest days on record, with daily rainfall amounts ranging from 474mm to 259mm, occurred between mid-December and end of March as a result of identified tropical cyclones. Consequently, runoff will report intermittently to the watercourses in the vicinity of the mine-site area. On occasion these flows may be very high, particularly in the Balla Balla River.

The Balla Balla River, Whim Creek and Salt Creek drain runoff from a combined catchment area of approximately 132km^2 to the south of the North West Highway towards the Project site. Runoff from an approximately 217km^2 catchment area to the north of the Highway then reports to these rivers and creeks and several other small creeks and watercourses, including Marnipurl Creek, before leaving the Project site and draining towards the tidal flats into Forestier Bay. There are some six or seven existing water bores/wind pumps over the Project site in the vicinity of the Balla Balla River and adjacent creeks.

The closest flow gauging stations for the Port Hedland Coastal Drainage Basin with reliable rating curves and catchment areas of a similar magnitude to the Balla Balla River are the stations located at the Sherlock and Harding Rivers. Sherlock Station is approximately 30km southwest of the Balla Balla site, while the Harding Station is some 65km further to the southwest. Sherlock Station commenced operation in March 1973 and Harding Station in September 1974. Both stations ceased operation in May 1999, giving rise to record lengths of some 22.7 and 24.7 years respectively.

The maximum instantaneous flow recorded at the Sherlock gauging station is particularly significant and, when compared to the Harding Station, highlights the hydrological variability of the region. Its significance was confirmed by inspection of the Sherlock rainfall record, which showed consecutive days of 185mm rainfall on 29 February and 1 March 1984. The combined total rainfall of 370mm was the highest two day total for the 28 years of gap-free record and exceeds both the annual mean and median rainfall for the station. Flow data from these two stations were used to “benchmark” flow

estimates for the Balla Balla River obtained by calculation methods. Potential impacts of the Balla Balla Project on catchment hydrology, included predicted runoff and peak discharge for the watercourses within the Balla Balla Project Area (pre- and post-disturbance) are discussed in **Section 10**.

The Balla Balla River and Coorinjinna Pool has a regionally significant conservation value for tourism and recreation, and aboriginal heritage. Balla Balla Road is used occasionally by anglers. The Balla Balla Landing ruins are on the State Register of Heritage Places because of a jetty that was built in 1898 and subsequently destroyed by a cyclone in 1958. There are also unidentified Lonely Graves at Balla Balla. Further detail is provided in **Section 2.3**. Salt Creek (Karinha) and the Balla Balla River have local significance as fauna habitats. The low woodland shrubland along the main drainage lines of Salt Creek and the Balla Balla River have fauna habitat that is considered locally significant due to the high concentration of faunal species they support and their restricted occurance (Bamford, 2006). These two drainage lines are also considered regionally significant for stygofauna. The stygofauna recorded in the Balla Balla area were either widely distributed in the drainage basin associated with the Project Area, in the Port Hedland Coastal Drainage Basin, or within the Project Area. Further information on stygofauna is presented in **Section 9**. Marnipurl Creek is not considered to be locally or regionally significant because of its poor condition and highly degraded state following years of cattle grazing.

Pipeline corridor

The pipeline corridor traverses the Peawah River, Yule River, Yule River West, Turner River West and Turner River (**Figure 3)**. Other smaller river crossings occur at the Balla Balla River, and Poverty and Whim Creeks. All of the rivers are located in the lower catchments fed by the Chichester Ranges. They flow northwards and comprise the main drainage system in the northern Pilbara area.

The pipeline corridor crosses two water resource protection areas – the Yule River water reserve and the Turner River water reserve. Both water supply areas draw water from borefields, rather than making direct withdrawals from surface flows. The Yule River water supply area forms part of the water supply for Port Hedland and South Hedland. The Turner River borefield was closed in the 1980s due to high operational costs and low yields, however the water reserve has not yet been de-proclaimed. Further discussion on the conservation significance is provided in **Section 10-6**.

None of the rivers, creeks and streams traversed by the pipeline corridor flow continuously and most require substantial rainfall events to produce flowing conditions. There are a number of springs and permanent water pools in the region, but these are not large enough to permit constant river flow (Pilbara Energy Limited, 1993).

Tidal flats at the coast to the north of the pipeline generally reach approximately 6 to 8km inland. These tidal flats are not crossed by the pipeline except at the boundary of the South West Creek, outside of Port Hedland. This section of the pipeline corridor lies within an area that is proposed to be

redeveloped by the Port Hedland Port Authority as part of its Point Utah development and does not form part of this assessment.

Figure 2 Surface hydrology - Balla Balla Project Area

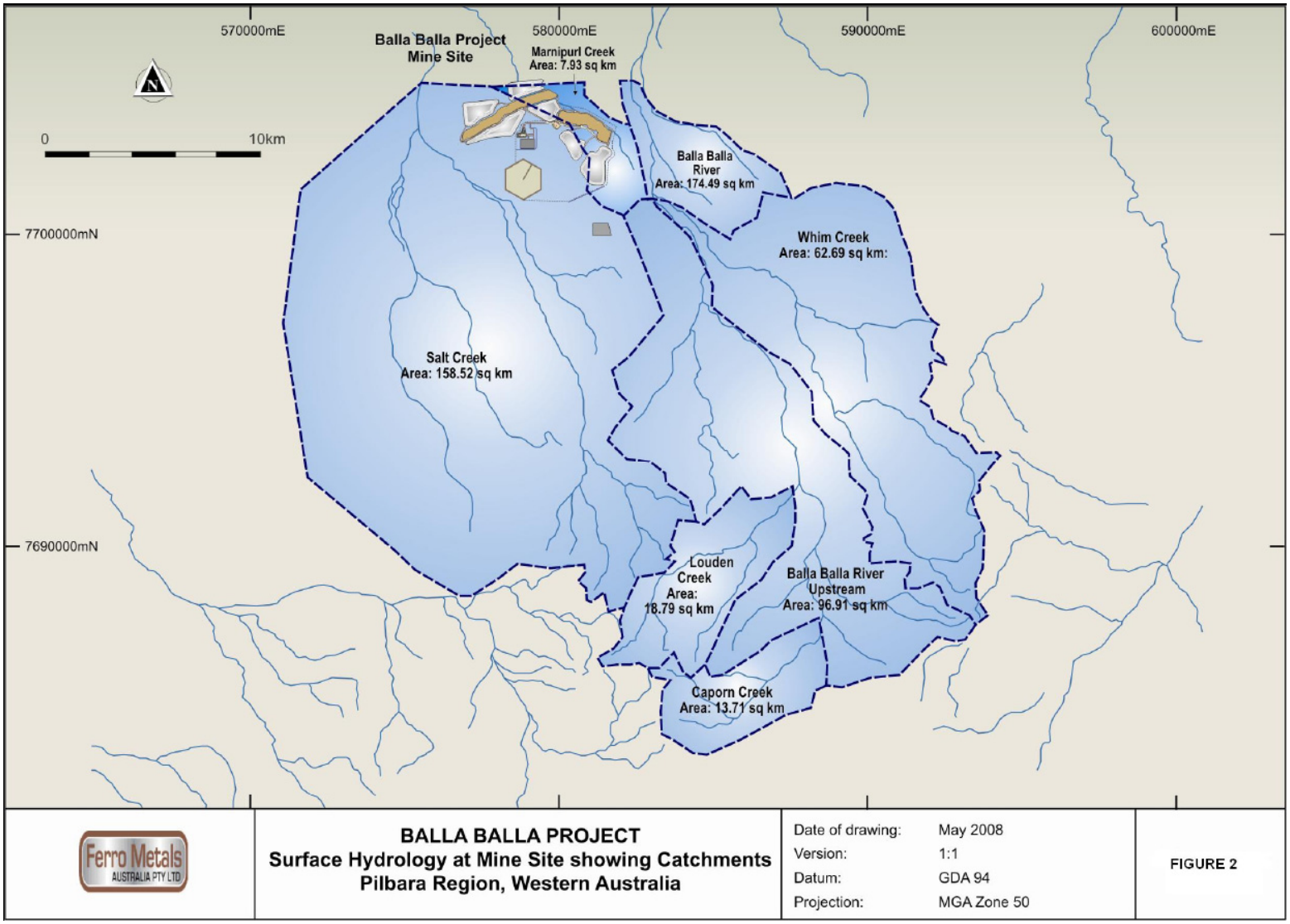
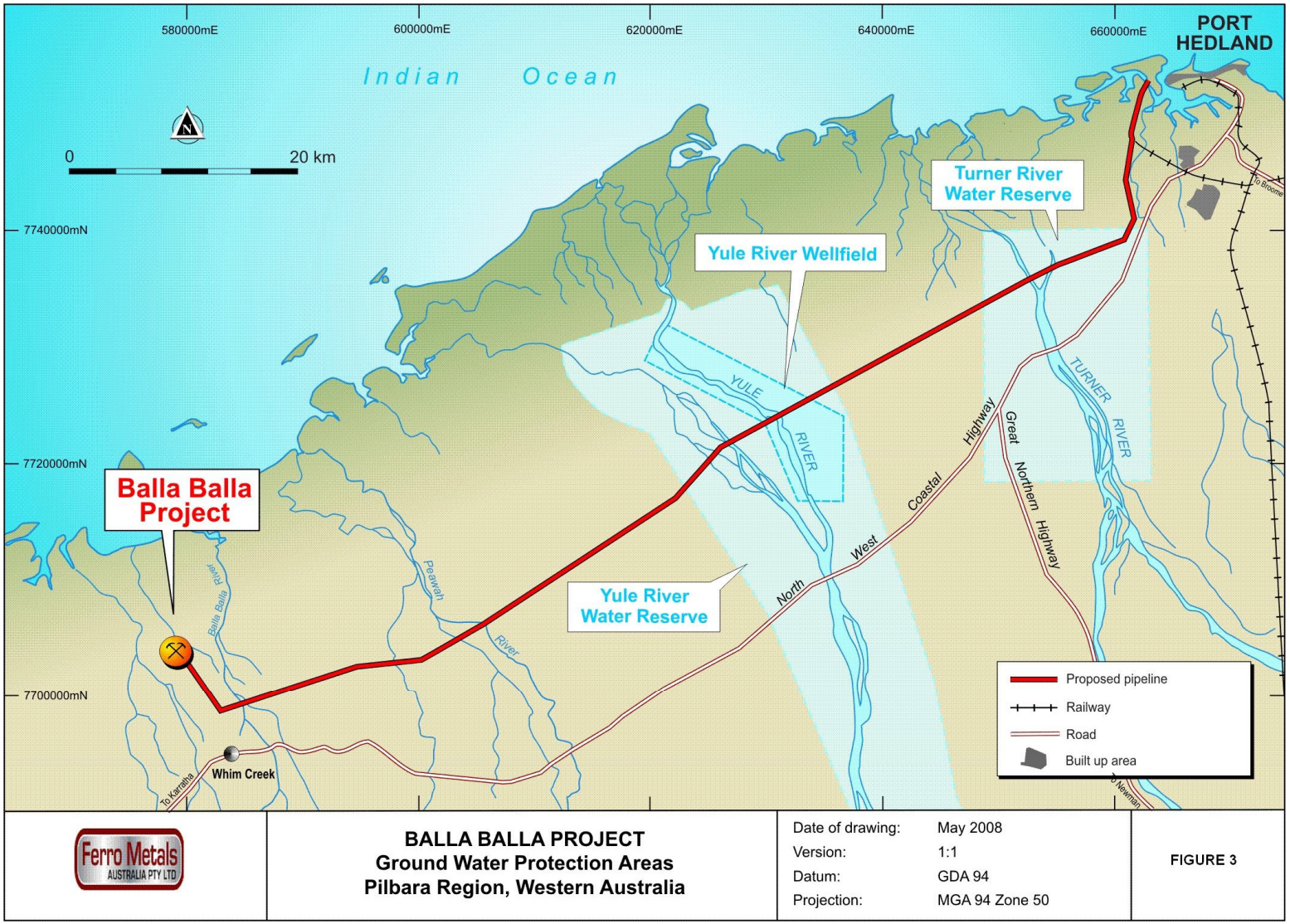


Figure 3 Balla Balla pipeline corridor - groundwater protection zones



Water quality

The quality of surface water in drainage lines traversing or in close proximity to the Balla Balla mine-site and pipeline corridor is expected to have low salinity but variable levels of turbidity. Intense rainfall events may cause sheet and streambed erosion, leading to moderate to high sediment levels in stream flow in the lower catchments. Few monitoring results are available for watercourses in the immediate Project Area (all of which are ephemeral). A sample of water recovered from Coorinjinna Pool in 2006 was found to be brackish and alkaline **(Table 4).**

Although the pool may at times be tidally influenced, the ionic composition of the water was markedly different to seawater, most likely reflecting the geochemistry of the rocks of the contributing catchment. At the time the pool was sampled, the salinity of the pool was considerably higher than would be usual in upper reaches of watercourses in the Pilbara Coastal Drainage Basin. Average ionic composition of the Harding and DeGrey rivers is provided in **Table 4** for comparative purposes.

Table 4 Surface water quality – Coorinjinna Pool and representative rivers.

Parameter	Units	Coorinjinna Pool	Harding River*	DeGrey River*	Sea water
pH	pH units	8.3	--	--	~7.5 - 8
Conductivity@25^{o}	µS/cm	2400	--	--	--
TDS	mg/L	1500	210	186	35,000
Sodium	mg/L (% of TDS by weight)	170 (12.5)	(6)	(13)	(31)
Potassium	mg/L (% of TDS by weight)	8.2 (0.6)	(2)	(1)	(1)
Calcium	mg/L (% of TDS by weight)	130 (9.6)	(10)	(8)	(1)
Magnesium	mg/L (% of TDS by weight)	99 (7.3)	(5)	(2)	(4)
Chloride	mg/L (% of TDS by weight)	610 (45)	(11)	(12)	(55)
Carbonate, CO_3	mg/L (% of TDS by weight)	<1 (<0.1)	--	--	--
Bicarbonate	mg/L (% of TDS by weight)	290 (21.4)	(50)	(50)	(0.4)
Sulphate	mg/L (% of TDS by weight)	49 (3.6)	(6)	(3)	(8)
Nitrate	mg/L (% of TDS by weight)	<0.2 (<0.1)	(2)	(1)	--

Notes: A dash (--) means no information was available. An asterisk (*) indicates information sourced from Surface Hydrology of the Pilbara Region (Water and Rivers Commission, 2000).

Table 5 Water quality, Yule and Turner Rivers

Parameter	Turner River				Yule River			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Al (tot) (mg/L)	0.33	4.41	1.95	3	0.05	0.61	0.29	4
Alkalinity (CO3-CO3) (mg/L)	2.00	2.00	2.00	1	0.00	8.00	1.75	8
Alkalinity (HCO3-HCO3) (mg/L)	42.00	175.00	88.33	3	30.00	172.00	89.69	13
Alkalinity (tot) (CaCO3) (mg/L)	28.32	146.87	59.56	6	24.61	151.08	87.29	26
C (sol org) {DOC} (mg/L)	6.57	13.88	9.63	3	4.19	13.81	9.96	4
Ca (sol) (mg/L)	6.00	12.00	9.16	6	6.00	26.00	16.22	17
Cl (sol) (mg/L)	1.88	84.00	21.45	6	3.00	82.00	38.94	49
Colour (TCU) (TCU)				0	4.00	32.00	13.33	3
Colour (true) (Hu)	6.00	100.00	36.28	18	4.00	170.00	26.53	95
Cond comp 25 deg C (lab) (uS/m)	77000	77000	77000	1	28000	61000	42400	5
Cond uncomp (in situ) (uS/m)	99300	161900	138900	3	36300	77200	63967	9
Cond uncomp (lab) (uS/m)	5800	177700	36736	22	6100	78900	29854	134
Discharge rate (estimated) (m3/s)				0	1.06	1.06	1.06	1
Discharge rate (m3/s)				0	19.60	19.60	19.60	1
F (sol) (mg/L)	0.12	0.12	0.12	1	0.10	0.26	0.21	3
Fe (tot) (mg/L)	0.21	4.90	1.86	3	0.15	0.30	0.22	3
Hardness (tot) (CaCO3) {Ca+Mg} (mg/L)	31.46	58.79	40.99	6	23.22	140.00	77.01	27
K (tot) (mg/L)	2.00	3.00	2.50	6	2.00	6.00	2.91	17
Mg (sol) (mg/L)	3.00	7.00	4.40	6	2.00	8.00	4.67	17
Mn (tot) (mg/L)	0.37	0.37	0.37	1				0
N (tot kjel) {TKN} (mg/L)	0.24	0.24	0.24	1	0.07	0.49	0.26	13
N (tot) {TN, pTN} (mg/L)	0.25	2.60	1.18	3	0.08	1.30	0.40	20
NH3-N/NH4-N (sol) (mg/L)				0	0.00	0.05	0.02	4
NO2-N (sol) (mg/L)				0	0.00	0.01	0.00	4
NO3 (sol) (mg/L)	1.00	4.00	2.00	3	1.00	14.00	4.23	13
NO3-N (sol) (mg/L)				0	0.02	0.02	0.02	1
Na (sol) (mg/L)	3.20	104.00	26.32	6	5.00	56.00	24.20	17
P (tot) {TP, pTP} (mg/L)	0.04	0.14	0.09	3	0.01	0.10	0.03	21
PO4-P (sol react) {SRP, FRP} (mg/L)				0	0.00	0.03	0.01	3
S(2-) (sol) (mg/L)	0.50	1.50	1.03	3	1.80	6.50	4.22	4
SO4 (tot) (mg/L)	6.00	21.00	11.00	3	3.00	13.00	6.15	13
SiO2 (sol react) (mg/L)	5.40	20.00	11.07	6	9.00	35.00	18.06	17
Suspended solids (ETR) (mg/L)				0	5.30	45.00	25.15	2
Suspended solids (gulp) (mg/L)	11.83	44.84	28.33	2	4.20	4.20	4.20	1
Suspended solids <63u (EDI) (mg/L)				0	0.70	118.90	58.51	3
Suspended solids <63u (ETR) (mg/L)				0	338.80	1405.10	871.95	2
Suspended solids <63u (gulp) (mg/L)				0	0.21	4.94	2.68	4
Suspended solids >63u (EDI) (mg/L)				0	3.00	12.00	6.27	3
Suspended solids >63u (ETR) (mg/L)				0	517.40	1091.90	804.65	2
Suspended solids >63u (gulp) (mg/L)				0	0.62	83.41	23.10	4
TDSalts (sum of ions) (mg/L)	429.00	429.00	429.00	1	74.00	357.00	193.00	12
TDSolids (calc @180°C-by cond) (mg/L)				0	170.00	322.00	243.33	9
TSS (mg/L)	60.00	60.00	60.00	1	1.00	24.00	8.80	5
Turbidity (NTU)	2.60	500.00	75.37	15	0.30	450.00	63.97	95
Water temperature (in situ) (deg C)	18.60	37.50	28.33	18	19.10	39.10	29.99	125
Water temperature (test) (deg C)	18.30	25.00	23.91	23	11.40	29.40	24.14	136
pH	6.60	8.74	7.46	19	5.90	9.13	7.76	89
pH (in situ)	6.90	8.70	7.82	5	7.00	9.00	7.88	6

Note: Data in **Table 5** are sourced from the Department of Water database and represent monitoring results from the period June 1973 to February 2006. Units are those used in the DoW database.

Water quality data for the Turner and Yule Rivers, both of which will be traversed by the Balla Balla pipeline corridor were sourced from the Department of Water (**Table 5**). The results represent a compilation of monitoring events conducted between 1973 and 2006. They show that:

- The pH of surface water was generally neutral to slightly alkaline;
- Concentrations of dissolved salts (TDS) are typically less than 500mg/L, which means that the water in both rivers was predominantly fresh;
- Total nitrogen concentrations in the Turner and Yule Rivers were generally similar to or higher than the default values given in the ANZECC guidelines for slightly disturbed lowland rivers in tropical northern Australia;
- Total phosphorous concentrations in the Turner and Yule Rivers were generally similar to or higher than the default values given in the ANZECC guidelines for slightly disturbed lowland rivers in tropical northern Australia;
- Turbidity values (NTU) and colour for both the Turner and Yule Rivers were highly variable, ranging over 3 or more orders of magnitude.

2.1.7. Hydrogeology

The extensive occurrence at the Balla Balla Project of crystalline basement rocks restricts the formation of large scale regional aquifers. Groundwater primarily occurs in saturated layers of floodplain sediments, in underlying saprolite zones, in fractured zones commonly associated with dolerite intrusions and lithological contacts, and within narrow river channel deposits. Groundwater recharge is likely to be from rainfall infiltration either directly or indirectly via creek interaction or over areas affected by flooding, especially following cyclonic rainfall events. Groundwater level rises in response to rainfall recharge can be significant and were measured by FMA at a number of bores between December 2005 and September 2006. The measured rises over this period ranged from 0.6m to 5.5m (GRM, 2008). Daily rainfall totals during the monitoring period ranged from 0mm to 117mm. Monthly total for the monitoring period ranged from 0mm to 263mm (records from Malina Station).

The average depth to groundwater in the mine site area is about 7m below ground level (m bgl), corresponding to a reduced level (RL) of about 12m above the Australian Height Datum (AHD). The water table is generally expected to be flat, with a low northerly hydraulic gradient towards the coast. A bore search in the vicinity of the Project was completed using the Department of Water's (DoW's) WIN database. The search identified a total of 16 bores and wells within a 10km radius of the proposed mine-site, and a further 15 situated in the Whim Creek locality just over 10km to the south. The nearest groundwater bores to the proposed mine pit and operations areas are bores which currently provide water for livestock operations on the Mallina Pastoral Station.

The DoW WIN database was also used to search for bores along the proposed slurry pipeline alignment. This search identified 21 bores and wells within 1km of the alignment. Recorded groundwater depths in the bores ranged from 4.98 to 11.03mbgl. Given that the pipeline depth will be

in the order of 2m (except in close proximity to major river crossings, where the pipeline will be installed using horizontal directional drilling methods) it is expected that dewatering will not be needed during pipeline construction.

Hydrogeological investigations carried out as part of the Bankable Feasibility Level Study (BFS) by Groundwater Resource Management (GRM, 2006) and further water supply investigations (GRM, 2008) indicate typical groundwater salinities of less than 4,000mg/L Total Dissolved Solids (TDS). More saline groundwater has been encountered in the pit area (up to 5,000mg/L TDS) and regionally at depth (greater than 10,000mg/L TDS).

2.1.8. Air quality

Air quality in the Project Area, particularly as it relates to oxides of sulphur, oxides of nitrogen, carbon monoxide and other "priority pollutants" is generally good due to the remoteness of the area; there are no existing developments near the proposed mine site. No baseline monitoring data are available for airborne particulates in close proximity to the mine site, however information contained in the Pilbara Air Quality Study conducted by the (then) Department of Environment (DoE) in 2004 is likely to be applicable to the overall Project Area (mine, pipeline and port). The DoE study found that even in the absence of anthropogenic (man-made) sources, airborne particulate levels in the Pilbara region are likely to routinely exceed the NEPM standard for fine ("PM_{10}") particulates. The National Environmental Protection Measure for PM_{10} particles (those having an effective diameter of less than 10 microns) says that 24-hour average concentrations of PM_{10} should not exceed 50 $\mu g/m^3$ on more than five occasions each year. The 2004 Pilbara Air Quality Study estimated that natural background concentrations in the Pilbara (specifically including the region around Port Hedland) may give rise to in the order of 15 exceedences of the NEPM standard each year (DoE, 2004). The study identified crustal material (wind-blown soil) and bushfires as key sources of the naturally high particulate levels in the Pilbara region.

The closest potential receptors of airborne emissions from the Project include:

- Whim Creek Hotel, approximately 9.5km south east of the Project Area;
- Balla Balla Landing (boat launching area only – no residential or commercial occupancy), approximately 11.5km north of the Project Area;
- Whim Creek Copper Mine, approximately 10km south east of the Project Area;
- Sherlock Pastoral Station Homestead, approximately 19.5km south west of the Project Area; and,
- Tourists and day-visitors who camp along the western banks of the Balla Balla River near Coorinjinna Pool, approximately 6km northeast of the Balla Balla mine-site.

2.2. Biological environment

2.2.1. Vegetation and flora

Regional context

The Project Area is located within the Fortescue Botanical District of the Eremaean Province (Beard 1975). The Eremaean Botanical Province is typified by plants from the families Mimosaceae (*Acacia* sp.), Myrtaceae (*Eucalyptus* sp.), Myoporaceae (*Eremophila* sp.), Chenopodiaceae (Samphires, Bluebushes, Saltbushes), Asteraceae (Daisies) and Poaceae (grasses). The Fortescue Botanical District covers over 175,000km^2 and comprises tree-steppe and shrub-steppe communities with *Eucalyptus* trees, *Acacia* shrubs, *Triodia pungens* and *T. wiseana*.

The Fortescue Botanical District, is divisible into nine different physiographic units (Beard 1975), and it is within one of these, the Abydos Plain that the Project Area occurs. The Abydos Plain extends from Cape Preston in the south to Pardoo Creek, east of the De Grey delta in the north. To the east it is bordered by the Chichester and Gorge Ranges. The Project Area lies on the alluvial plains that parallel the coastline and primarily consist of red earthy sands with extensive areas of red earths and hard red soils along creek lines (Beard 1975).

Mine-site area

The Mattiske (2006) survey found a total of 50 vegetation communities (and seven mosaic communities) within the survey area, parts of which extended beyond the area proposed for mining and related operations. Within the Project Area, Mattiske identified and mapped 31 vegetation communities (and five mosaic communities). All vegetation communities in the mine-site area are well represented in either the Horseflat land system or the Pilbara region generally. No threatened ecological communities (TECs) as defined by the EPBC Act or by the DEC were located in the survey area.

Pipeline corridor

Vegetation along the preferred Balla Balla pipeline corridor alignment generally lies within the area surveyed by Dames and Moore as part of studies commissioned by Pilbara Energy Limited during the environmental impact assessment of the gas pipeline between Port Hedland and Karratha (PEPL, 1993). The vegetation in this section of the Balla Balla pipeline corridor was described in 1993 as comprising predominantly treeless plains with a short bunch-grass savannah. Shallow depressions along the corridor had dense taller grass cover, and there were claypans with sparse cover and extensive bare areas. Patches of snakewood bush (*Acacia xiphophylla)* and large areas of Spinifex occur, especially in tree and shrub steppe, near creeks and rivers, on gravelly soil and calcrete, on foothills and on sand. Kanji (*Acacia inaequilatera*) is the principal shrub or small tree in the steppe. River, creek and drainage lines were recorded as having a diverse range of herbaceous, shrub and tree vegetation, dominated by river red gums, coolabahs, cadjeputs, with smaller species of the genera *Eucalyptus, Acacia* and *Melaleuca* occurring in riverine areas.

Flora and vegetation surveys along the proposed pipeline corridor from Balla Balla to Port Hedland (Mattiske, 2008) found a total of fourteen vegetation communities (refer maps in **Appendix A**). These included eight different Hummock Grasslands communities of *Triodia* species with variable emergent stands of *Acacia* species and *Corymbia* species; one Woodland of *Eucalyptus camaldulensis* and *E. victrix* on major creeklines and river beds, three Tall Shrublands of *Acacia* species on variable sandy soils and two *Melaleuca* shrublands and woodlands on seasonal flats and flow lines. A further four mapping units defined for tidal flats, open estuarine water, mangroves and seasonal lakes. These latter units, to the extent that they fall within the proposed pipeline corridors, lie almost entirely within the Port Hedland Port Authority area. These sections of the Project will be developed by the Port Hedland Port Authority as part of its proposed Utah Point development. As such, no additional disturbance to vegetation will occur as a result of the Balla Balla pipeline construction.

None of the pipeline corridor vegetation communities mapped by Mattiske in 2008 are listed by the Department of Environment and Conservation as TEC's. Neither are any of the vegetation assemblages recorded along the proposed pipeline corridor listed under the EPBC Act. The condition of vegetation along the pipeline corridor varied from completely degraded (in previously cleared areas) to degraded (grazed areas and those affected by weed infestation) to very good. Regular fires in the area have also had adverse impacts on vegetation along the pipeline corridor.

Mine-site

No Declared Noxious Weeds (Department of Agriculture WA, 2006) were recorded in the survey area, during baseline studies. However four environmental weeds have been recorded:

- *Cenchrus ciliaris* (buffel grass) was recorded in six vegetation communities, predominantly associated with drainage lines, drainage zones and floodplains (Mattiske, 2006)
- *Aerva javanica* (kapok) was recorded in two vegetation associations associated with low rises and stony plains (Mattiske, 2006)
- *Malvastrum americanum* (spiked mallow) was recorded in three vegetation associations associated with flood plains and major channels (Mattiske, 2006)
- *Melochia pyramidata* (pyramid flower) was identified in the 2005 survey (Astron, 2005).

Pipeline corridor

Weeds were not investigated during studies for the Karratha – Port Hedland gas pipeline by Dames and Moore (1993). Botanical surveys conducted along the proposed pipeline corridor in April 2008 (Mattiske, 2008) recorded eleven weed species, most notably buffel grass (*Cenchrus ciliaris*). However none of the weed species were Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Act* 1976.

Further detail on flora and vegetation is provided in **Section 7**.

2.2.2. Fauna

A fauna survey of the mine-site Project Area was undertaken in 2006 and a fauna survey of the pipeline corridor was undertaken in 2008.

Seven main fauna habitats were recognised within the pipeline corridor. Four of these were also found in the mine-site Project Area. They were:

1. Spinifex stony plain: *Triodia* sp. dominated hummock grassland with isolated mixed *Acacia* shrubs. This was the dominant habitat type encountered along the proposed pipeline corridor.
2. Flood plain: cracking clay/loam soil with mixed grasses, scattered *Acacia* and other shrubs, and isolated *Corymbia* sp. (bloodwood) trees to 5m. Similar to mine site habitat described as "mixed scattered shrubland over tussock/hummock grasslands on floodplains."
3. Low rocky hills with vegetation consisting of hummock grassland, dominated by *Triodia* spp., with scattered mixed *Acacia* shrubs to 2 metres. Similar to mine site habitat described as "mixed scattered shrubland over tussock/hummock grassland on low hill rises".
4. Ephemeral creek lines, densely vegetated with eucalypts (to 10m).

Three habitat types encountered along the proposed pipeline corridor differed to the habitats encountered in the mine-site Project Area. They were:

5. Open short grass plain, with mixed perennial and semi-perennial grasses. Scattered *Acacia* shrubs occur in gilgai depressions. Similar to, but not identical with, the system described as "tussock and hummock grasslands on gilgaied soils".
6. Major watercourses typified by tall eucalypt and *Melaleuca* trees (to 10m) and *Acacia* shrubs (to 4m). They have broad expanses of deep sand in the bed of the water channels. No equivalent habitat on the Balla Balla mine site.
7. Dense *Acacia* sandy plain: sandy loam soil with mixed grass and low shrubs; dense *Acacia* shrubs to 4m. No equivalent habitat on the Balla Balla mine site.

The area including the proposed pipeline corridor may support 354 vertebrate species (excluding vagrants): 9 freshwater fish, 8 frogs, 102 reptiles, 184 birds and 51 mammals. This assemblage potentially includes 66 species of conservation significance occurring in the study area. Of these, 43 are of high significance (Conservation Significance Level 1), being listed under legislation, 10 are of moderate conservation significance (Conservation Significance Level 2), being listed as Priority species by the Department of Environment and Conservation, and 4 are of local significance (Conservation Significance Level 3), because they have restricted distributions.

Following an extended inspection of the site, fauna specialists concluded that the number of significant taxa that are likely to occur in or near the pipeline corridor is in the order of 27 (Bamford,

2008). The significant species likely to occur in the Project Area include: 4 reptiles, 14 birds and 9 mammals. Fauna is discussed in further detail in **Section 8**.

Stygofauna are known to occur within the Project Area. The Project Area is not considered suitable for troglofauna habitat based on the geomorphological characteristics of the area. Further discussion on fauna is provided in **Section 9**.

2.3. Social environment

2.3.1. Local and regional setting

The proposed Project is located on the Sherlock Station and Mallina Station pastoral leases within the Shire of Roebourne (population ~15,320 – ABS, 2006). Both stations are operated together and are used predominantly for low-density grazing of cattle. The Sherlock Station homestead is located approximately 18km south-west of the mine-site area and the Mallina Station homestead is located approximately 28km west-south-west of the mine-site area.

The slurry pipe line traverses parts of Mallina, Mundabullangana and Boodarie Pastoral Stations. The nearest permanent settlement to the mine-site area is Whim Creek, located approximately 10km south east. Straits Resources currently utilises the Whim Creek Hotel as accommodation for its fly-in/fly-out staff. The regional centres of Karratha and Port Hedland are located, respectively, 110km west and 120km northeast of the Balla Balla mine-site.

2.3.2. Aboriginal heritage

In the Pilbara region, the Aboriginal population comprises about 5,700 people, who live in towns and 37 scattered communities. This is 12 per cent of the total Western Australian Aboriginal population, the third highest proportion of Aboriginal people in the State. The local native title claimant groups for the Project Area are the Ngarluma, Yinjibarndi and Karriyarra.

Archaeology

A search of the Department of Indigenous Affairs' (DIA) Register of Aboriginal sites for the Mining Leases M47/804, M47/311, M47/541, M47/360, M47/361 and M47/298, General Purpose Lease L47/57,G47/1229, plus Miscellaneous Leases L47/168 and L47/171, in which the Project occurs, listed no registered Aboriginal sites except within L47/57 well to the south of any proposed works. The most recent DIA database search was completed in May 2008. Six archaeological and/or ethnographic surveys have been conducted over the Project Area and pipeline corridor. These surveys are:

- Australian Interaction Consultants (2007) Report of an Archaeological and Ethnographic Survey at Balla Balla, Western Australia. Prepared for FMA from the 2006 survey.
- Murphy *et al.* (1994) Report of an Aboriginal Heritage Survey Proposed Karratha-South Hedland Gas Pipeline and Power Station Site.

- Murphy, A, Edwards, K and Campbell-Smith, S (1994). Desk top review and preliminary field investigations of Aboriginal Heritage issues associated with the proposed Karratha and Port Hedland Heavy Industry Estates.
- Fry R. and Haydock P. (1999) Report of a Survey for the Aboriginal Archaeological and Ethnographic Sites. Prepared for Dominion Mining Limited.
- Stevens R. (1999) Archaeological Report of an Aboriginal Site Survey: Balla Balla, West Pilbara. Prepared for Tanganyika Gold NL.
- Veth, P and O'Connor, R (1983) Survey for Aboriginal Sites in the Vicinity of the Proposed 220kv Overhead Powerline Route from Cape Lambert to Port Hedland. Prepared for State Energy Commission.

The May 1999 survey commissioned by Dominion Mining Limited and conducted by Fry and Haydock on behalf of the Cultural Research Group Pty Ltd, indicated that eight archaeological sites were found in Mining Leases M47/311 and M47/298. None of these sites have the potential to be disturbed by the Project as all sites are being avoided.

The archaeological survey commissioned by Tanganyika Gold NL in July 1999 included Mining Leases M47/360, M47/541 and M47/361, plus a section to the north of General Purpose Lease G47/1229. The survey, conducted by Robin Stevens on behalf of the Centre for Anthropological Research of the University of Western Australia, identified 21 archaeological sites. None of these sites will be impacted by the proposed Project.

The 2006 survey conducted by Australian Interaction Consultants (AIC), located an additional ten archaeological sites found in Mining Leases M47/297, M47/298, M47/311, M47/312, M47/360, M47/361 and Mining Lease Application MLA47/541, Miscellaneous Licences L47/57, L47/168 and L47/171, and within E47/956. Of these sites none will be impacted by the proposed Project.

A discussion of how potential impacts to significant archaeological sites will be avoided is presented in **Section 6.2.1**.

2.3.3. European heritage

Searches of places of cultural heritage in the vicinity of the mine-site and surrounding area have been conducted on the following databases:

- Register of the National Estate (RNE) Database.
- State Register of Heritage Places.
- The National Trust.
- Shire of Roebourne Municipal Heritage Inventory.

- Lonely Graves of Western Australia and Burials at Sea.

The results of the searches are presented below.

Register of the National Estate

A search of the Register of the National Estate Database identified no sites listed as occurring within the mine-site area. The closest sites to the mine-site area are:

- Crown of England Shipwreck, Depuch Island via Whim Creek, WA (10112) approximately 13km north of the mine-site area;
- Croydon Station Group, Croydon - Mallina Rd, Croydon via Whim Creek, WA (10117) approximately 40km south-south-east of the mine-site area;
- Eddystone Shipwreck, Depuch Island via Whim Creek, WA (10111), approximately 13km north of the mine-site area;
- Indigenous Place, Depuch Island, WA (10088), approximately 13km north of the mine-site area;
- Indigenous Place, Sherlock via Whim Creek, WA (16194) exact location not given;
- Mallina Homestead and Kitchen excluding other outbuildings, Croydon - Mallina Rd, Mallina via Whim Creek, WA (10118), approximately 30km east-south-east of the mine-site area;
- Mundabullangana Station Group, Wedgefield Coast Rd, Mundabullangana, WA (10074), approximately 45km north-east of the mine-site area; and
- Sherlock Station Group, Sherlock via Whim Creek, WA (10115), approximately 18km south-west of the mine-site area.

State register of Heritage places

A search of the State Register of Heritage Places database revealed that no sites are listed as occurring within the mine-site area. The closest registered sites to the mine-site area are:

- Balla Balla Landing Ruins (04551). This was a jetty located approximately 11.5km to the north of the mine-site area constructed in 1898 for river and sea transport, and for communication. It was destroyed by cyclones (c1958) and was not subsequently rebuilt.
- Whim Creek Hotel, constructed in 1890 (02349). This is a collection of pink painted buildings with steel and timber frames and clad in corrugated iron. The group consists of the hotel, two blocks of motel units, a house (on the hill behind the hotel), a fuel station, dongas, toilets, an outdoor stage and campground (Heritage Council of WA website, 2006). This site is located approximately 7.5km south-east of the mine-site area.
- Sherlock Station Group (04032). This is referring to the Sherlock Station Homestead constructed in 1920 and located approximately 19.5km south-west of the mine-site area.
- Mallina Station (04029). This is referring to the Mallina Station Homestead constructed in 1920 and located approximately 28km west-south-west of the mine-site area.

National Trust

A search of the National Trust database revealed that no sites are listed as occurring within the mine-site area. The closest sites to the mine-site area are:

- Sherlock Station, Great Northern Highway (Lease 3114/558), approximately 18km south-west of the mine-site area;
- Croydon Station, Great Northern Highway (Lease 3114/1029), approximately 40km south-south-east of the mine-site area;
- Mundabullangana Station, Whim Creek/Wedgefield Coast Road (Lease 3114/517), approximately 45km north-east of the mine-site area.

Shire of Roebourne Municipal Inventory

A search of the Shire of Roebourne Municipal Heritage Inventory revealed that no sites are listed as occurring within the mine-site area. The closest sites to the mine-site area are:

- Balla Balla Landing, Mallina Station, north of Whim Creek, approximately 11.5km to the north of the mine-site area;
- Depuch Island, in the vicinity of Balla Balla and Whim Creek, approximately 13km north of the mine-site area; and
- Whim Creek, North West Coastal Highway, Roebourne, approximately 10km south-east of the mine-site area.

The Shire of Roebourne Municipal Heritage Inventory also contains a review list of sites, which have been identified as potentially significant, but which have not yet been added to the inventory. No sites are located within the mine-site area, although five sites are in the general vicinity of the mine-site area and include:

- Croydon Station, approximately 40km south-south-east of the mine-site area;
- Mallina Station, approximately 30km east-south-east of the mine-site area;
- Sherlock River Landing, approximately 28km west of the mine-site area; and
- Old Sherlock Station Site and Sherlock Station, approximately 18km south-west of the mine-site area.

Lonely graves

Coate (1986) lists four grave sites within 50km of the mine-site area, however none occur within the mine-site area. These graves comprise:

- Croydon Station - an unidentified lonely grave approximately 40km south-south-east of the mine-site area;
- Mundabullangana Station - McTaggart A.R., approximately 45km north-east of the mine-site area;
- Whim Creek – Darlington T., Gordon N.H., Hill T.J. and unidentified lonely graves (Balla Balla), approximately 10km south-east of the mine-site area.

Tourist sites

The closest known tourism site to the Project Area is the Balla Balla Landing, a recreational fishing location frequently used by locals and tourists, and accessed via the Balla Balla Road. The Balla Balla Landing is located approximately 9.8km north of the mine-site area. Tourists also camp along the Balla Balla River, mainly in the vicinity of the Coorinjinna Pool.

3. DESCRIPTION OF PROPOSAL

3.1. Key characteristics of Proposal

The Balla Balla Magnetite Project involves open pit mining and processing of magnetite iron ore to produce 6 million tonnes of concentrate per annum (Mtpa) over a 15 year mine life. The concentrate will be sent to Port Hedland via a slurry pipeline. Concentrate will be dewatered at the port, prior to shipping overseas, where it will be used predominantly in steel manufacture. Key characteristics are summarised in **Table 6:**

Table 6 Summary of the key project characteristics – Balla Balla Magnetite Project

Element	Description
Life of project (mine and ore processing)	15 years
Type of product	Magnetite (iron ore)
Quantity of ore to be mined over life of project, kilotonnes (kT)	129,332
Mining method	Open pit
Method of conveying product	Below ground slurry pipeline
Number of pits	2 – to be mined concurrently
Mine pit dimensions (length x width x depth, m)	Central pit (1800 x 300 x 135) Western pit (4000 x 200 x 165)
Number of people to be employed during operations	280
Size of residential accommodation facility (number of units)	Permanent 300 Construction 800
Employment roster	FIFO 8 on, 6 off
Pipeline corridor (length, km x width, m)	110 x 40
Area of disturbance (mine and pipeline, ha)	1515
Quantity of waste rock and overburden, kilotonnes (kT)	283,684
Quantity of tailings produced over life of mine, megatonnes (MT)	59
Maximum height of waste dumps (m)	55
Size of 2 hexagonal TSF's (ha x m)	232 x 45
Size of concept TSF and Integrated Waste Landform (ha x m)	174 x 45 (max)
Source of water	Groundwater, recycled water from processing plant, pit water
Estimated groundwater use (pit dewatering and borefields) over life of mine (GL)	98.4
Quantity of ore to be dewatered at port (Mtpa)	6
Quantity of ore to be stockpiled at port (maximum at any given time), tonnes (t)	500,000
Estimated CO_2 (equivalent) emissions, kilotonnes (kT) over life of project – AGO scopes 1, 2 and 3. Includes construction and operations phases of project. No allowance for sequestration.	5065
Additional vehicle movements on North West Coastal Highway, per week (road trains, light vehicles, buses)	16 x 15 x 10

A more detailed list of Project components includes:

- Two open cut pits, the Central and Western Deposits;

- A pit dewatering system to enable stable mining conditions;
- A processing plant with capacity to produce 6Mtpa of magnetite concentrate;
- A tailings storage facility (TSF) and integrated waste landform (IWL) for the disposal of non-magnetic tailings;
- Waste landforms and low grade ore stockpiles;
- Borefields to supply processing and potable water;
- A steel pipeline and associated pumping stations to convey magnetite concentrate slurry, 110km to the Port Hedland port;
- A HDPE return water pipeline and associated pumping stations to convey clarified process water 110km from Utah Point back to the Balla Balla mine site;
- A concentrate dewatering plant located at Utah Point, Port Hedland;
- Grid supplied electricity via a 220kV substation at the electric transmission line (ETL) and 4km of underground high-voltage (HV) cable to a proposed switchyard;
- A new all weather access road from the site to the North West Coastal Highway;
- Associated infrastructure comprising:
    - Administration/office buildings;
    - Mining complex and workshop facilities;
    - Medical and emergency response facilities;
    - Waste recycling & sorting station;
    - Security gatehouse;
    - Fuel farm;
    - Warehouse and laydown areas;
    - Accommodation village;
    - Communications network and high-voltage switchboards;
    - Substations and MCC rooms;
    - Haul roads and site access roads;
    - An explosives magazine;
    - Core farm;
    - Borefield water pump stations;
    - Reverse osmosis (RO) package plant(s);
    - Proprietary package plants for treatment of septic wastes; and

- Landfill for disposal of putrescibles and other non-process wastes.

The mine site layout is depicted in **Figure 4** and the proposed location of the Utah point dewatering and loading facility is given in **Figure 5**.

Figure 4 Mine site layout

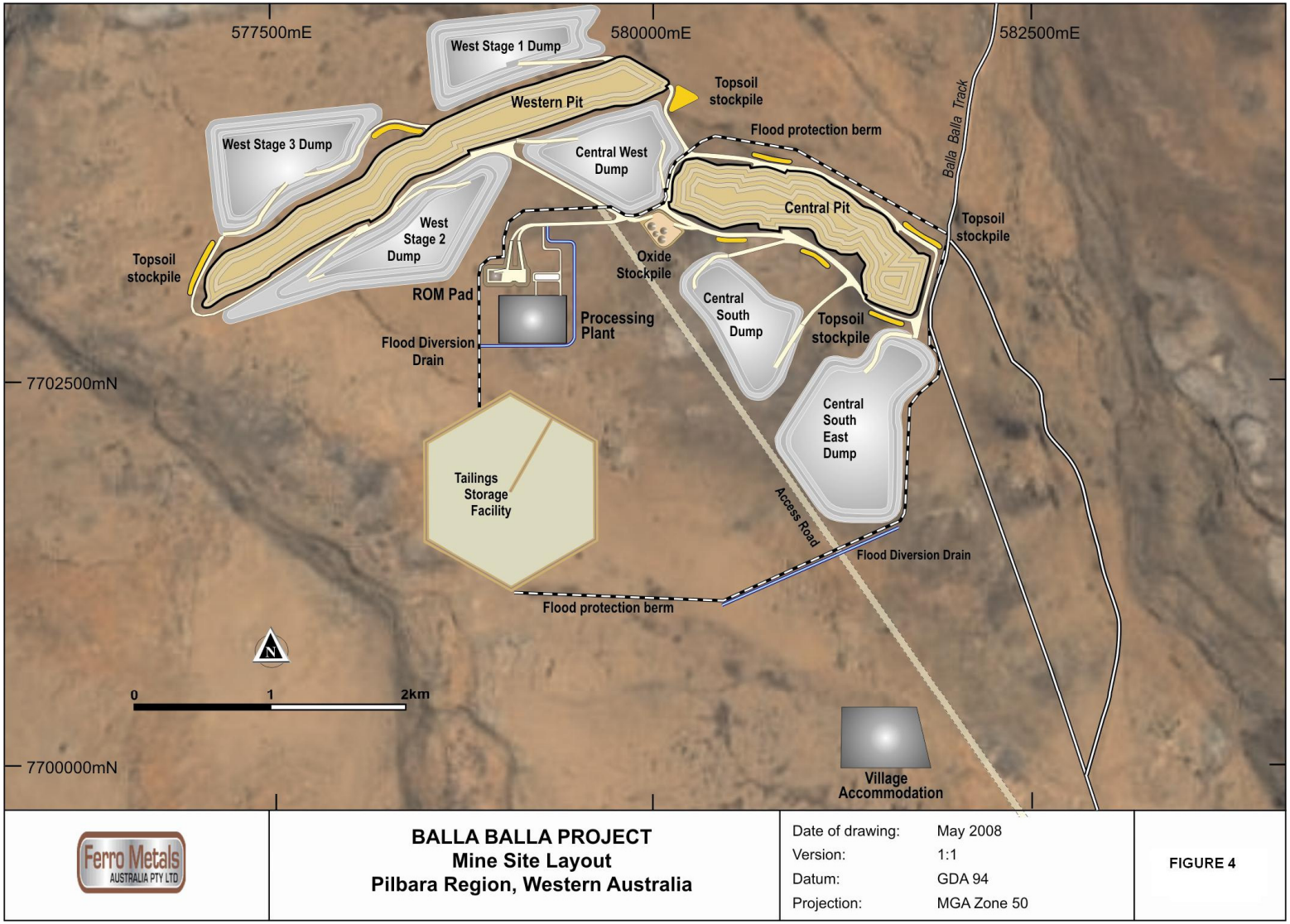
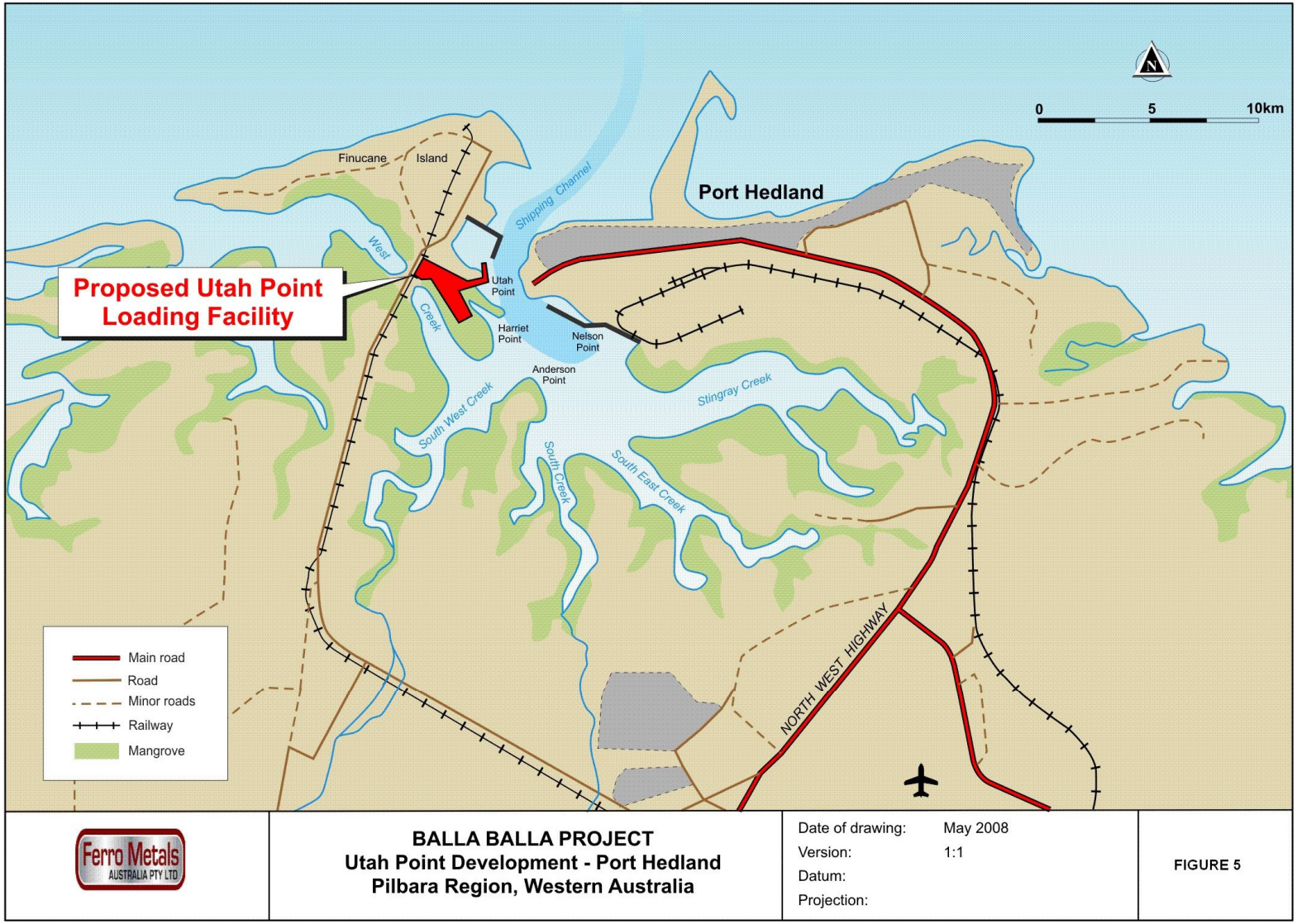


Figure 5 Location of Utah Point dewatering and loading facility



3.2. Resource and ore reserves

The current Australasian Joint Ore Reserves Committee (JORC) compliant resource estimate for the Central and Western deposits is 116.8 million tonnes of magnetite with a grading of 45.8% Fe. The current JORC compliant ore reserve estimate for the Project is 103.8 million tonnes of magnetite grading at 45.7%.

The magnetite mineralisation occurs over a strike length of 18km. The stated ore reserve estimates are based on a 5km central eastern section of this strike zone. The magnetite ore horizon is approximately 20 to 30m wide and lies within a layered mafic-ultramafic intrusion at the contact of the Caines Well Granitoid Complex and the Whim Creek Group. Other accessory minerals occurring in minor quantities within the deposit include ilmenite, chlorite, silicates, calcite and minor (generally <1%) vanadium and sulphide minerals.

3.3. Access

3.3.1. Roads and transport

The North West Coastal Highway passes some 9 kilometres to the south of the Project plant site (**Figure 1**). Prior to and during construction, processing plant components, equipment and materials will be transported to the Project Area for construction of the Project from the ports of Kwinana, Geraldton and Port Hedland, and then by road transport to the Project site works.

The intersection of the plant access road and the highway will be bitumenised and constructed to the standard required by the WA Main Roads Department. Suitable signage will be provided in accordance with WA Main Roads regulations. A plant access road from the North West Coastal Highway will be gravel surfaced, and will be constructed as an all-weather road. This road will service the accommodation village, the mining facilities, and the plant site. The running surface will be approximately 16m wide, including drains to allow for the passing of road trains entering and exiting the site.

The existing Balla Balla track (**Figure 4**), which is sometimes used by tourists and other recreational users to access fishing and camping spots along the Balla Balla River will not be incorporated into the Project access road and use of the existing track will not be affected by the Project.

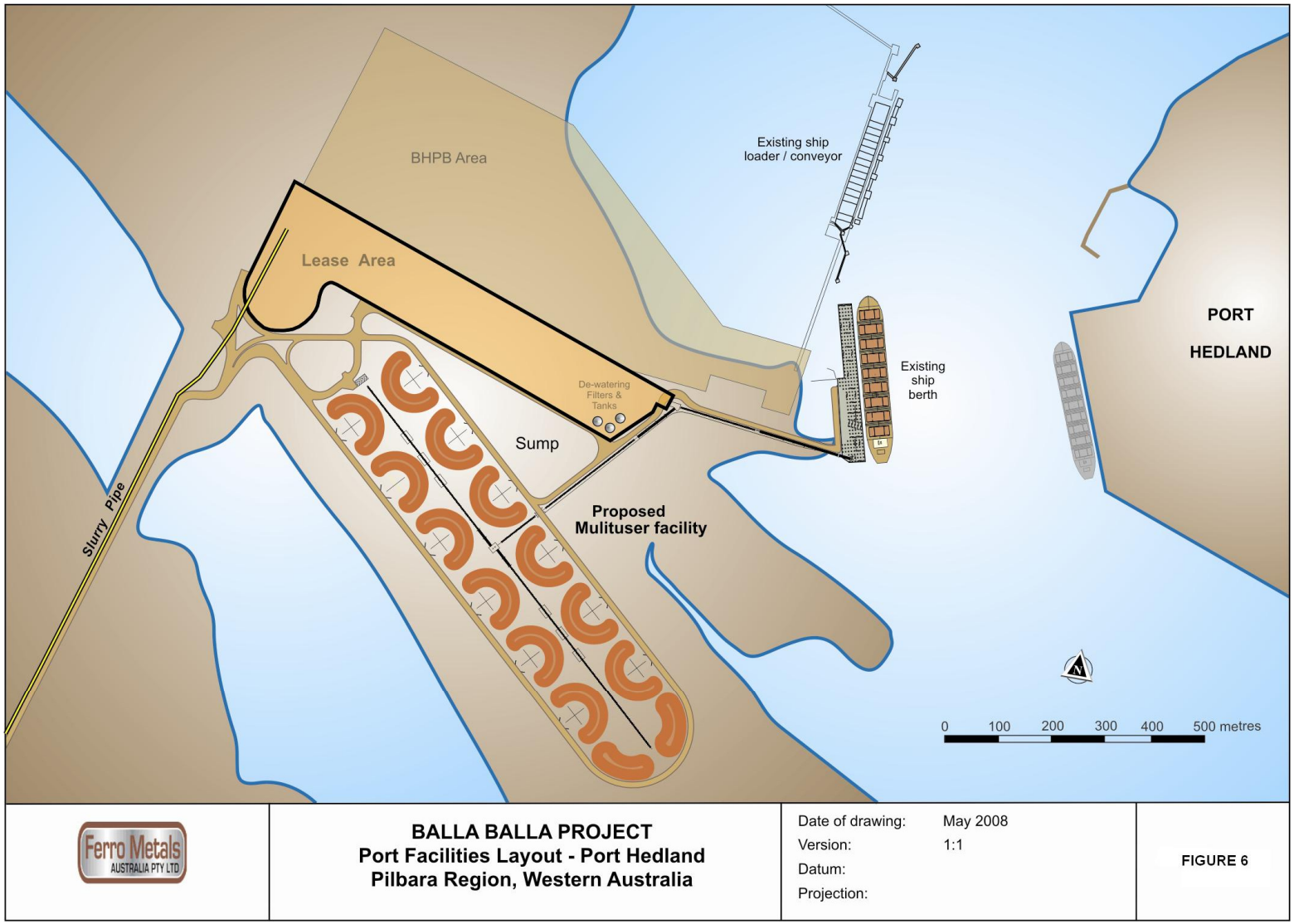
No bitumenised in-plant roads have been included in the Project design. Access to the tailings impoundment area immediately adjacent to the plant will be on unsealed gravel tracks and will be limited to maintenance and operations vehicles only.

Haul roads will be constructed by dozing and grading the land surface to achieve a hard durable running surface and will be approximately 20m wide, including drains. They will be elevated above the surrounding ground level to avoid damage during extreme rainfall events.

3.3.2. Port

Three large industrial ports are located in the Pilbara region. They are located at Dampier, Port Hedland and Port Walcott (Cape Lambert). Of these, the port at Port Hedland is the only multi-user facility that has the necessary capacity to serve as the export point for the Balla Balla Project. The Utah Point Berth Project will accommodate the Balla Balla product as well as service other mineral exporters (**Figure 6**). Consequently, the Port Hedland Port Authority (PHPA) is managing the environmental impacts associated with the construction and operation of the port facilities, not FMA. The PHPA has described the potential environmental impacts and identified the proposed management and mitigation measures in the PHPA Utah Point Berth Project Public Environmental Review (PER) (SKM, June 2008).

Figure 6 FMA's port facilities layout



3.3.3. Proposed pipeline route

The proposed pipeline route is given in **Figure 7**. At the western end of the pipeline, there are three possible routes being considered (Options 1, 2 and 3). As far as possible, these alternatives are all parallel to an existing infrastructure corridor, thereby reducing the requirement to disturb new areas.

Option 1 is north of and adjacent to the easement of the existing gas Pilbara Energy Pipeline (PEPL) and travels the entire distance from the Balla Balla Project tenure to Boodarie near Port Hedland running parallel to the PEPL. Option 1 is the preferred route as it is the shortest and requires the least disturbance to the environment.

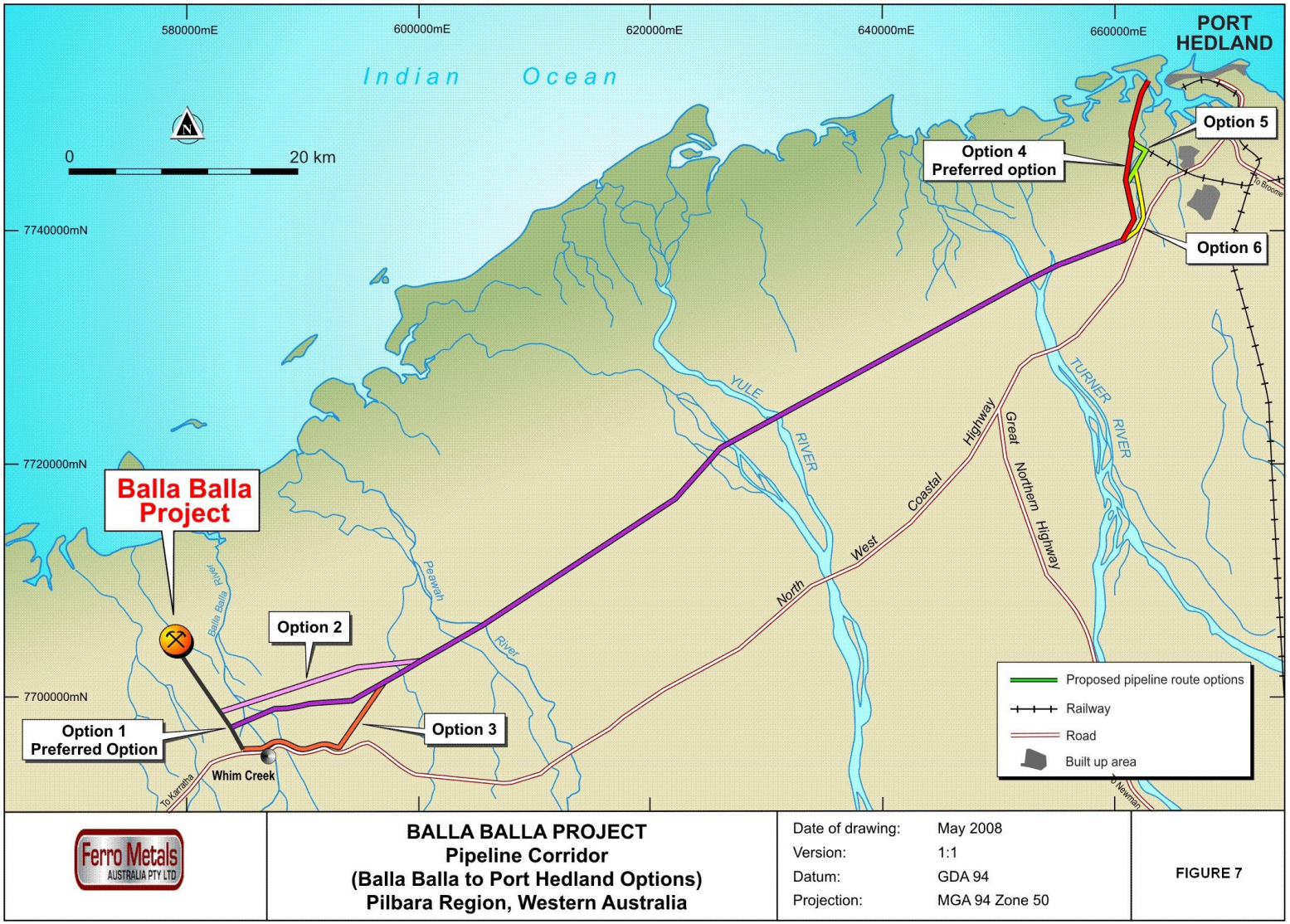
Option 2 has been defined as an alternative alignment which may offer lesser distance of difficult trenching conditions, compared to Option 1, which may encounter rock at shallow depth for several kilometers between the Balla Balla and Peawah Rivers. Option 2 passes from the mine processing plant, travelling along the northern side of the existing 220kV power line corridor until it crosses the PEPL as in Option 1. However, Option 2 is not preferred due to the possibility of induced electrical currents from the adjacent 220kV power line.

Option 3 is another possible pipeline route that largely avoids rocky ground conditions. However, it involves a slightly more indirect route and several bends. Option 3 passes from the mine towards the North West Coastal Highway, then runs within the highway reserve for approximately 9 kilometers before turning northeast to join the PEPL corridor, which it then parallels to Boodarie..

Three possible pipeline routes (Options 4, 5 and 6) have also been proposed near the north-eastern end of the PEPL corridor, from Boodarie prior to the point where the FMA slurry pipeline corridor enters the Port Hedland Port Authority area. Each of these options was selected to follow existing infrastructure or disturbances, whilst avoiding new developments such as rail loops that may be constructed or factored for future construction by other parties. The northern-most of these, Option 4, is the preferred option, although a combination of Option 4 and 5 may be required to avoid a future possible rail loop. Option 4 is the preferred route as it is the shortest and requires the least disturbance to the environment.

The slurry and return water pipelines would be offset by about 50m from the PEPL.

Figure 7 Proposed pipeline route



3.4. Construction

Project construction is expected to commence in Q1 2009 following receipt of environmental approvals and permitting and will take approximately 20 months to complete.

Construction activities will include:

- Removal and stockpiling of vegetation and topsoil;
- Construction of drainage and flood protection works;
- Construction of the access and internal haul roads;
- Construction of laydown areas;
- Construction of the accommodation village, offices, workshops and infrastructure;
- Construction of the processing plant;
- Construction of the tailings storage facility (TSF);
- Construction of the slurry and return water pipelines;
- Establishing groundwater supply and dewatering borefields;
- Commencement of mine dewatering;
- Removal and stockpiling of overburden;
- Construction of a switchyard and underground HV cables; and
- Construction of de-watering, stacker and reclaimer facilities at Utah Point.

3.5. Mining operations

3.5.1. Mining strategy and pit design

FMA proposes to mine the Central and Western Deposits concurrently from two pits. The Western Deposit pit will be approximately 4 km long and 200 metres wide, and the Central Deposit pit will be 1.8km long and 300 metres wide. The proposed final Central and Western pit designs are illustrated in **Figure 8.**

FMA is yet to finalise the mining method (owner operator or contract mining) for the Balla Balla Project. All resources will be developed by open pit using 5m high benches. In known waste areas, higher bench heights up to 10m will be used to minimise costs and maximise machine productivities. Mining operations will consist of:

- Site preparation - the open pit, waste rock landforms and laydown areas will be cleared and grubbed of all vegetation. All topsoil will be stockpiled in strategic locations in preparation for progressive rehabilitation.

- Road building - all internal (haul) roads will be built to an appropriate standard for heavy earth moving equipment usage. Appropriate surface water management measures will be put in place to ensure all weather access.

- Dewatering - in pit sumps will be developed in advance of mining. Water will be pumped to a bunded pond at the crest of the pit, which will be equipped with a pump, power pack and standpipe for the provision of water for dust suppression purposes. Surplus water will be pumped to the process water pond to be utilised by the mining/processing facilities.

- Drill and Blast - all material will be drilled and blasted to ensure equipment productivities are maximised. Modern blasting practices will be used to limit mining dilution and ore loss.

- Grade control - will be either blast hole sampling and/or angled RC drilling. Data will be processed, and blocks will be marked out as per grade control guidelines which will be developed prior to mining. Ore will require in-pit geological monitoring to ensure quality control and minimise dilution/ore loss. Only waste will be mined during night shift periods.

- Load and haul - all material will be mined using 2 x 550 tonne hydraulic excavators loading a fleet of 190 tonne off-highway trucks. Trucks will be loaded from the rear or from the sides, with the excavator loading above the truck. All material will be hauled from the open pit to either an ore stockpile, a waste rock landform or directly to the crusher at the processing plant.

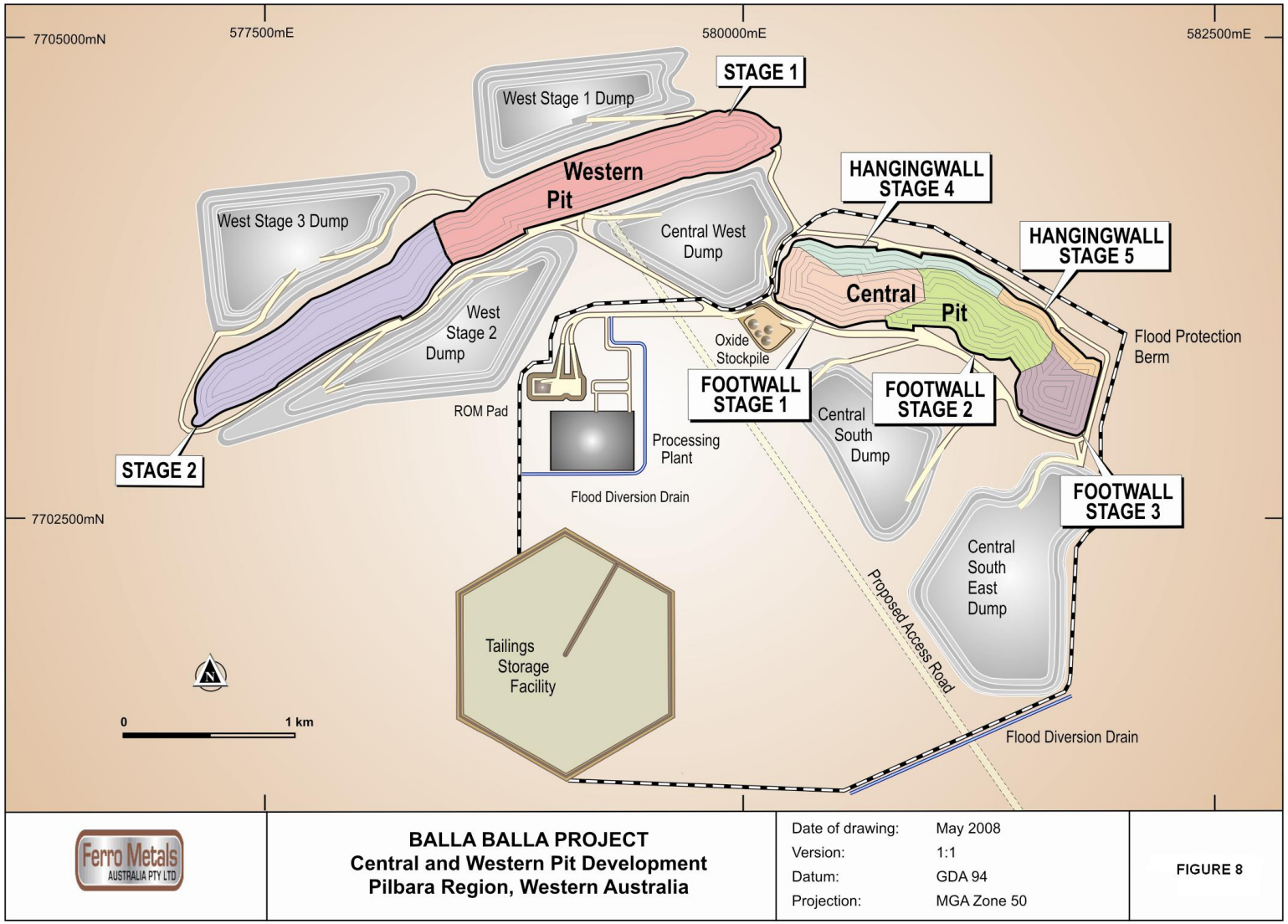
To facilitate material movement schedules, ore presentation and the ability to mine on lower and upper benches simultaneously, a staged approach has been developed for both Central and Western pits.

The Central pit will provide the first 8 years of ore and subsequently additional stages have been developed for this area. That is, the resource has been split into three footwall stages and two hanging-wall stages, which allows the ore to be accessed earlier in the schedule, whilst minimising waste stripping. This will facilitate in-pit blending to produce a consistent ore feed blend and also allows mining to continue on the higher bench levels during and following heavy rain events.

The Western pit will be developed in two stages that extend across the entire width of the orebody. This staged approach for both pits is illustrated in **Figure 8.** Geotechnical investigations for pit design were carried out by Golder Associates Pty Ltd in 1999. A further review of geotechnical information was completed by Golder Associates in 2006. Results of the geotechnical investigation were used to define the appropriate range in face slopes and berm widths that should be considered for use in open pit mining for the Balla Balla deposits.

Geotechnical investigations for the Balla Balla Project were also undertaken by URS in December 2005 and by Golder Associates in March 2008 (**Appendix B**).

Figure 8 Central and Western Pit development



3.5.2. Mining schedule

The current life of mine (LOM) for the Balla Balla Project is 15 years. The LOM schedule has been generated on the basis of 6Mtpa concentrate production.

The goal is to expose enough fresh ore for continuous ore production of 10.3Mtpa to produce 6Mtpa of concentrate. It will take approximately 12 months to achieve this goal. All oxide ore will be stockpiled and then rehandled during periods when there is insufficient oxide ore to provide a 15% oxide/85% primary blend.

The Central Footwall Stage 1 will be mined first, as this is the closest to the mill. Initially, all waste will be directed to the Central Western waste landform, located to the west of the Central Pit. All subsequent stages will be directed to the nearest waste landform either to the south or west of the Central pit. Oxide ore will be mined from Month 1 and fresh ore mined from Month 6.

The schedules are based on each excavator mining on average ~15.5Mtpa. Only one excavator is required for the first two years of operation. It is intended that the ROM rehandle loader be utilised as a back-up production machine during this period. A second excavator will be commissioned at the start of Year 3 to ensure hanging-wall waste stripping is ahead of ore.

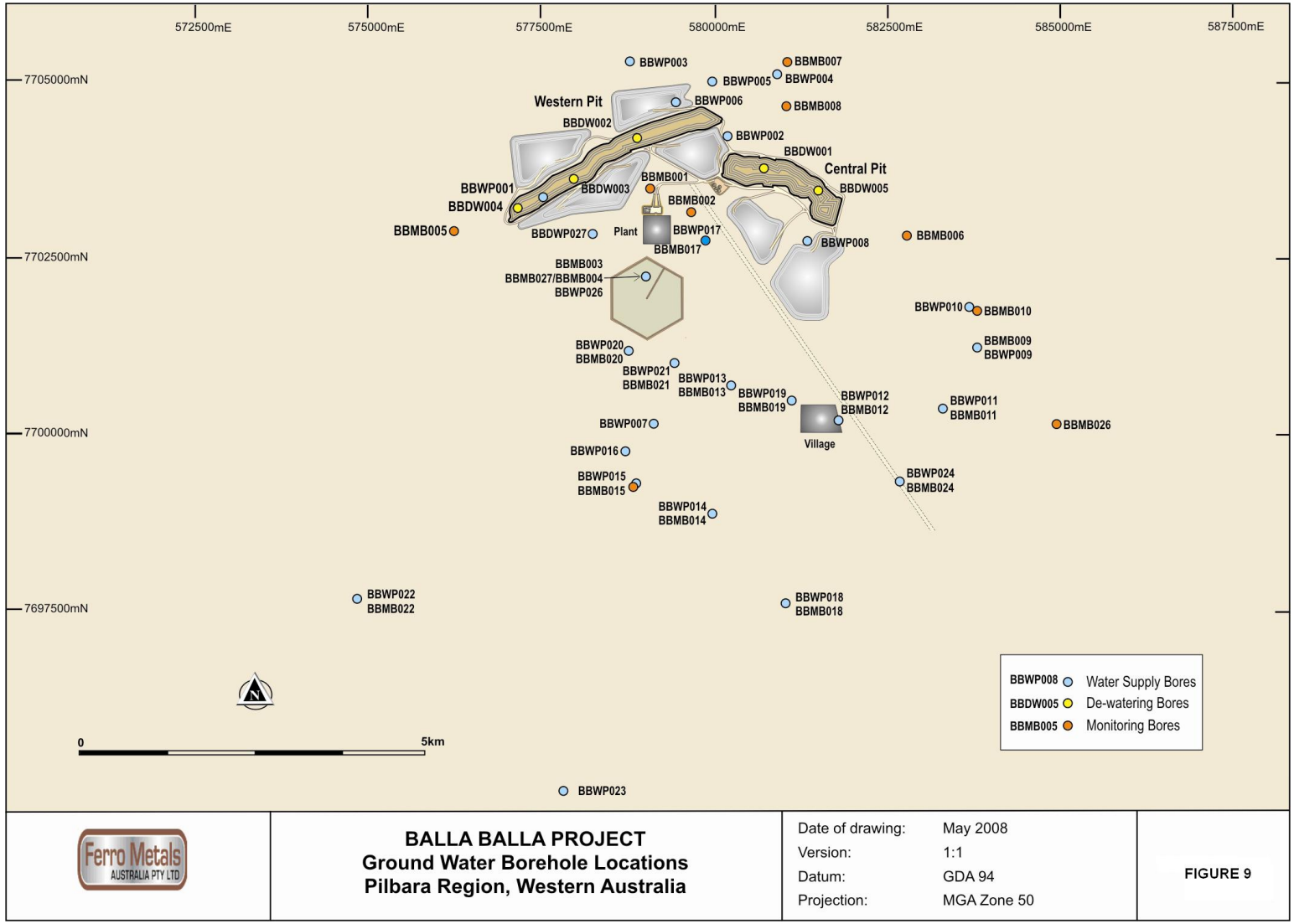
3.5.3. Water supply

Approximately 7.80GLpa of fresh to brackish water is required for the processing plant operations on-site, reducing to 5.90GLpa, as clarified water is returned from the dewatering operations at the port. An additional 0.56GLpa is required for dust suppression and for plant and mine equipment washdown.

Process water will be sourced from a combination of mine dewatering and groundwater abstracted from 38 bores (**Figure 9**) Groundwater in the Balla Balla Project Area is relatively shallow (typically less than 10m below surface). The water quality is generally of an adequate standard for processing purposes, but not of a potable quality for human consumption (due to its predominantly brackish nature).

FMA has developed a groundwater abstraction philosophy aimed at preserving the groundwater resource and minimising drawdown where possible. This has been done by making provision for approximately 38 production bore sites spread over a wide area to promote minimal drawdown by preventing between-bore interference effects. This water supply approach will assist in safeguarding the resource for the duration of the Project, while reducing the likelihood of impacts on subterranean fauna or groundwater dependent vegetation. Once completed, bores will be equipped with electric submersible pumps. Water will be transported to the processing plant water storage pond via a polyethylene pipe that will be buried in sections to accommodate site access requirements.

Figure 9 Borehole layout



3.5.4. Potable water

Approximately 0.1GLpa of potable water will be required for the Project. About half of the water will be required at the accommodation camp and half at the mine and plant areas. Potable water will be sourced from groundwater production bores and will be treated by reverse osmosis to meet the National Health and Medical Research Council/Australian and New Zealand Environment Conservation Council (NH&MRC/ANZECC) Drinking Water Guidelines (2004).

3.5.5. Water use efficiency

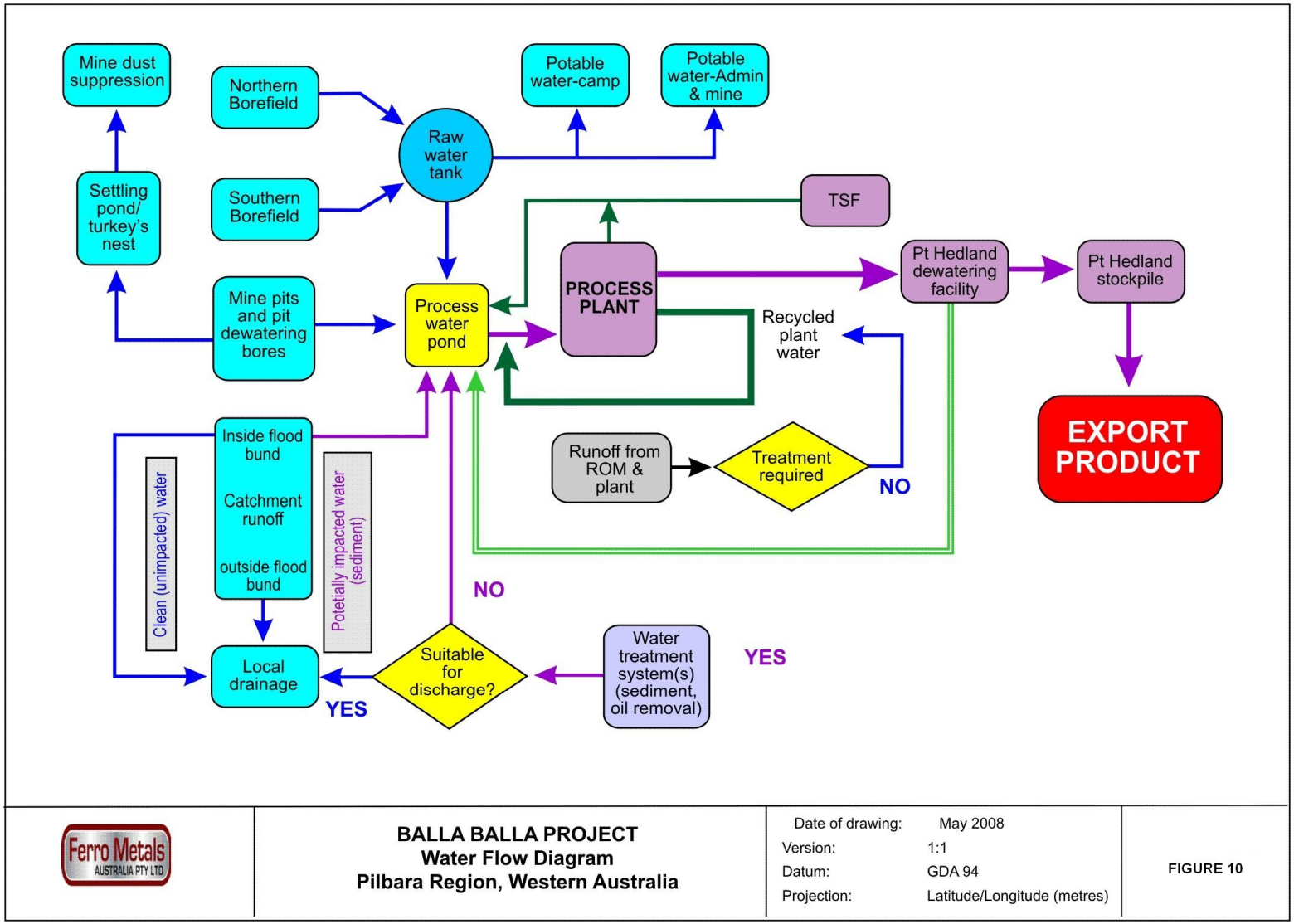
The site water balance is summarised in **Table 7** and is illustrated diagrammatically in **Figure 10.** The greatest requirement for water is associated with ore processing at the Balla Balla plant site. Over 85% of the water used in ore processing is recycled within the plant (i.e. is not discharged to tailings or used in conveying slurry). Approximately 10% of the water entering the processing circuit is used in conveying slurried concentrate to the port. After dewatering, some water remains in the exported magnetite product (approximately 7 to 10% by weight). A large proportion (~65%) of the water used to convey slurry to Port Hedland is returned to the Balla Balla ore processing circuit, with the balance being used for dust suppression at the port or remaining in the exported concentration. When combined with the water reclaimed from the tailings decant and from other minor sources (pit water return, RO return), the total percentage of recycled water within the Balla Balla plant is approximately 89%.

Discussions have been held with DoW and PHPA regarding the possible use of slurry-transport water for dust control rather than return the transport water to Balla Balla for re-use as process water. FMA is willing to participate in such a scheme, but care is required to ensure that, by not returning slurry-transport water from Port Hedland to Balla Balla, the hydrogeological regime at Balla Balla is not altered to the point of unsustainability. FMA intends to continue discussions with DoW, PHPA and other interested parties to provide a regionally-balanced outcome for efficient water use. It is possible that a partial-return strategy is developed with some water retained at Port Hedland and some returned to Balla Balla.

Table 7 Balla Balla water balance

Water Use	Requirement		Quality
Construction	*L/sec*	*GLpa*	
Construction Accommodation Camp	4.5		Potable
Site Office	1.5		Potable
Construction	20.0		Raw
Construction Dust Suppression	5.0		Raw
Total	**31.0**	*0.98*	
Operations			
Process Plant	1856.3	*58.54*	Process
Accommodation Camp	1.6		Potable
Plant and Administration	1.5		Potable
Mine	0.1		Potable
Site Dust Suppression	17.8		Raw
Total	**1877.3**	*59.20*	
Recycle			
Total Process Plant Recycle	1609.1	*50.74*	Process
Tails Return	14.0		Process
Port Recycle	61.58	*1.94*	Process
RO Recycle	0.7		Process
Pit Water Return	6.0		Process
Total	**1691.4**	***53.34***	
Critical Water Figures			
Total Operations Usage	1877.3	*59.20*	
Total Recycle (excluding TSF return)	1677.4	*52.90*	
TOTAL SITE NEW WATER REQUIREMENT (including ALL recycle streams, except TSF recycle)	**199.9**	***6.30***	
***Total Potable Water Requirement (Operations)**	**3.2**	***0.10***	

Figure 10 Water flow diagram



3.5.6. Dewatering

Groundwater Resources Management (GRM) was commissioned by FMA to provide dewatering estimates for the life of mine (**Appendix C**). A dewatering methodology has been devised for both the Central and Western pits in order to allow mining operations to proceed safely and to supply process water to the plant. The methodology relies on in-pit sumping to manage inflows from predominantly low permeability materials that extend over most of the area of the pits.

Two areas associated with more permeable horizons have been identified at the west end of the Western pit and along a shear zone that bisects the pits GRM (2008). It is envisaged that two dewatering bores will be constructed: one bore located at the western end of the Central pit and another bore at the eastern end of the Western pit. An existing historical production bore (BBWP02) located at the western end of the Central pit is judged to intersect high permeability materials associated with the shear zone and hence may be suitable for dewatering purposes.

The two dewatering bores targeting the shear zones will be constructed using casing to allow installation of standard electrical submersible pumps of size up to nominal 200mm. Pumping rates to control groundwater inflows will almost certainly be significantly less than the pumping rates required to manage surface water ingress associated with high intensity cyclonic rainfall.

3.5.7. Site drainage and flood protection

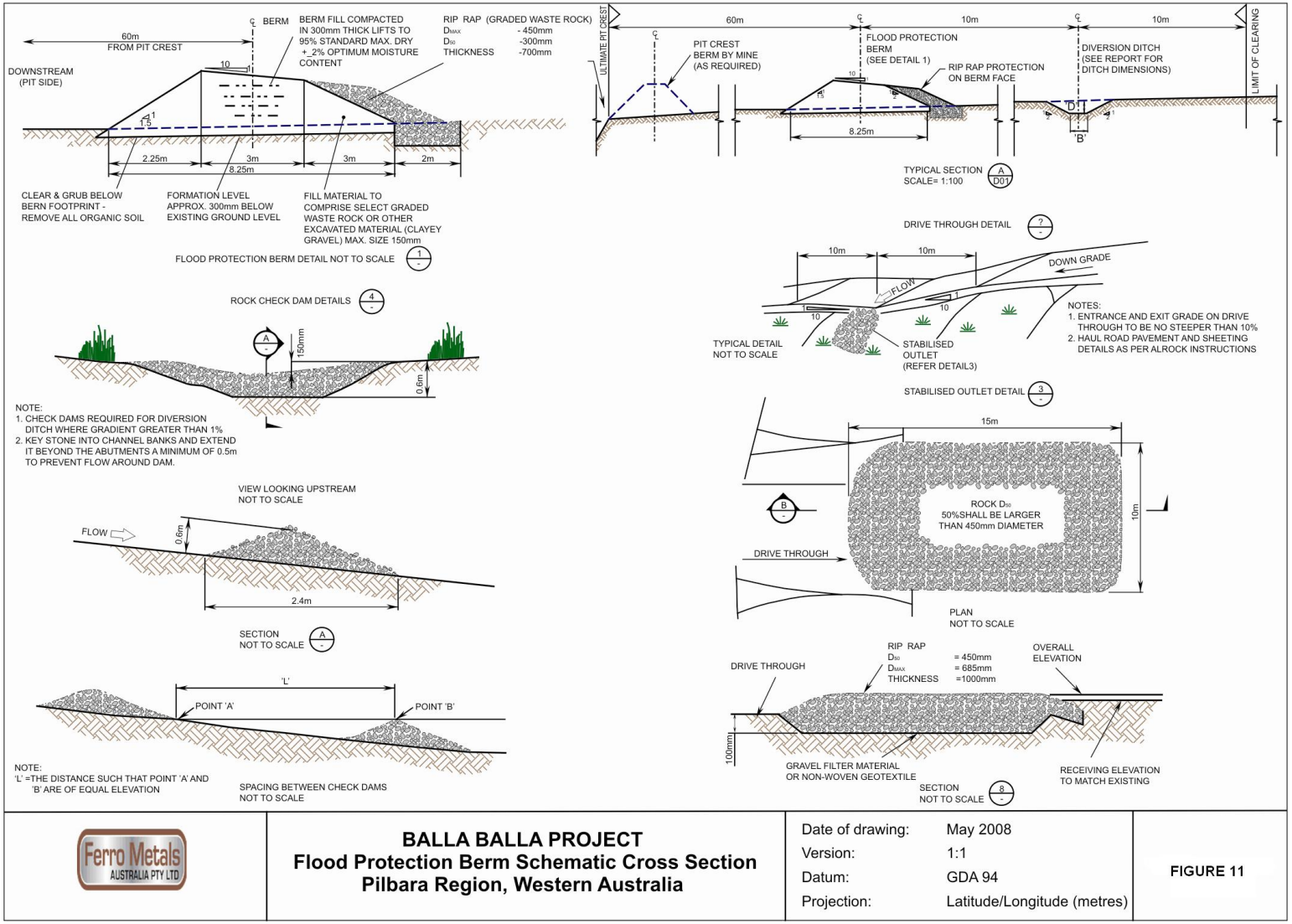
There are a number of local watercourses or drainage features that could adversely impact the proposed Project facilities if not managed properly. They include the Balla Balla River, Marnipurl Creek and Salt Creek, along with other relatively minor unnamed on-site drainages. Hydrological baseline studies for the Project Area (**Appendix D**) have found that during a significant rainfall event the majority of flow in Salt Creek will likely pass safely to the west of the Project site. The study concluded that other than the south-western toe of the TSF embankment, which can be protected by armouring the embankment, flooding from this creek is not considered to be a significant risk to the mine facilities at start-up. Nonetheless, it is proposed to construct the proposed village site on an earthwork fill platform above the existing ground level, to ensure safety during extreme rainfall events.

The hydrological analysis has identified that the greatest flooding risk to the Project facilities relates to the Balla Balla River and the flooding that would occur if it were to spill over-bank downstream of its confluence with Whim Creek, approximately 1km north-northwest of the existing Caine Well. If this were to occur due to extremely high flows or channel blockage or impediment, it is possible that floodwater from the Balla Balla River could spill over-bank and enter the Marnipurl Creek and ultimately report to the mine pits. Alternatively, due to the flat topography over the Project site, such an event could cause widespread flooding over the proposed mine services and process plant areas.

Consequently the proposed mine facilities will require flood protection on the eastern, northern and southern side of the Project Area. Flood protection will need to be provided along the 11,365m long

perimeter of the proposed mine facilities (**Figure 11**). Flood protection works will take the form of constructed berms and diversion ditching, combined with strategically placed waste rock dumps and above-grade haul roads. Given the potential consequences of floodwaters reporting to the pit or flooding the process plant, the flood protection measures have been designed for the 100 year ARI flow event. The required flood protection berm will be approximately 8km long, and approximately 1.0-1.5m high and 8.25m wide across the base.

Figure 11 Flood protection berm cross section



3.5.8. Waste rock and overburden

Waste rock will initially be used in the construction of site infrastructure, such as access and haul roads and the starter embankments for the TSF. Following construction of infrastructure, six waste landforms will be developed. Where possible, the waste landforms will be located on the footwall side of each pit. Two waste landforms will be developed adjacent to the Central pit, one to the west and one to the south west. One waste landform will lie between the Central pit and the Western pit. Three waste landforms will be developed adjacent to the Western pit (two to the north and one to the south).

FMA will determine the appropriate final waste rock landform design through rehabilitation trials during the operational phase of the Project. Waste landforms will be designed to resemble (in scale and form) naturally occurring geomorphic features in the north Pilbara coastal region. FMA has developed a conceptual waste rock landform designed to be safe, stable, non-erodable and integrated into the surrounding environment. The conceptual design was based on a flat-top hill in the area. There will be sufficient waste rock available for encapsulation as the majority of mine waste material will be rock.

3.5.9. Plant design and processing

The ore will be processed on-site to produce a slurried magnetite concentrate which will be piped 110km to dewatering facilities located at Utah Point in Port Hedland. The concentrate will be filter dried for export and the majority of the residual water returned for use at Balla Balla. A portion of the process water will be kept for dust management purposes at the port.

The plant is designed to produce 6Mtpa magnetite concentrate per annum based on a throughput of 1252 tonnes per hour (tph) and grinding availability of 92%. The intended feed to the concentrator is a blend of 85% primary and 15% oxide ore.

ROM ore will be delivered to the plant at Balla Balla by haul trucks and dumped either directly into the ROM bin or on the ROM pad. The ROM bin feeds directly to the primary (Gyratory) crusher. Crushed ore will discharge to the crushed ore stockpile (COS) via conveyor and will be fed to the grinding circuit. Classification of the gearless SAG and Ball mill products is achieved by hydrocyclones. A portion of the coarse product (or cyclone underflow) passes through a ‘cobbing’ (coarse magnetic separation) stage to remove gangue or waste material from the milling circuit to reduce power consumption, whilst the fines (or cyclone overflow) enter the magnetite concentrate magnetic separation circuit.

Magnetics will be thickened for transport (via pipeline) to Utah Point, whilst the non-magnetics report to tails for discharge to the TSF. The slurried concentrate arriving at Utah Point will require additional thickening before being filtered to approximately 7% moisture for stacking and reclaim for export. The majority of the clarified filtrate will be piped back to site and recycled for use into the process water pond; a side-stream will be extracted and used for dust suppression at the port.

The facilities at the plant and at the port will be individually controlled by central automation packages; the instrumentation philosophy is to maximise automation and to minimise labour requirements.

The processing plant is supported by general services such as electrical power, water (raw, potable and process) as well as a high pressure air system. Air is required for various stages in the process and will be reticulated through the plant in both high pressure and low pressure systems. Raw water is supplied to the process water system for use throughout the process plant and reagent make-up/dilution.

Reagents

Ore processing is primarily mechanical and requires little use of reagents. The reagents employed at Balla Balla include commonly used non-hazardous and non toxic synthetic high molecular weight anionic polymers to assist settling in the thickeners and oxalic and nitric acid for automatic cleaning of the dewatering filters.

The main processing reagents are a mixture of flocculants used to enhance settling of solids in the thickeners, thereby reducing suspended solids in the overflow which reports to the process water pond. Flocculants are used at three points in the processing train:

- At the plant site to aid settling in the concentrate thickener;
- At the plant site to aid settling in the tailings thickener;
- At the port site to aid settling in the filter feed thickener.

An anionic polymer supplied in 25kg bags will be used for flocculation at the Balla Balla plant and port sites. The estimated usage rate of the reagent will be about 179kg/day for the concentrate and filter feed thickeners each and 608kg/day for the tailings thickener. The flocculant is consumed at a dosage solution strength of 0.25%. The storage tanks used to contain the flocculant solutions have individual volumes of about 71m^3.

As the flocculant(s) exhibit a very low order of toxicity, they will be stored in the undercover area of the warehouse at the plant site and in the storage shed at the port facilities. The chosen flocculants are not classed as dangerous goods.

There is potential for the dewatering filters to be designed to be washed automatically every shift (12 hours) with an industry standard nitric and oxalic acid mix. Nitric Acid (100kg) will be consumed at a 60% strong solution per filter per day, whilst 240kg dry powder of oxalic acid will be consumed per filter per day. A recommended one month supply for the designed five dewatering filters is described below:

- Nitric acid 60% solution, 15 tonne; 10m^3;
- Oxalic acid, 36 tonne dry powder.

The nitric and oxalic acid will not be stored close to working areas. Nitric acid is stored in stainless steel tanks with adequate leakage pools. Oxalic acid is delivered in 1-2m^3 'big' bags, that will be stored indoors, as moist air from the sea could cause lumps.

Beneficiation

The primary purpose of the beneficiation stage of the process is to upgrade the iron content of the ore by selectively removing gangue minerals, the main mass of which comprises silica, ilmenite and alumina. Beneficiation will be done at the Balla Balla mine site. Beneficiation is a purely physical process, which involves crushing, grinding, classification and magnetic separation. Beneficiation does not involve the use of any chemical reagents. Magnetite is ferromagnetic (strongly magnetic) and hence the majority of the contained iron is recovered to the magnetic fraction, which is the product stream to be exported.

Thickening and filtration

The magnetite concentrate is settled in a high-rate thickener to increase the solids density for transportation via pipeline to Utah Point; the slurry is further thickened at the port to produce an optimum filter feed density and ensure consistent flow to the filters. The thickened slurry requires filtration to reduce the moisture content to ensure maximum solids loading during export. An optimum moisture content of 7-10% is required during stacking and reclaiming of the concentrate to reduce the risk of dust generation.

3.5.10. Slurry pipeline

The slurry pipeline is required to transport 6Mtpa, equating to 750tph for 8000 hours per year operation (assumes 92% plant availability). The pipeline will be operated intermittently, with an average of one shutdown and restart every 24 hours. This operating strategy was selected on the basis that it maintains favourable flow conditions, while limiting wear and corrosion. Intermittent operation results in a lower water demand than batch operation (pumping continuously, with batches of slurry separated by batches of water).

The slurry pipe will most likely comprise HDPE (or polyurethane) lined steel pipe, having a nominal outside diameter of approximately 457mm. The pipeline wall thickness is telescoped, with wall thickness ranging from 11.1mm to 5.6mm ANSI flanges connect each welded section. The preliminary pipeline and liner thicknesses have been designed to take into account possible wear and/or corrosion. Prior to commissioning the pipeline will be hydrostatically tested to meet code requirements

3.5.11. Return water pipeline

The return water pipeline comprises a single HDPE or polyurethane pipeline from the Port to the Balla Balla mine site. The pipe is manufactured to Australian Standard AS4130. The salinity (total

dissolved solids, TDS) of the water conveyed in the return water pipeline will typically be in the range of 2000 to 4000mg/L (similar to that of shallow groundwater in the Balla Balla Project Area).

3.5.12. Tailings storage facility

The proposed TSF is located south of the plant site. The development will provide tailings storage for the 15 year life of mine, and will consist of a staged approach, initially with a traditional hexagonal paddock-style TSF, with options for a second paddock TSF or a proposed integrated waste landform (IWL), pending trials during operations.

The TSF concept design comprises a hexagonal starter facility (Cell 1) with the initial embankments sufficient to contain tailings for 2 years operation with 2, 2.5m raises, by upstream construction techniques, to provide a further 2 years storage capacity (Coffey Sept. 2008).

During the first 4 years of operations, FMA proposes to undertake further work in two stages to improve tailings storage. The first project involves trials to establish the IWL. The IWL has significant advantages over the traditional TSF including reduced disturbance footprint, progressive rehabilitation, reduced water loss and increased geotechnical stability. The second project is to assess the feasibility of producing a filtered tailings product consisting of 78% solids. This would reduce water consumption, and facilitate co-disposal of the filtered mine waste with the mine waste into an IWL. If the trials are successful then approval would be sought to develop the IWL concept with one cell remaining as a TSF. If the trials are unsuccessful then a second hexagonal storage cell (Cell 2) will be constructed and tailings would then be cycled between both cells.

The TSF cells will initially occupy an area of about 116ha each and the initial footprint for the IWL will be 58ha. The final IWL structure will have a footprint of 174ha within the current waste dump footprint. This reduces the TSF footprint by nearly 100ha from the traditional TSF design of 270ha.

The key tailings parameters are listed in **Table 8.**

Table 8 Key Parameters for preliminary design of tailings storage facility

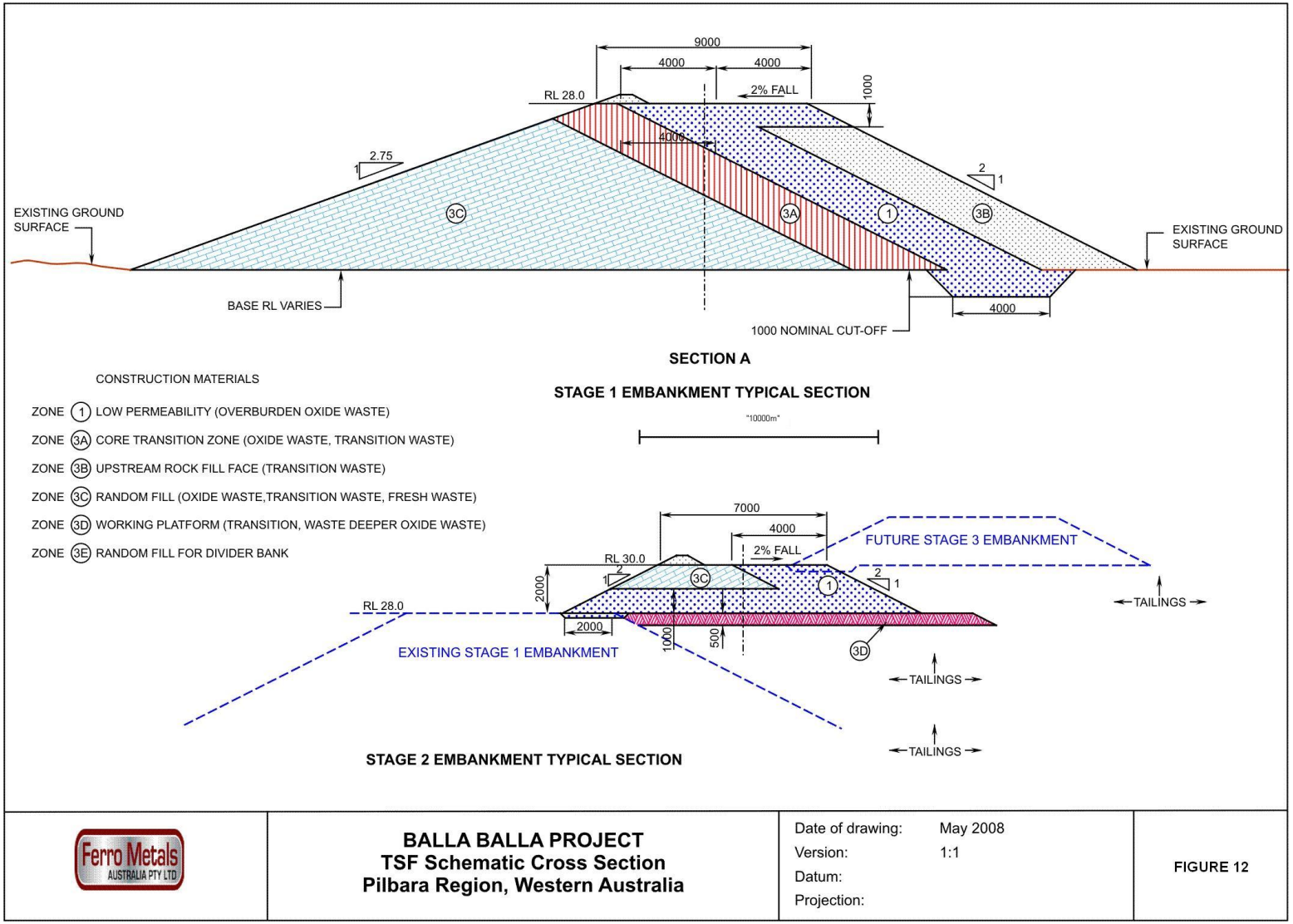
Annual production	Million dry tonnes (Mdt)	3.9
15 year production	Million dry tonnes (Mdt)	59.0
Average stored density	Dry tonnes per cubic metre	1.4
15 year storage volume	Million cubic metres	13 – 16
Discharge density	Percent solids by weight (%w/w)	62
Particle size distribution	Microns (µm)	80% finer than 75-106

TSF design and operation will be in accordance with the Department of Industry and Resources (DoIR) “Guidelines on the Safe Design and Operating Standards for Tailings Storage” 1999 and the following Australian National Committee on Large Dams (ANCOLD) Guidelines where applicable:

- Guidelines on the Consequences of Dam Failure;
- Guidelines on Dam Safety Management;
- Guidelines for Design of Dams for Earthquake; and
- Guidelines on Tailings Dam Design, Construction and Operation.

The storage will be operated to minimise the volume of water within the decant ponds at all times, and in particular to ensure that there is negligible likelihood of water being stored directly against the perimeter embankments of the upstream lifts. The TSF site is essentially flat, and consequently the storages are “turkey nest” arrangements with no external catchment. Hence, flood management during extreme rainfall events will be a relatively simple process, with the incident rainfall being stored within the core of depression of the tailings beaches. The TSF will be designed for a 1 in 100 year average recurrence interval 72 hour storm event of 475mm. A minimum operational freeboard of 300mm, together with a minimum beach freeboard of 200mm will be maintained in accordance with the requirements of the DoIR guidelines.

Figure 12 TSF cross section



The TSF will have starter embankments designed as free standing structures with mine waste placement being progressive over the life of the Project (refer **Figure 12**). To provide for the initial phase of operation of cell 1, compacted starter embankments ranging in height from 9.5m to about 12.5m high will be constructed using overburden from the open cut pre-stripping, or sandy compacted clay borrowed from within the TSF area.

Compacted clay will be used for the internal embankment and oxidised surface mine waste will be placed as a transition material and fresh mine waste on the downstream batter. Mine waste will be progressively placed as each lift is constructed to the final design height throughout the mining operation. The downstream batter slopes can be rehabilitated immediately after the mine waste has been placed. A central decant with a dedicated recovery pump will return supernatant water from the cell. Closely spaced spigots, placed at centres of approximately 40m will enable cyclic deposition of tailings to maintain a centrally located water pond around the decant facility (Coffey, Sept. 2008). Embankment raising will involve placing compacted tailings, excavated from within Cell 1 on the tailings beach with transition mine waste placed over the compacted tailings. Further details on the TSF design are provided in **Appendix E**. Details of potential impacts on groundwater by the TSF are given in **Section 11**.

4. STAKEHOLDER CONSULTATION

4.1. Introduction

The objective of the consultation programme conducted during preparation of this EPS document was to enable individuals, groups and agencies potentially affected by the proposed Project to have their interests considered during the environmental assessment process.

The purpose of this section is to summarise the stakeholder consultation undertaken since the early stages of Project design and development in 2005.

4.2. Stakeholder consultation programme

FMA commenced a stakeholder consultation programme in late 2005 during the early stages of Project design and development. The aims of the consultation undertaken were to:

- Identify key stakeholders;
- Provide stakeholders with information on the proposed Project; and
- Identify the major points and potential impacts that need to be addressed during project planning.

FMA has identified and consulted with the following stakeholders:

State Government:

- Environmental Protection Authority Services Unit (EPASU);
- Department of Environment and Conservation (DEC);
- Department of Conservation and Land Management;
- Department of Planning and Infrastructure (DPI);
- Department of Industry and Resources (DoIR);
- Department of Water (DoW);
- Department of Consumer Protection and Employment (DoCEP);
- Department of Indigenous Affairs (DIA)
- Office of Development Approvals Coordination (ODAC);
- Pilbara Development Commission;
- Port Hedland Port Authority (PHPA);
- Main Roads of Western Australia (MRWA);
- Horizon Power.

Local Government:

- Shire of Roebourne;
- Town of Port Hedland.

Indigenous:

- Ngarluma Yinjibandi Group;
- Karriyarra Group.

Other:

- Mallina Station;
- Sherlock Station;
- Straits Resources;
- Boodarie Station;
- Mundabullangana Station;
- Conservation Council of Western Australia Inc;
- Wildflower Society of WA.

Adjoining Mining Tenement Holders;

- Karratha Tourist Bureau.

The Proponent will continue with additional stakeholder consultation during and after project development. The aims of this consultation will be to:

- Disseminate information;
- Obtain feedback from stakeholders;
- Respond to stakeholder concerns (if any).

It is considered that the stakeholder consultation process could be enhanced by encouraging site visits for key regulators to assist their understanding of the Project.

4.3. Stakeholder comments and Proponent's response

Table 9 presents the points raised by stakeholders throughout the stakeholder consultation process. The dates listed are those upon which consultation commenced or major points were raised.

The objective of the consultation programme conducted during preparation of this EPS document was to enable individuals, groups and agencies potentially affected by the proposed Project to have their interests considered during the environmental assessment process.

The purpose of this section is to summarise the stakeholder consultation undertaken since the early stages of Project design and development in 2005.

Table 9 Stakeholders issues and Proponent's response

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
June 2005	**Office of Development Approvals Co-ordination (ODAC)** *(Eric Parkes)*	ODAC offered to assist, but commented that the Balla Balla Project was relatively small and that there appeared to be no difficult areas where we required assistance, thus leading to a mutual conclusion that the extra administration resources required by FMA would be better spent elsewhere.	FMA agreed & decided to keep the relationship informal.	N/A
June 2005 to present	**Straits Resources** *(Ron Heeks, Lon Terinyaki, Peter Storey, Harry Holle, Ivan Jerkovich, Paul Calvin)*	Request proposed for an agreement for reciprocal access and co-operation between Straits Resources and FMA.	FMA agreed to the proposal and commented on the benefits of the excellent relationship between the two companies, leading to sharing of resources where possible.	N/A
August 2005 to present	**Mallina Station & Sherlock Station** *(Peter Cook)*	Request to be kept updated during development.	This has been done, with a good working relationship.	N/A
		Request for reimbursement for lost income due to not grazing cattle on some areas due to mine activities.	Agreed to by FMA.	
		Request to liaise and fence some areas to prevent cattle ingress.	Agreed to by FMA.	
October 2005	**Department of Indigenous Affairs** *(Tristan Harmer)*	DIA advised that the relevant mapping files for heritage sites have periodically been updated by DIA, however said there are no listed sites in the vicinity of the main Balla Balla Project Area and all bores to the south of the Project are remote from known sites. The area has been surveyed for heritage sites and no new sites were located.	FMA made contact with the DIA regarding mapping files for known heritage sites in the general region of the Project. FMA has surveyed the Balla Balla Project Area for heritage sites and no new sites were located.	The heritage reports have been requested by the Ngarluma Group to be kept confidential, and therefore have not been included in this document or appendices.
December 2005	**Shire of Roebourne**	Consultation should be undertaken with the Shire on construction of the camp and accommodation village, specifically sewage	Agreed and this has been done through to present & any work has complied with Shire regulations and	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
to present	*(Bob Sharkey, Shire of Roebourne councillors (attended council meeting for presentation), Environmental, Building and Development Officers)*	treatment, potable water supply and waste management.	has passed inspections by Shire officers.	
		Consultation should be undertaken with the Shire on the potential upgrade of the Whim Creek airstrip.	Agreed current specifications and costs being investigated for conversion to 24 hour RFDS emergency airstrip.	N/A
		Potential impact on recreational users of and condition of the Balla Balla Road if used for Project access.	Project will construct its own access road due to not wishing to mix recreational and commercial traffic.	EPS, Section 3.3
		Transport of ferro vanadium product. Is it a dangerous good?	Ferro vanadium is not dangerous, but Project is now iron ore, not vanadium.	N/A
		Potential for soil and groundwater contamination from tailings. Have tailings characterisation analyses been undertaken?	Low potential for contamination due to design TSF. Design and characterization tests are complete; kinetic leach testing continues, after 18 months the leachate remains neutral.	Appendices E & I
		Potential for impact on Aboriginal heritage. Have Aboriginal heritage surveys been undertaken?	Two heritage surveys have been completed. Mostly scattered artefacts have been identified. Development plans avoid all sites.	EPS, Section 6.2.1
		Surface water management should be considered during Project design.	A comprehensive hydrological study has been undertaken.	EPS, Section 10 & Appendix D
		Progressive rehabilitation should be considered for the Project	Waste dumps, tailings storage facilities & disturbed areas will be rehabilitated progressively.	EPS, Section 12 & the draft Ground Disturbance & Closure EMP
		The Shire wishes to be kept informed during environmental assessment of the Project.	Presentations have been made to the Shire & individual officers have been consulted.	N/A
		No additional regional/local stakeholders to consult than proposed in current stakeholder consultation programme.	The proponents sought advice from the Shire & they confirmed that local stakeholders had been correctly identified.	EPS, Section 4.1

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
December 2005	**Pilbara Development Commission** *(Carolyn Biar, apologies from Mark Hainsworth).*	Potential for impact on recreational fishermen at the Balla Balla Landing, if the Balla Balla Road is used for Project access.	Balla Balla Road is not being used for Project access.	EPS, Section 3.3
		Availability of local workforce for Project during resource boom and potential for migration of skilled workforce regionally and from overseas.	Proponent has monitored the situation and government approved import of skilled workers.	EPS, Section 1.5.2
		Provision of adequate facilities/accommodation for workforce.	It was recognized that to compete for quality labour, exceptional accommodation is required.	N/A
		Ability to retain workforce during resource boom. Pilbara Development Commission can facilitate Aurox with migration of skilled workforce for the Project, if required.	The proponent has been monitoring the availability of skilled personnel and further advice from the Pilbara Development Commission will be sought in the future.	N/A
		Fly-in/fly-out workforce via Karratha is not viewed favourably by local people.	There is not availability of housing for anything but a FIFO operation & many workers prefer it as opposed to living in the vicinity of the Project.	N/A
December 2005	**Department of Environment**	Advice should be sought from CALM and DoE on the potential for and management of erosion.	Comprehensive environmental surveys have been completed and draft environmental management plans in place to combat erosion.	Draft Ground Disturbance & Closure EMP
		Floodplain tidal surge issues need to be considered.	Level surveys to high accuracy show the Project and access is out of tidal surge areas.	EPS, Section 10 & Appendix D
		Works Approval Application should identify all emissions and their management.	Emissions have been identified as virtually negligible for the iron ore Project. Management of emissions is detailed in the Emissions Environmental Management Plan.	EPS, Section 6.2.3 & the draft Emissions EMP
		Interaction between surface water and groundwater should be considered.	Groundwater recharge has been monitored for several years by measuring water table response to rainfall. It appears that there is significant recharge following large rainfall events. GRM consultants have considered the interaction of surface and	EPS, Sections 10 & 11 & Appendices C & D

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			groundwater, and this it detailed in the surface and groundwater reports.	
December 2005	**Department of Conservation and Land Management**	Targeted fauna surveys may be required.	Fauna and habitat surveys completed for the Project indicate that there is not a significant concern regarding fauna disturbance.	EPS, Sections 8 & 9, & Appendices G & H
		Potential impacts to DRF and PF species, groundwater dependent vegetation, weeds, stygofauna and fauna need to be considered. Fauna management and the implementation of a fauna recovery crew during gas pipeline trenching should be considered.	These items have been considered, scientifically surveyed and discussed in the relevant reports (Appendices A, G and I); the environmental management plans detail how miminal disturbance will be achieved for the Project, including the Ground Disturbance and Rehabilitation Environmental Management Plan for weeds. No gas pipe for this project in immediate plans, however the management of fauna during the construction of the slurry pipeline from Balla Balla to Utah Point is detailed in the Construction Environmental Management Plan.	EPS, Sections 8 & 9, & Appendices G, H & I & the draft Ground Disturbance & Rehabilitation, and draft Construction EMP's
		Potential impact on short-range endemic species.	Potential impacts have been assessed to be low, with regard to survey results generated via Mike Bamford.	Appendix G
		Potential impacts on vegetation from air quality emissions.	This has been considered & due to no processing emissions on site, there should be no impacts on vegetation. Air Quality modelling at the Utah Point site has been completed by SKM.	EPS, Section 7
December 2005	**Department of Conservation and Land Management**	Potential impacts on the ecology of ephemeral creeks, e.g. Salt Creek and Balla Balla River.	Surveys have covered potential impacts and these are considered negligible as watercourses will not be impacted on directly and studies predict no indirect impact. Further discussion can found in Appendix A (Flora and Vegetation) and Appendix C (Groundwater).	Appendix A & C
		Potential impacts on mangroves.	Impact on mangroves is considered negligible due to distance of the Project from any mangroves and	

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			the benign nature of operations. In latter times, any mangrove disturbance will be covered by the PHPA PER, as FMA is only one of the lease holders at Utah Point and basic site preparation works will be completed by the PHPA.	N/A
		Potential impacts on recreational activities, i.e. fishing at Balla Balla Landing.	The operation is some distance from the coast and areas where people commonly camp & fish (approximately 6-9 km).	N/A
		Weed management during construction.	Appropriate wash down practices & facilities are incorporated into design. The weed management can be found in the Ground Disturbance and Rehabilitation Environmental Management Plan.	Draft Ground Disturbance & Rehabilitation EMP
		Backfilling of pits should be considered for closure.	The backfilling of pits was considered not economic in 2005. As metallurgical testwork has been completed, it has become apparent that FMA need to blend between pits and at different bench heights to achieve product specifications and mitigate downtime caused by heavy rain events. The FMA pits are yet to reach sterilisation and this is a consequence of time, pending iron ore pricing. It is not appropriate to consider backfilling of the pits at this time.	N/A
December 2005	**Tourist Bureau Karratha**	No comments. When asked if there was any fishing club that might be interested, reply was none was known to them.	As a dedicated road will be built and FMA personnel will not have the time available to fish due to 12 hour rosters, there should be no impact on any people fishing which is the only recreational activity at Balla Balla Port which is 9 km from the Project.	EPS, Section 3.3.1
December 2005	**Environmental Protection Authority Services Unit** *(Ray Claudius, Doug Betts)*	Potential impact on Aboriginal heritage.	No impact, as sites will not be disturbed (2 comprehensive surveys undertaken).	EPS, Section 6.2.1
		Sustainability principles should be considered and incorporated into the Project.	Sustainability and minimal impact principles are planned, examples include the choice of energy efficient equipment choices and slurry pipeline in	EPS, Section 5.1

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			preference to trucking.	
		Potential impact on short-range endemic species.	Potential impacts have been assessed to be low, with regard to survey results. See report and addendum from Mike Bamford in Appendix G.	Appendix G
		Liaise with DoIR and the CALM during mine closure planning and development of completion criteria.	FMA have commenced liaison with DoIR in regards to the preliminary closure planning, and will continue to liaise with DoIR and DEC to ensure best practice.	N/A
		Potential impacts on flora and fauna.	Surveys have been completed (in 2005 and 2006) to evaluate the potential impacts of mining activities in the Balla Balla operations areas. Further surveys have been completed for the pipeline corridor to supplement studies conducted at the time of the original environmental impact assessment for the PEPL gas pipeline in the early 1990's.	Appendices A, G and H.
		Potential impacts on groundwater.	Comprehensive pump testing, monitoring & modelling has been done and will continue.	Appendix C
		Potential impacts on aesthetics.	Impacts on aesthetics will be reduced using appropriate management and rehabilitation techniques. FMA has commenced discussions with DoIR in regards to waste dumps and tailings storage facilities.	EPS, Section 6.2.7
		Potential for soil and groundwater contamination from tailings. Characterisation of tailings should be undertaken.	Tailings characterisation testwork has been completed to a high standard; kinetic leach column testing continues.	Appendices E and I
		Environmental impact assessment of the Project should focus on outcome-based objectives.	This is a sound philosophy and has been implemented.	N/A
December 2005	**Department of**	Cumulative impacts should be considered.	These have been considered, an example is the cumulative noise and air quality modelling at Utah	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
	Environment *(Gary Humphreys, Mark Peacy, Rebecca Moen)*		Point.	
		Landscape values are considered during both the initial mine design and site closure.	Best practices for best environment and landscape will be continual.	N/A
		Marine issues are considered, noting that mangroves are present on the nearby coastline.	The Project is not considered a threat to the coastline due to distance and its benign nature, however, the regional environment will be monitored continually. Any mangrove disturbance at Utah Point is the responsibility of the PHPA and is covered in the PHPA PER.	N/A
		Potential impacts on Balla Balla Road acknowledging its recreational usage.	There will not be any impact on the road, as it will not be used by the Project.	EPS, Section 3.3.1
		Does Aurox have an environmental policy?	Yes FMA has an environmental policy.	N/A
		Early identification of environmental issues to feed into Project design and throughout Project life to achieve positive environmental outcomes. Encourage FMA to identify environmental outcomes and use a risk-based approach during environmental assessment.	FMA is also confident in using the recommended approach and sound management plans which are being developed will lead to best management practices.	Draft EMP's
		Works Approval Application may be processed in parallel with the EPA process.	FMA is aware of the requirement; the intention is to run both processes in parallel.	N/A
December 2005	**Department of Water** *(Gary Humphreys, Mark Peacy)*	Proximity to floodplain and management of surface water.	This has been addressed after a comprehensive hydrological survey and reported in Appendix D.	EPS, Section 10, & Appendix D
		Potential impacts on groundwater.	This has been addressed after comprehensive field work and modelling and reported in Appendix A. A site visit whilst pump testing was made to Balla Balla by DoW staff who liaised with Groundwater Resource Management (who are performing the	EPS, Section 11, & Appendix C

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			Balla Balla water studies).	
December 2005	**Department of Industry and Resources** *(Alistair Conn, Emma Halligan)*	Management of open voids.	A closure/rehabilitation plan has been prepared, and an abandonment bund will be presented to DoIR in the Mining Proposal.	EPS, Section 12, & the draft Ground Disturbance & Rehabilitation EMP
		Waste rock handling and management.	A plan has been prepared and will be submitted to DoIR in the Mining Proposal.	N/A
		Waste dump design and its ability to handle high intensity rainfall events associated with cyclonic conditions.	Suitable design and allowance for abnormal events is being planned, however FMA will commit to commissioning waste dump trials to identify the best wast dump design for Balla Balla, as suggested by DoIR.	EPS, Section 6.2.5
		Backfilling of pits instead of creating waste dumps	As metallurgical testwork has been completed, it has become apparent that FMA need to blend between pits and at different bench heights to achieve product specifications and mitigate downtime caused by heavy rain events. The FMA pits are yet to reach sterilisation and this is a consequence of time, pending iron ore pricing. It is not appropriate to consider backfilling of the pits at this time.	N/A
		Flood protection of pits and infrastructure, and its bearing on closure.	Flood protection has been designed, see Appendix D.	EPS, Figure 11, & Appendix D
		The potential for tidal surges during cyclonic events.	Tidal surges are not a threat due to heights above sea level, as discussed in the Surface Water Report in Appendix D.	EPS, Section 10 & Appendix D
		Long term decommissioning of the TSF and associated infrastructure for the Project.	A draft Ground Disturbance and Closure Environmental Management Plan has been	EPS, Section 12, & the draft Ground

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			generated.	Disturbance & Rehabilitation EMP
		Potential impacts to the nearby coastal environment.	The Project is not considered a threat to the coastline due to distance and its benign nature, however, the regional environment will be monitored continually, examples of monitoring commitments can be found in the Groundwater Report in Appendix C.	Appendix C
		Implementing total stakeholder engagement.	Stakeholders have been engaged and informed. FMA have known stakeholders and will continue consultation, for example, FMA will consult with DoIR before finalising the Mining Proposal.	EPS, Section 4
		Management of short and long-term ARD and landform instability, and adequately encapsulating all potentially acid forming (PAF) material.	FMA take ARD very seriously, as shown by the commitment toward ARD testwork, in particular the kinetic leach testing of the tailings has been running for 18 months and continues. The only PAF material is the tailings; the encapsulation of tailings is described in the Conceptual TSF Design Report in Appendix E.	EPS, Section 6.2.5, & Appendices E & I
		Consulting with the Geotechnical Engineers from DoCEP to discuss the Project.	TSF designers have had contact with DoIR, and DoCEP have been contacted, to ensure current best practices and regulations are followed. The detailed design of the TSF will be delivered to DoIR as part of the Mining Proposal.	N/A
December 2005	**Department of Conservation and Land Management** *(Hayley Valentine, Jay Shailes)*	Stygofauna sampling should be conducted both within and outside the zone of impact from groundwater abstraction activities	Three sampling programmes have been undertaken; FMA consultants understand the stygofauna sampling requirements. Details of the surveys can be found in the Assessment of Balla Balla Stygofauna in Appendix H.	EPS, Section 9, & Appendix H
		Approximately 15 to 20 sites sampled within the zone of impact is considered good practice by the CALM. Less than six sites	See response above.	EPS, Section 9, & Appendix H

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
		sampled within the zone of impact will not be accepted by CALM. No limit on the number of sites sampled outside the zone of impact.		
		Two surveys, approximately six months apart is considered good practice by CALM.	FMA have followed relevant guidelines, see Appendix H.	EPS, Section 9, & Appendix H
		Sampling should follow CALM's netting procedure. It was discussed that Brenton Knott's bailing and baiting procedure were also proposed to be undertaken.	Several different techniques were trialled for comparison purposes, including netting.	EPS, Section 9, & Appendix H
		Water quality sampling should be undertaken at the same time as stygofauna sampling.	A comprehensive water analysis database has been compiled, and the hydrology and stygofauna experts in consultation.	EPS, Section 9, & Appendix C & H
		Reporting of results should consider both hydrogeological and biological aspects.	Results have been reported considering both hydrogeological and biological aspects in the Assessment of Balla Balla Stygofauna report, see Appendix H.	EPS, Section 9, & Appendix H
January 2006 onwards	**Ngarluma Group** *(Trevor Solomon, Maxy Sambo, Roger Barker, David Walker)*	A waterhole on Whim Creek, which is at the south east extremity of the ore horizon on M 47/311, should not be disturbed through water abstraction. Mine workers should have a module on heritage and protection of sites included in the induction process.	Levels in this water hole have been monitored seasonally and during pump tests of bores to ensure its integrity. This was agreed by FMA as a good philosophy to ensure site disturbance did not occur.	N/A
		Ron Parker of AIC should conduct heritage surveys over leases held by FMA.	This has been done and it complements other prior surveys.	N/A
		FMA should use the services of local Roebourne businesses and personnel.	Locals have been approached regarding this, including Brida Contracting. Parameters of programs for employment and training are now being formulated in the hope to establisha working group to discuss, modify and ultimately implement	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			employment, training and vocational education initiaves.. Last contact 12 June 2008, (assisted with meeting costs, also provided new multi function colour copier which was urgently required by NAC) other dates in 2007 include 18/1, 31/1, 2/2, 26/2, 8/3, 19/3, 20/3, 4/4, 20/7, 20/9, 8/10, 14/10, 16/10, 9/11, 14/11.	
February 2006	**Department of Conservation and Land Management** *(Steve Van Leeuwin, Nick Phillips)*	Potential impacts to groundwater and vegetation from tailings seepage.	This has been studied and monitoring will be continuous, this is discussed in the Conceptual TSF Design report in Appendix E.	EPS, Section 6.2.5, & Appendix E
		Storm surge potential from the ocean should be considered.	Potential is negligible according to weather records and hydrological studies. Discussed in the Surface Water report in Appendix D.	EPS, Section 10, & Appendix D
		Potential impacts of discharge of excess mine and surface water to the environment.	Disturbed water will not be discharged to the environment; FMA have developed a strategy, including mining at different bench heights to ensure disturbed water is used in the process plant.	Appendix D
		Potential impacts on *Gomphrena cucullata*.	Comprehensive environmental surveys have not flagged any risks, see Appendix A.	EPS, Section 7, & Appendix A
		Potential impacts to the Roebourne Clay Community, which is under consideration as a TEC, occurring in the southeast clay flats of the Project mining leases.	Comprehensive environmental surveys have not flagged any risks. A list of CALM's biological survey sites on the Roebourne Plains was requested. (Provided by Steve Van Leeuwen 8 Feb) The nearest site DRE 18 (Botanical) was noted and identified in the field, to ensure avoidance, although it is south of mine activities. Further discussion, including an addendum from Libby Mattiske can be located in Appendix A.	EPS, Section 7, & Appendix A
		Gilgai clays should be avoided where possible as they are dust and erosion prone.	Appropriate measures are planned to minimise potential for dust & erosion, as discussed in the draft Emissions and Ground Disturbance and Closure Environmental Management Plans.	Draft Emissions and Ground Disturbance and Closure Environmental

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
				Management Plans
		TSF fencing should be considered to prevent fauna access.	The TSF will be monitored-the design is not conducive to fauna entry. If required, fencing will be erected.	Appendix E
		Potential impacts from weeds, predominately Ruby Dock, which is common throughout the area.	Washdown facilities will be built and monitoring will be continuous to ensure there is no proliferation of weeds. Weed management is detailed in the draft Ground Disturbance and Closure Environmental Management Plan.	The draft Ground Disturbance and Closure Environmental Management Plan
		Access roads should be designed for "all weather" conditions.	Access roads will be designed for all weather conditions.	EPS, Section 3.3.1
		Potential impacts to environment (mangroves) from recreational fishing undertaken by workforce.	The workforce will be FIFO and will not have the opportunity to fish.	N/A
		Potential impacts on vegetation from air quality emissions.	There will not be any chemical air emissions for the iron ore project processing plant. A draft Emissions Environmental Management Plan has been prepared.	The draft Emissions EMP
		Fauna management during gas or other pipeline trenching.	Rescue teams will be utilised and only short sections of trench will be open at any time. Details are provided in the draft Construction Environmental Management Plan.	The draft Construction Environmental Management Plan
March 2006	**Department of Employment and Consumer Protection**	Design of the TSF to meet the Australian National Committee on Large Dams (ANCOLD) and DoCEP guidelines.	Design and engineering does meet or exceed required specifications.	N/A
		Adequate flood protection for the Project. Consideration for extreme rainfall events and tidal surge given the proximity of the Project to drainage lines.	Flood protection has been studied and designs have been completed for bunding & drainage. See the Surface Water report in Appendix D.	EPS, Figure11, & Appendix D
		Lifts to TSFs should be considered to	This has been implemented in designs, see	Appendix E

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
		decrease proximity to drainage lines.	Appendix E.	
		TSF design should incorporate seepage analysis and consider impacts to groundwater. Groundwater permeability testing should be undertaken during the seepage assessment.	Extensive seepage analysis including seepage modelling and geotechnical laboratory testwork has been completed to characterise the tailings floor, details can be found in the Conceptual TSF Design report in Appendix E.	EPS, Section 6.2.5, & Appendix E
		A groundwater monitoring network should be established to monitor groundwater levels and quality.	FMA has commited to a groundwater monitoring plan to be developed in consultation with the DoW, details are listed in both the draft Water Environmental Management Plan and the Groundwater report in Appendix C.	Appendix C, & the draft Water EMP
		Design of access roads should consider haulage use during life of the Project.	Haulage has and is being considered in design, for example, the Project is using a low impact slurry line, in preference to truck haulage.	EPS, Figures 4 & 7
		Waste dumps should be designed for long-term stability and should consider erosion characteristics of the waste rock. Surface materials for waste dumps should be characterised.	Waste rock characterisation has been completed (see Appendix I); as per the DoIR request, FMA has commited to trials to determine optimum waste dump design.	EPS, Section 6.2.5, & Appendix I
		All waste from the Project should be characterised geochemically and for acid generation potential.	See Appendix I	Appendix I
		Pit wall stability should be examined, particularly in relation to proximity to the TSFs.	The TSF is distant from the pit walls. Pit wall stability is constantly examined; included geotechnical drilling – this will be detailed in the Mining Proposal.	N/A (to be included in Mining Proposal)
		Pit abandonment bunds should comply with ANCOLD and DoCEP guidelines.	FMA will comply with ANCOLD and DoCEP guidelines.	N/A (to be included in Mining Proposal)
		Building/plant site foundations should be characterised.	Geotechnical pitting and drilling have been undertaken, see Appendix B	Appendix B
March/April 2006	**Adjoining Tenement**	Straits Resources surrounds most of the Balla Balla Project, but other nearby tenement	Most tenement holders would have already been aware of activities planned at Balla Balla. There was no interest displayed by any of the tenement holders.	N/A

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to present	**Holders** *(Mark Creasy, Bushjet Pty Ltd, Peter Goonan, Fox Resources Ltd, Christopher Dashorst, Fox Radio Hill Pty Ltd, Croydon Gold Pty Ltd, Adelaide Prospecting Pty Ltd, Tapeko Investments Pty Ltd,Straits (Whim Creek) Pty Ltd, AGIP Australia Pty Ltd)*	holders were consulted also. There was no comment returned.		
December 2006 to present	**Port Hedland Port Authority** *(Andre Bush, Neil Parker, Mark Oddy, Chris Drinkwater, Michael Hunt, Craig Wilson)*	General commercial negotiations regarding the new Pt Utah development.	Liaison with PHPA regarding engineering detailed designs and some finer detail regarding contracts and leases.	EPS, Figures 5 & 6
June 2007	**Main Roads of Western Australia** *(Justin Mc Curdy)*	Access roads meeting the NW Coastal Hwy to be constructed to Aust Standards & MRWA conditions.	Obtained copies of relevant standards so intersection design can be submitted to MRWA for comment and approval.	N/A
July 2007	**Department of Conservation and Land Management**	Met with Stygofauna specialist to discuss Stygofauna impacts, especially *Reidcyclops?* Identification and significance.	Discussed possible rarity of *Reidcyclops?* And CALM advised of existence elsewhere in the region, or possibly mis-identification. CALM advised that rule-of-thumb for acceptable impacts was reduction of >30-50% of depth of water column.	EPS, Section 9, & Appendix H
August 2007	**Environmental Protection Authority**	Discussions on crucial environmental impact	EPASU officers noted that onshore slurry pipeline	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
	Services Unit	issues and approach to reporting. Follow up telephone conversation several days later.	was an acceptable transport strategy; and that offshore pipeline would be complex environmental impacts and take longer. Noted that most other issues appeared manageable, based on FMA briefing note and discussions.	
September 2007	**Town of Pt Hedland**	General interest in Project parameters, especially regarding transport to port.	Spoke to officers and provided powerpoint presentation.	N/A
November 2007	**Horizon Power**	FMA should obtain engineering opinion on the earthing and galvanic protection systems that may need to be deployed where the slurry line is proposed to transit 18 km along the Horizon power easement FMA should liaise with Horizon.	It was agreed that this work would be performed in conjunction with the detailed engineering; close liaison with Horizon should be maintained if this route is to be used for a slurry pipe.	EPS, Figure 7
January 2008	**Mundabullangana Station**	Contacted when slurry pipe route selected.	No feedback to date FMA will follow up with a comprehensive briefing & update.	N/A
January 2008	**Other Tenement Holders Along Slurry Pipe Route**	Some comments have been received from sand mining lease holders requesting information.	Briefings with further details of the proposed installation is being communicated with an explanation that the slurry pipe will run adjacent to & parallel to the PEPL which already runs through their tenure, therefore minimising impacts. The mining leases concerned can only mine to a depth of 3 metres, therefore, the slurry line could easily be buried below this depth so there is no interference to their operations. A powerpoint presentation outlining proposal was sent to tenement holders.	EPS, Figure 7
February 2008	**Boodarie, Station**	Contacted when slurry pipe route selected owned by BHPB.	Liaising to ensure future development plans not compromised.	EPS, Figure 7
March 2008	**Department of Water and Department of Environment and Conservation; Karratha**	Contacted and accepted a meeting/discussion held at the DoW office in Karratha.	Suggestions from DoW and DEC taken on-board and included in the environmental impact assessment, such as water efficiency; potential for FMA to provide a regional benefit in regards to water at Utah Point; tailings seepage modelling, water flow diagram and illustration of surface water	EPS, Section 3.5.5, Figure 10 Appendix C, D & E and the draft Water EMP

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
	(Gary Humphreys, Darryl Abbott, Louise Mailey, Suzy Roworth, Susan Moore Jenny Jan, Cally Coster, apologies Jim Kaucz)		flows.	
April 2008	**The Conservation Council** *(Tim Nicol)*	Meeting/discussion held at the Conservation Council. Raised topics, such as Stygofauna, asked of the potential to backfill, TSF, closure and rehabilitation, greenhouse gases.	FMA were able to respond to all questions as these had been previously investigated for Balla Balla.	Throughout EPS
April 2008	**The Wildflower Society of Western Australia** *(Brian Moyle)*	Meeting/discussion held at the Conservation Council. Raised topics such as, pipeline construction and the use of best practices, closure and rehabilitation.	FMA were able to respond to all questions as these had been previously investigated for Balla Balla.	Throughout EPS
May 2008	**The Town of Port Hedland**	The Town of Port Hedland was responsive, suggesting FMA send through a presentation of the Project.	FMA sent through a powerpoint presentation.	N/A
May 2008	**Karriyarra/ Pilbara Native Title Service**	24MD (6B) Objection to Infrastructure Facility Road, Powerline, and Pipeline 48km SW'ly of Port Hedland L47/230.	Telephone discussion 9 May 2008 and letter from FMA seeking clarification of the nature of the objection and a request to meet with next Working Group meeting. 26 August 2008 a powerpoint presentation was made to a group of 15 Kariyarra governing committee plus their lawyers. The proposed slurry pipe was explained and questions were invited. Engagement with the group is ongoing.	N/A
June 2008	**Ngarluma Aboriginal Corporation**		New photocopier/fax gifted to NAC for the Manager	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			for which Laurie Polard was very appreciative.	
June 2008	**Ngarluma Aboriginal Corporation**	Native Title Agreement discussions. First pass meeting and NAC agreed that the chairperson would write a paper for FMA to consider, and aim to reconvene in a month.	FMA provided an explanation on the status of the Project.	N/A
June 2008	**Ngarluma Aboriginal Corporation** *(Laurie Polard)*		Courtesy visit. General discussions on the status of the Project and the Project relationship with the Ngarluma Aboriginal Corporation.	N/A
June 2008	**Port Hedland Port Authority** *(Andre Bush)*	Successfully concluded facility agreement following months of negotiation.	Successfully concluded facility agreement following months of negotiation.	N/A
July 2008	**BHPBIO** *(Eric Shegog, Mike Fitzpatrick)*	Meeting/discussions on slurry pipeline routes through HBI area and access to water. BHPBIO tabled future plans and rail and road infrastructure in the FMA preferred route location. BHPBIO requested an understanding of the potential to acquire water from the Balla Balla Project and what is the quality and quantity of the water source.	Agreed to sign CA and share information on GIS data, flora/fauna and heritage surveys for suitable pipeline corridors. Provided BHPBIO with verbal advice on current water plans for the Project and at Pt Hedland.	N/A
July 2008	**Shire of Roebourne** *(Amy Hughes)*	Shire of Roebourne happy to visit, no concerns raised; however flagged mosquito training for site inductions.	Meeting/consultation on site to review lodging house and pest management plans for the Exploration Camp. Mosquito training will be included in the site inductions.	N/A
July 2008	• **Pilbara Development Commission** • **Australian Resources** • **BHP Billiton Iron Ore** • **Chamber of Minerals and**	Pilbara Dialogue meeting held in Port Hedland, organised by the Pilbara Development Commission.	FMA gave an overview of the Balla Balla Project at 0930 on Friday 25th July.	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
	Energy WA • **Chevron/Gorgon** • **Citic Pacific Mining** • **Curtin University** • **Dampier Port Authority** • **Department for Education and Training** • **Department for Environment & Conservation** • **Department for Planning & Infrastructure** • **Department of Housing & Works** • **Department of Industry & Resources** • **Department of Justice** • **Department of Sport & Recreation** • **Disability Services Commission** • **FMG** • **Landcorp** • **Mainroads WA** • **Newman Chamber of Commerce &**			

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
	Industry • **North West Iron Ore Alliance** • **Pilbara TAFE** • **Pluto** • **Port Hedland Port Authority** • **Rio Tinto** • **South Hedland Indigenous Coordination Centre** • **Straits Resources** • **Town of Port Hedland** • **URS** • **WA Country Health Service – Pilbara** • **Water Corporation** • **Woodside**			
August 2008	**Karriyarra/** **Pilbara Native Title Service**	Information request.	Meeting attended in Port Hedland; powerpoint presentation given to group.	N/A
August 2008	• **Department of Water** • **Department of Industry & Resources** • **Environmental Protection Authority**	Consultation with Government Regulators at the Balla Balla Project site. Persons attending were: • *Kaylene Carter (EPASU)* • *Gary Humphreys (DoW)* • *Darryl Abbott (DoW)* • *Louise Mailey (DoW)*	FMA commissioned a day-trip to site to facilitate stakeholder consultation on Wednesday 13 August.	N/A

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
		• *Demelza Dravneik (DoIR)* Apologies for not being able to attend were: • *Suzy Roworth (DEC)* • *Hayley Valentine (DEC)* • *Tim Nicols (Conservation Council)*		
September 2008	**Department of Industry & Resources** *(Danielle Risbey, Demelza Dravneik)*	DoIR advised the TSF concept change would not result in a change to the DoIR comments on the Balla Balla EPS, so there would be no need for DoIR to re-review the revised EPS document. DoIR liked the idea of co-disposal of tailings and waste, and suggested trialling when in operations. DoIR commented that it would be disappointing if the concept was not investigated in operations, due to the environmental, structural, economic, and operational advantages. In regards to waste dumps, DoIR recommended outcomes based waste dump design, based on stability, safety and non-polluting.	FMA requested a discussion with DoIR to flag the concept of a revision to the TSF design, to include trials towards co-disposal, and to discuss best practice for waste dump design to be included in the Balla Balla Mining Proposal. FMA welcomed DoIR's response to the conceptual design changes to the Balla Balla TSF, and committed to including in the revised EPS and Mining Proposal. FMA acknowledged DoIR's preference for conceptual, rather than detailed waste dumps designs, with commitments to conducting trials.	EPS, Figure 4, & Appendix E
September 2008	**Department of Indigenous Affairs** *(Cesar Rodriguez)*	DIA has recommended that the intent of the DIA for Balla Balla is that a Cultural Heritage Management Plan that includes site identification surveys of Aboriginal heritage be a condition of Ministerial approval granted pursuant to the EPA 1986 Act. DIA requests that such survey be undertaken prior to the commencement of ground disturbance works in the vicinity of sites. DIA commented that no delay be required to progressing the Balla Balla EPS.	Two heritage surveys involving close spaced (5 metre) pedestrian transects by senior Aboriginal lawmen, custodians and recognised Native Title holders have been undertaken over the areas of proposed development and surrounds. FMA personnel consulted with elders in the field, regarding the significance of particular sites and the means to ensure they were protected. FMA has throughout the Project site design and engineering had a policy of avoidance of all heritage sites and this has been achieved through careful planning and review of all lay-outs. Any engraving sites are distant	Heritage surveys or details are not included in the appendices for general viewing to respect the wishes of the survey participants.

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
			from possible blasting impact zones. FMA has surveyed the heritage sites to a precision of less than 3 metres. Prior to major earthworks related to construction activities, sites will be marked off, access will be excluded and a buffer as recommended in the AIC report will also be marked out. FMA will ensure that prior to ground disturbance in the vicinity of heritage sites, the sites are professionally re-surveyed to confirm their location and boundary. The development will not involve disturbance of any heritage sites. As part of site induction, all contractors and staff will be required to undertake a heritage and cultural module. Ngarluma people will be invited to be involved in the curriculum preparation and to present this training. This was discussed with senior people, as was the significance of particular sites and the best way to protect them; one site “Emu Foot” has been fenced. It is intended that in the unlikely event a new site is discovered, FMA will protect the site as outlined above and ensure it is adequately surveyed. FMA will comply with the Aboriginal Heritage Act 1972 and in the future if impact on sites is proposed, FMA will seek the Minister’s consent under section 18 of the AHA and will seek consultation with Ngarluma People.	

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
September 2008	**Environmental Management Branch of the Department of Environment & Conservation** *(Nic Woofley, Tania Jackson, Misty Shipway)*	EMB happy to receive the outstanding information, which included the GRM Hydrology report, Sept2008, addendums from Libby Mattiske and Mike Bamford, and the Stygyfauna Assessment, Oct2008, independently of the EPASU, and providing the information would be received, advised they would not need to re-revise the EPS document.	FMA met with EMB to discuss the comments raised in relation to the Draft EPS. Outcomes to resolve the comments made were: 1. FMA to send through the updated Hydrology report to show modeling of 200L/sec groundwater extraction (as per requirement for Balla Balla). 2. FMA confirmed that there would not be any disturbed discharge of water. 3. FMA to include in the EPS a worst-case riparian disturbance figure if horizontal directional drilling for the construction of the slurry pipeline is unsuccessful. 4. FMA to clarify the management of the Marnipurl Creek. 5. FMA to send through the updated Stygofauna report to show sampling in the Southern borefield 6. FMA to provide a Stygofauna impact scenario. 7. FMA to comment on reasons why Balla Balla contains unsuitable conditions for Troglofauna. 8. FMA to comment on GDE's in relation to the updated Hydrology report. 9. FMA to provide reasoning for level of fauna survey chosen and short range endemic surveys. 10. FMA provided guidance for location of specific requests in existing environmental management plans. 11. FMA confirmed no mangrove disturbance in the Balla Balla EPS. 12. FMA to clarify a couple of minor issues raised with the flora and vegetation surveys.	Appendices A, C, G & H

Start Date	Stakeholder	Stakeholder comment	Proponent response &/or action through to November 2008	Information location
October 2008	**Environmental Management Branch of the Department of Environment & Conservation** *(Tania Jackson)*	EMB acknowledged receipt of FMA documents.	FMA delivered the: • GRM Hydrology report, Sept2008; • Mattiske addendum; • Bamford addendum; • OES Stygofauna Assessment, Oct2008, to EMB.	Appendices A, C, G & H

5. SUSTAINABILITY

5.1. Sustainability

The EPA released its position paper on sustainability (Position Statement No. 6 'Towards Sustainability'), in August 2004. To determine whether the proposed activities of a proposal undergoing environmental assessment are consistent with attaining the goal of sustainability (EPA, 2004), the position paper defines a series of questions to be asked of the Proponent. These questions, along with FMA's responses are listed in **Table 10.**

Table 10 Sustainability checklist

Question	Proponent's Response
1. Does the proposal deplete non-renewable resources significantly?	No, iron ore mineralisation is extensive throughout the Pilbara and the scale of the Balla Balla Project is relatively small by local mining standards. FMA has used a best practice energy efficiency philosophy for design and operations of the Project and is actively continuing to explore the orebody.
2. Does the proposal deplete assimilative capacity significantly?	No. The Project presents no significant threat to the assimilative capacity of the surrounding environment.
3. Does the proposal use natural resources responsibly?	Yes, the Project has maximised its proposed use of natural resources by: • Ensuring maximum water recycle by returning clarified process water from the dewatering operations at the port; designing the TSF to maximise decant return (the use of a multi-celled facility), and recycle of the RO waste stream. • The processing facilities (plant and port) have been designed to utilise gravitational flow where relevant. • The Project has been designed with a compact footprint; • The Project has chosen to transport the concentrate slurry to Utah Point, in preference to trucking to reduce greenhouse gas emissions and impacts to local roads and traffic. • There is the potential to re-use the slurry water at Port Hedland, replacing scheme water.
4. Does the proposal satisfactorily restore any disturbed land?	Yes. Growth medium will be collected and stored for rehabilitation. Progressive rehabilitation (for example, the downstream embankments of the TSF) will occur to the extent practicable. A formal closure plan, including plans for final rehabilitation works, will be documented and progressively updated throughout the life of the mine.
5. Does the proposal follow the waste hierarchy and manage satisfactorily any waste produced?	Yes, a waste management and recycling program will be implemented from Project commencement.
6. Does the proposal incorporate best practice in water and energy efficiency?	Yes, water will be used from the pit, TSF and clarifier decant at the port facilities in preference to extracting fresh groundwater. The Project has been based on a best practice energy efficiency philosophy including: • The choice of gearless versus geared mill drive motors for the SAG and Ball mills. Gearless statistically show reduced power consumption and significantly reduce power surging during mill start-ups; • Equipment and footprint design to maximise gravitational flows to reduce pumping requirements; • Metallurgical investigations to ensure the coarsest product practicable is incorporated into the process flow to minimise over-grinding (and waste of energy).

Question	Proponent's Response
	• The addition of a cobbing (coarse magnetic separation) stage, to reduce gangue (waste) to the Ball mill, to reduce unnecessary grinding. • TSF located in close proximity to the processing facility to minimise energy used in pumping of tailings and tailings return water.
7. Does the proposal make good use of best practice to prevent pollution?	Yes, all potential pollutants will be contained and managed within the operational footprint, using concrete slabs and containment bunding; toe-drains and recovery bores to recover seepage from the TSF, should the need arise. Water sprays, dust suppressants and dust extraction equipment will be employed to manage fugitive dust emissions. The magnetite concentrate will be sent to Utah Point in a slurry form via pipeline in preference to filter drying on-site and transporting via trucking. The plant and accessory equipment has been designed with local wind information in mind. Non-toxic reagents have been selected to minimise the risk of impacts on the environment.
8. Does the proposal increase use of non-renewable transport fuels?	Yes, however the impact of the use of non-renewable fuels will be minimised by: • Installation of slurry and water pipelines from the plant to the port site to eliminate trucking of concentrate; • Compact site footprint to minimise vehicle movements on-site; • Solar power for hot water in the village.
9. Does the proposal use energy efficiency technologies?	Yes, energy efficient technologies are utilised within the Project, including: • Gravity flows where practicable; • Gearless mill drives; • Coarse grind for particle liberation; • Installation of a cobbing circuit to reduce gangue within the mill; • Solar power for hot water at the village. • Use of existing infrastructure (such as an airstrip) at either Karratha or Port Hedland.
10. Does the proposal result in net improvements in biodiversity?	Yes, the Project has and will continue to contribute to the body of knowledge on the biodiversity in the Pilbara, including flora, fauna, subterranean fauna and short range endemic surveys of the Project area.
11. Does the proposal increase greenhouse gas emissions?	Yes, marginally. A formal estimate of the Greenhouse consequences of implementing the project has been prepared.
12. Does the proposal involve acceptable levels of risk?	Yes, the Balla Balla Project is of low risk, and can easily be managed at an acceptable level.
13. Does the proposal have a secure foundation of scientific understanding of its impacts?	Yes, the ore, concentrate and groundwater have undergone chemical analyses to ensure understanding of their constituents. Scientific investigations have been undertaken in relation to flora, fauna, soils, ARD and Aboriginal heritage.
14. Does the proposal minimise the ecological footprint?	Yes, the Project is strategically located in close proximity to existing gas and power infrastructure and adjacent to the North-west Coastal Highway. Existing tracks have been used where practicable, and the existing Pilbara Gas Pipeline corridor has been identified for the slurry pipeline to Port Hedland to eliminate further disturbance.
15. Does the proposal avoid or minimise adverse impacts and promote beneficial impacts on the surrounding community?	Yes, the Project is currently exploring the options for employment of local people, with the facilities at Port Hedland and on-site. Local suppliers and contractors will be supported where commercially competitive. The Project avoids adverse impacts to residents, and vegetation and fauna communities by proposing to use existing access ways and transport corridors. The choice to pump rather than truck concentrate from site significantly reduces traffic impacts and dust generation to local residents. Access to recreational areas along the Balla Balla river will not be affected by the proposal.
16. Does the proposal produce	Yes, indigenous people and local pastoralists will benefit from better access in the

Question	Proponent's Response
sustainable net economic benefits?	area. Pastoralists will be benefit from potential improvements to fencing and water extraction infrastructure.
17. Does the proposal produce sustainable net social benefits?	Yes, there will be employment opportunities for local indigenous people where practicable, and direct and indirect benefits for the local communities.
18. Does the proposal add to heritage protection and provide a sense of place?	Yes, the Project has assisted identification of previously unknown Aboriginal heritage sites. Infrastructure, such as waste dumps and TSF footprint has been designed to avoid these sites.
19. Does the proposal produce net environmental benefits?	Yes, the Project has and will continue to contribute to the understanding of the biodiversity and ecology of the Pilbara area. Areas disturbed by the Project will be rehabilitated.
20. Does the proposal contribute to a more equitable and just society?	Yes, local communities and local indigenous people will have the opportunity to benefit either directly or indirectly from the Project.
21. Does the proposal interact positively with other likely developments?	Yes, FMA is a key member of the multi-user iron ore facility at Point Utah at the Port Hedland port. FMA is contributing to the construction of the facility to enhance export capabilities of the port. FMA actively works closely with its resource neighbours within the area.
22. Does the proposal provide new opportunities (social, economic or environmental)?	Yes, described throughout the table above.

Table 11 Sustainability principles

Principle	Objective	Action	Timing
Precautionary Principle	Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	• The Project will minimise impacts through appropriate design of facilities with a focus on limiting vegetation loss. • Detailed scientific investigations into existing environment to accurately assess potential impacts have and will continue for the Project Area. • Best industry practices will be applied throughout the design, construction and operational phases of the Project. • Preparation of management plans for key environmental factors will be developed prior to Project commencement.	During design, construction and operations.
Intergenerational Equity	The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	• Detailed investigations will occur into existing environment for reporting purposes and will become part of the environmental management plan. • FMA will employ ongoing management and monitoring of the surrounding environment where required, such as around the tailings facility perimeter. • Appropriate decommissioning and rehabilitation will be considered and developed throughout the Project, including progressive rehabilitation of the tailings embankment walls.	During design, construction and operations.
Conservation of Biological and Ecological Diversity	Conservation of biological diversity and ecological integrity should be a fundamental consideration.	• Investigations into terrestrial ecology will be commissioned as required. • A flora and vegetation assessment of the service corridor meeting the requirements of Guidance Statement (EPA 2004) will be completed prior to the start of ground disturbing works for pipeline installation. • Specific environmental management plans will be developed to ensure ongoing protection of biological and ecological diversity.	During design, construction and operations.
Improved Valuation, Pricing and Incentive	Environmental factors should be included in the valuation of assets and services.	• Environmental impacts are to be taken into consideration at all stages of the design, construction and operational phases. • Ongoing monitoring and assessment of the Project site will ensure contamination or environmental degradation is minimised by early identification and action. • As the port facilities include multiple users, all users are to contribute to the environmental management of the site.	During design, construction and operations.
Waste Minimisation	All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	• Appropriate facility design will be incorporated to minimise waste production during construction and operations. • Waste management plans for construction and for operations are to be developed and incorporated into an environmental management plan. • Waste management principles (avoid, reuse, reduce and recycle) have and will continue to be applied to the design of the Project.	During design, construction and operations.
Eco-efficiency	Producers of goods should aim to progressively reduce ecological degradation and resource use intensity to	• Water will be actively recycled to minimise groundwater demand. • Energy efficient principles have and will continue to be applied into the design of the Project, including gearless mill drives, gravitational process flows and	During design, construction and operations.

Principle	Objective	Action	Timing
	a level consistent with the sustainability of biodiversity and ecological systems.	solar hot water systems for the village. • Environment friendly greenhouse gas emission levels by eliminating concentrate trucking transport. • Comprehensive metallurgical testing to optimise the resource processing operations.	
Best practice and continuous improvement	When designing policies, systems, procedures or technologies for environmental management, best practice measures available at the time should be applied (EPA 2003). The implementation by everyone of environmental practices should aim for continuous improvement in environmental performance. This requires that not only are relevant laws and requirements met but also environmental protection should extend beyond compliance.	• Best practice philosophy has and will continue to be the target for the Balla Balla Project, including erosion and sedimentation BMP's, collation of previous design (for example, communication with PEL in regards to the gas pipeline engineering and construction) and exploring technical advances, such as gearless mill drives. • Environmental factors have and will play a major role in the Project decision making, waste dumps, tailings storage facilities etc, have all been located in accordance with environmental and social factors in mind. • Pollution impacts have been minimised with the elimination of concentrate trucking transport and tailings management.	During design, construction and operations.
Accountability and transparency	The aspirations of the people of Western Australia for environmental quality should drive environmental management. (1) Members of the public should therefore be given: (a) access to reliable and relevant information in appropriate forms to facilitate a good understanding of environmental issues; and (b) Opportunities to participate in policy and program development. (2) Environmental decisions should be made in a transparent manner and made public.	• FMA has and will continue to consult with relevant stakeholders. • FMA will estimate and report dust, plant, blast and exhaust emissions in the National Pollution Inventory submitted annually to the DEC. • FMA will continue to submit reports to the public in regards to performance and significant changes to the Project.	During design, construction and operations.
Shared Stewardship	The costs of environmental protection should be distributed equitably between the beneficiaries, including landholders, other users of that land, community interest groups and the general public.	• FMA will replace and upgrade Pastoralist infrastructure affected as a result of the Project. • FMA has begun alliances with contracting companies to create Indigenous training programs to the local communities.	During design, construction and operations.

6. ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1. Scoping of relevant factors

Scoping of the key environmental factors and objectives for the Balla Balla Magnetite Project was undertaken based on EPA guidelines and informal advice, stakeholder consultation and the experience of the proponent. The scoping process involved preliminary identification of environmental aspects and an environmental risk assessment to identify the key environmental factors associated with the Project. These key factors were then investigated in detail to enable an understanding of these factors predict impacts from the Project.

The key environmental factors relevant to the Balla Balla Project have been identified as:

- Flora and vegetation
- Terrestrial fauna
- Subterranean fauna
- Surface water and water quality
- Groundwater protection and
- Rehabilitation and closure

These factors have been addressed in **Sections 7 to 12**.

6.2. Minor environmental factors not further assessed

The scoping process also identified a range of minor environmental factors. These factors have been assessed but have not been addressed in detail. These factors are:

- Aboriginal Heritage
- European Heritage
- Air quality and greenhouse gases
- Landforms, geology and soils
- Waste rock and tailings
- Noise
- Visual amenity
- Waste management
- Public risk and safety

6.2.1. Aboriginal heritage

In the Pilbara region, the Aboriginal population comprises about 5,700 people, who live in towns and 37 scattered communities. This is 12 per cent of the total Western Australian Aboriginal population, the third highest proportion of Aboriginal people for any region in the State. The local native title claimant groups for the Project Area are the Ngarluma and Yinjibarndi.

Project objectives include:

- Ensure that the Project complies with the requirements of the *Aboriginal Heritage Act* 1972.
- Ensure that changes resulting from the Project do not adversely affect historical and cultural associations with the area.

Relevant legislation and standards include:

- *Aboriginal Heritage Act 1972.*
- EPA Draft Guidance for the Assessment of Environmental Factors No 41 (Assessment of Aboriginal Heritage).

The management and protection of Aboriginal heritage sites is to be implemented to avoid potential disturbance of ethnographic and archaeological sites. The Project, through extensive heritage surveys has located and will not disturb the Aboriginal heritage sites. FMA has endeavoured to design the Project around the heritage sites (most of which are scattered artefacts) and will ensure appropriate management measures are put in place to ensure the sites are not disturbed through the life-of-mine (LOM) of the Project. The AIC survey involved a combined archaeological and ethnographic survey. The fieldwork component of the survey with Ngarluma participants took place between 17 and 27 April 2006. The final survey report was produced in December 2007. The AIC survey report also reviews and summarises the results of two earlier surveys of the Project Area.

The AIC survey was comprehensive and involved the walking of transects with Ngarluma participants across the Project Area with the objective of identifying all of the potential heritage sites in the Project Area. The location of all sites has been recorded using a differential GPS which is accurate to within 3 metres or less. Buffer zones were identifed around all of the sites. FMA is aware of and acknowledges its obligations under Section 17 of the Aboriginal Heritage Act 1972 (AHA) to not in any way alter any of the sites without the Minister's permission under Section 18 of that Act. FMA will ensure the buffer zones are marked and if any impact on Aboriginal heritage sites is proposed, FMA will seek the Minister's consent under section 18 of the AHA. This would include consultation with the Ngarluma people.

FMA will ensure that prior to project construction earthworks in the vicinity of heritage sites, the sites are professionally re-surveyed at site identification level, to confirm their location and boundary. Ngarluma people will be invited to consult regarding these surveys.

FMA will also include in its' management plans the consideration of Aboriginal heritage sites that are outside the Project Area and a means to minimise potential for indirect impact on them. These indirect impacts could include:

- Dust from construction and land clearing;
- Water runoff or sediment eriosion;
- Noise and vibration (vehicles, construction, blasting);
- Fire;
- Waste management disposal;
- Risk from hazardous substances, explosives, fuel, oil and lubricants;
- Service corridors and visitor access; and
- Final rehabilitation.

None of the engraving heritage sites are located where blasting is likely to result in flying rock damage or other indirect disturbance. However specific management actions will be incorporated into a Cultural Heritage Management Plan to protect heritage sites from impacts by works associated with the Project.

FMA is committed to engaging a suitably qualified professional to develop the Cultural Heritage Management Plan, including the opportunity for indigenous stakeholders to be consulted about that plan and its contents.

FMA is committed to continued consultation with Traditional Owners regarding the management of those identified sites located both within and in close proximity to the Project activities.

If a subsurface site or artefact is found during construction, work in the area will immediately cease, and the native title claimant groups, Ngarluma and Yindjibarndi, will be advised of the find. The site will be avoided in all further work until it has been professionally assessed and, depending on the results of the assessment, approval sought under Section 18 of the Aboriginal Heritage Act 1972. Consultation will also be undertaken with the Ngarluma and Yindjibarndi people prior to the recommencement of work.

In addition, the archaeological and ethnographic survey of the Project Area conducted by AIC recommended that FMA continues with the Project and the following guidelines are used:

- A buffer of at least 50m is maintained from Salt Creek and Balla Balla River and 30m from any site, with the exception of ABB06 and ABB07 which have been requested to be avoided by 50m.

- FMA continue to consult with the Ngarluma and Yindjibarndi, people on any heritage matters concerning the Project.

- Should it become necessary to disturb any site, an application under Section 18 of the Aboriginal Heritage Act 1972 should be made. If this should be the case, any sites disturbed under Section 18 should be salvaged and Ngarluma and Yindjibarndi, representatives consulted.

- All FMA employees and contractors be made aware of their obligations under the *Aboriginal Heritage Act* 1972. FMA has been talking with local elders and the Ngarluma People regarding a heritage awareness programme to be conducted by Ngarluma people and incorporated into employee inductions.

FMA will further manage Aboriginal heritage sites by:

- Demarcation of sites requiring protection on Project site maps;
- Demarcation of sites requiring protection on-the-ground where required;
- Establish appropriate exclusion zones using signage and fencing where required;
- Implementation of a site induction programme that informs personnel of nearby sites, their legal obligations, and disturbance procedures; and
- The development of an Aboriginal Cultural Heritage Management Plan and supporting procedures.

Indirect impacts will be managed through FMA's AS/NZS ISO 140001:2004-compatible Environmental Management System (EMS) and supporting environmental management plans. Indirect impacts will also be managed through the works approval and licence issued under *Part V of the Environmental Protection Act 1986.*

6.2.2. European heritage

The objective of the Project is to ensure that the proposal complies with the requirements of the *Heritage of Western Australia Act 1990* and Commonwealth requirements.

A search of the Register of the National Estate Database, the State Register of Heritage Places, of the National Trust database, of the Shire of Roebourne Municipal Heritage Inventory and the Shire of Roebourne Municipal Heritage Inventory revealed no sites listed as occurring within the Project Area. No adverse impacts on European heritage are expected as a result of the proposal and no mitigation/management measures are required.

6.2.3. Air quality and greenhouse gases

Baseline air quality parameters are addressed in **Section 2.1.8**.

Particulates

The main source of atmospheric pollution associated with the Project will be dust. Airborne particulates may be generated from a number of sources and activities, including:

- Land clearing and construction activities;
- Blasting, handling, and haulage/conveying of ore and overburden;
- Crushing and grinding at the process plant;
- Wind erosion of ore stockpiles, tailings storages and waste landforms;
- Exhaust emissions from machinery and vehicles;
- Fugitive emissions of concentrate stored or handled at the Utah Point dewatering and export facility.

The closest potential receptors of airborne emissions from the Project include:

- Whim Creek Hotel, approximately 9.5km south east of the Project Area;
- Balla Balla Landing (boat launching area only – no residential or commercial occupancy), approximately 11.5km north of the Project Area;
- Whim Creek Copper Mine, approximately 10km south east of the Project Area;
- Sherlock Pastoral Station Homestead, approximately 19.5km south west of the Project Area; and
- Tourists and day-visitors who camp along the western banks of the Balla Balla River near Coorinjinna Pool, approximately 6km northeast of the Balla Balla mine-site

Dust suppression in high traffic areas including haul roads, access roads, around the plant and offices and other disturbed areas, will be undertaken with water carts, where required during construction and operations. Water used for dust suppression will be monitored periodically to ensure water quality, especially salinity, is acceptable for use. Vehicle, plant and generator exhaust emissions will be minimised through regular servicing and maintenance. All diesel machines will be scheduled for regular service and maintenance programs, and emissions will adhere to all relevant standards and regulations. As the slurry is pumped to Port Hedland in preference to trucking, vehicle emissions have been substantially reduced.

Dust generated during crushing, stockpiling and ore processing will be reduced by:

- Irrigated stockpiles on the ROM;
- A crusher, conveyor and crushed-ore stockpile irrigation system;
- Dust collection equipment;
- A slurry pipeline to the Port, eliminating concentrate stockpiling and trucking on-site;
- A partially covered conveyer system at the dewatering facilities; and
- Filtered cake moisture of 7 -10% to minimise the generation of airborne particles.

Other dust controls will include:

- Maintaining speed limits on roads and driving to conditions;
- Dust suppression by regular watering of roads and other high traffic areas with the water cart;
- Concrete flooring within the processing facilities;
- Site layout designed according to local wind rose information;
- Coarse tailings deposition;
- A multi-celled tailings facility to limit live tailings and beach lengths;
- Progressive rehabilitation of exposed/disturbed areas.

Personalised occupational sampling of respirable and inhalable dust will be undertaken to meet regulatory requirements. Plant emissions will be monitored and reported according to licence conditions and regulatory commitments.

Dust, plant, blast and exhaust emissions will be estimated and reported in the National Pollution Inventory submitted annually to the DEC.

Greenhouse Emissions

FMA aims to adopt energy efficient design and operational practices throughout its Balla Balla operation. The main energy using activities – those which dominate greenhouse gas emissions from the Balla Balla Project are:

- Operation of the processing plant and dewatering plant;
- Transport of product;
- Burning of fuels by vehicles and equipment during construction and operation.

The choice of a slurry pipeline to convey ore concentrate has been based, in part, upon energy use and greenhouse emission considerations. Other design features that will reduce energy consumption and greenhouse emissions include**:**

- The choice of gearless versus geared mill motor design for the SAG and Ball mills. Gearless motors enable the drives to be driven at variable speed (VSD), hence optimising speed to suit the situation (for example, the VSD will reduce speed when soft ore is fed into the SAG mill, thus reducing energy consumption). The VSD enables soft starts, instead of surging power. Published literature shows that gearless drives are more energy efficient than conventional dual pinion drives.
- Metallurgical investigations to obtain the coarsest grind sizing to minimise over-grinding and energy wastage.
- The addition of a cobbing (coarse wet magnetic separation) stage will reduce gangue (waste) material to the Ball mill by approximately 10%. Reduction of gangue to the mill will reduce the energy that would otherwise be used to mill non-valuable constituents.

- The site plant layout has been designed to maximise gravity flows, minimising pumping requirements.
- The port layout has been designed to minimise conveyor lengths to minimise energy requirements.
- The tailings facility is located within close proximity to the tailings thickener to reduce pumping to and from the TSF.

Further information on the greenhouse gas emissions estimates are provided in **Appendix F**.

6.2.4. Landforms, geology and soils

The environmental objective is to maintain the integrity, ecological functions and environmental values of landforms, geology and soils. The primary risk to these systems is acid generation from disturbed soil.

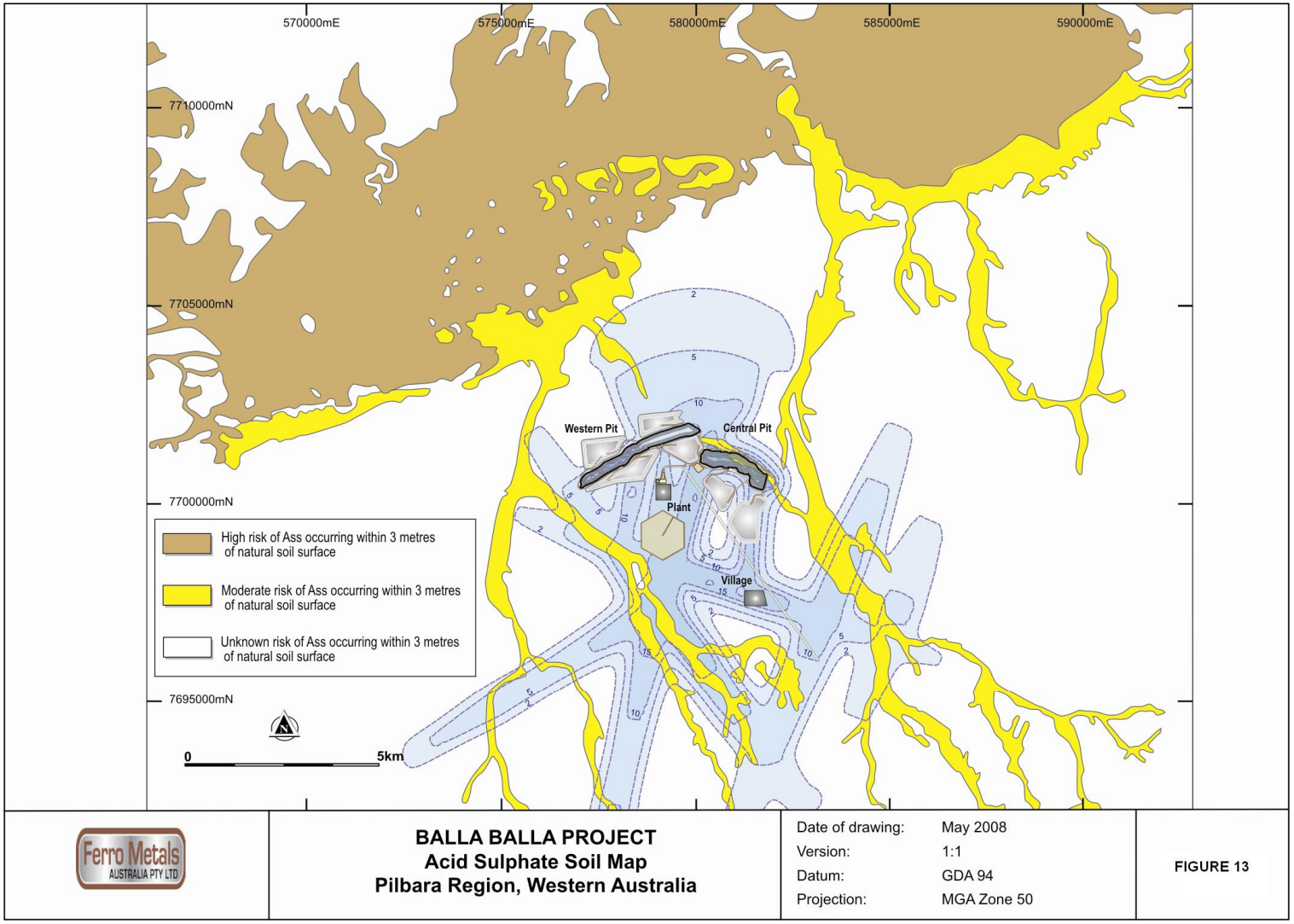
A desktop review was conducted by URS (URS, 2007) to determine the potential for acid sulphate soils within the mine-site area. The desktop review was conducted in accordance with the Acid Sulphate Soils Series Guidelines as adopted by the Department of Environment (2004). In addition, Mattiske and GRM (Groundwater Resources Management) completed acid sulphate soils indicator checklists while undertaking field work in the mine-site area.

The desktop review and field analysis both concluded that sulphate soils are unlikely to be encountered within the mine-site area. These findings are generally consistent with acid sulphate soil maps published by the Western Australian Planning Commission (May 2007), which provided the basis for mapping shown in **Figure 13.** Most of the pipeline corridor has been mapped as having no known risk of acid sulphate soils, however some sections of the corridor, mainly in the vicinity of major river crossings, have been mapped as having “moderate to low risk of ASS occurring within 3m of natural soil surface”. Testing for acid sulphate soils will be carried out in these areas as part of planned geotechnical investigations for the final pipeline design.

The main strategies proposed to manage the risk impacts associated with acid sulphate soils are:

- Manage dewatering and water abstraction so as to avoid changing the water table depth in areas of moderate to high acid sulphate soil risk;
- Adopt construction practices (use of horizontal directional drilling, use of piled or other low volume footing systems) that minimise excavation and related ground disturbance in areas underlain by soils having a moderate to high risk of acid generation;
- Conduct field sampling and laboratory/field testing on a representative number of soil samples before commencing ground disturbing works in any area mapped as having a moderate or higher level of ASS risk;
- Develop and work in accordance with an Acid Sulphate Soil Management Plan (Department of Environment, 2003 and 2006) in those parts of the project underlain by soils mapped as having a moderate or higher level of ASS risk.

Figure 13 Acid sulphate soil – Balla Balla locality



6.2.5. Waste rock and tailings

The objectives are to manage and minimise adverse environmental impacts from ore, waste rock and tailings materials and to ensure that post mining landforms are safe, stable, non-erodible, non-polluting and, as far as practicable, integrated into the surrounding environment.

Storage of waste rock and tailings in surface structures has a range of potential environmental impacts, including:

- Direct disturbance of vegetation and habitat;
- Release of sediments;
- Release of acidity/contaminants;
- Changes to groundwater levels (especially under the TSF);
- Interference with surface hydrology (*e.g.* shadow effects downstream, ponding upstream).

Geochemical testing (including over 12 months of kinetic testing on representative tailings samples) has generally found that the chemical characteristics of leachate from the tailings is benign and unlikely to give rise to environmentally detrimental concentrations of acidity, salts or metals. Seepage modelling has found that the likely rate of migration of any leachate from the TSF would be very slow, in the order of 4mm to 10mm depth of seepage per year. Therefore, it is unlikely that adverse environmental impacts will arise as a result of the surface storage of tailings. Nonetheless, FMA proposes to implement a programme of routine surveillance and monitoring of all surface storage of waste rock, tailings and ore in order to ensure that the Project is achieving good environmental outcomes:

- Surface runoff and seepage from waste rock storage areas, will be monitored and managed to limit any risk to the immediate and downstream environment.
- Electrical conductivity and pH of shallow groundwater will be monitored monthly in areas used to store/ stockpile waste rock and/or tailings. These parameters will be used as broad indicators to trigger more detailed monitoring, if required. In the event that the runoff or seepage pH is found to decline below 6.5 or the EC exceeds 0.3dS/m (300µS/cm), detailed analysis will be carried out.
- The further testing programme will include pH, EC, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), acidity / alkalinity, Al (total and soluble), As, Ca, Cd, Cr, Co, Cu, Fe (total and soluble), K, Mg, Mn, Na, Ni, Se, SO_4, V and Zn. These parameters will, in any event, be evaluated at least annually on filtered, acidified and unfiltered, non-acidified water samples recovered from monitoring bores surrounding the surface storages of waste rock and tailings.
- Revegetation/rehabilitation field trials will be completed for waste rock storage facilities during the operational phase of the Project. These trials will be done based on the Balla Balla rehabilitation strategy detailed in **Section 12**.

6.2.6. Noise

The Project objectives are to ensure that noise emissions, both individually and cumulatively, meet appropriate criteria and do not adversely impact on the social surroundings; and to ensure that noise impacts comply with statutory requirements. These include the *Environmental Protection Act 1986* and the *Environmental Protection (Noise) Regulations 1997*.

Apart from FMA's proposed ore dewatering facilities at Utah Point, the Balla Balla Project is generally located in a remote setting far from sensitive receptors. Potentially significant sources of noise at the Balla Balla mine site include:

- Blasting;
- Crushing, milling and processing; and
- Reversing alarms from mobile plant.

The nearest sensitive receptor outside the Project Area is the area along the banks of the Balla Balla River, approximately 6km to the northeast of the mine, which is sometimes used by tourists and other recreational users as a camping area. The proposed accommodation village for the mine is located approximately 2.5km from the Central and Western Pits and from the processing plant. In order to protect the amenity of recreational users of the Balla Balla River and of resident workers, all noise emissions associated with all mining and processing activities will meet the requirements of the Mines Safety and Inspection Act 1994, Mines Safety and Inspection Regulations 1995 and Environmental Protection (Noise) Regulations 1997.

6.2.7. Visual amenity

The environmental objective is to minimise impacts on the visual amenity of the area surrounding the Project. The mine and pipeline corridor are characteristic of the grassy, generally flat or undulating land of the north Pilbara coastal plain. In places, the landscape has been altered by pastoral uses, by infrastructure such as overhead powerlines and by proximity to transport routes including the North West Coastal Highway. The potential impacts from the Project are altered surface relief in the mine operations area. No significant visual impact along pipeline corridor (buried pipeline).

Proposed management actions:

- All practicable measures will be implemented to design and operate facilities to minimise impacts on visual amenity.

- At mine closure all buildings, roads and other structures/infrastructure (with the exception of the TSF, the pit voids, the underground slurry pipeline and the built landforms) will be removed and the area rehabilitated.

- Waste landforms will be designed to resemble (in scale and form) naturally occurring geomorphic features in the north Pilbara coastal region.

- The TSF and waste landforms will be rehabilitated to blend in with the pre-disturbance environment, to the extent that such an approach is compatible with a safe and stable landform.

Surface relief in the mine operations area will be permanently altered. However, once rehabilitation is complete, engineered landforms will be visually similar to naturally occurring geomorphic features in the region.

6.2.8. Waste management

The environmental objectives are to ensure that hazardous chemicals storage and usage does not adversely impact on the environment or public health and safety; and to minimise solid and liquid wastes produced as a result of mining, minerals processing and related activities. The intention is to use the waste hierarchy (i.e. avoid, reduce, reuse, recycle, treat, dispose) for waste minimisation.

Sources of solid and liquid waste generated from the Project include:

- Overburden, waste rock and tailings (discussed in **Section 8.4**);
- Inert structural waste;
- Domestic waste;
- Sewage;
- Fuels, lubricants and other hydrocarbons;
- Operational wastes, including batteries and tyres;
- Process reagents.

Waste minimization, reuse and recycling initiatives will be implemented where possible. Solid waste management will focus on:

- Avoiding the generation of waste;
- Reducing total waste volumes generated;
- Maximising recycling to promote efficient use of resources; and
- Disposing of waste products in a responsible manner.

Salvageable goods will be reused and recyclable materials including structural waste, scrap metals, poly-pipe, mill liners, 205 litre drums, paper, aluminium cans, printer cartridges *etc.* will be recycled where possible or disposed of to an approved on-site landfill facility.

Domestic waste

Domestic waste such as general refuse, green waste, paper and putrescibles will be disposed of to an approved on-site landfill facility. Where possible, recyclable wastes will be collected separately, stored and transported off site to a recycling facility.

Sewage

Sewage generated at the mine site, plant and accommodation area will be treated in a vendor-supplied sewage treatment plants. The sewage treatment system will be designed and operated to comply with the Shire of Roebourne and Department of Health regulations. The resulting treated effluent will be utilised in irrigating soils being treated at the hydrocarbon contamination treatment facility and/or used for haul road dust suppression, providing it can be shown to be of an appropriate quality. Otherwise, the effluent will be disposed of to leach drains. Greywater from the accommodation area will be used in irrigating garden areas.

Inert structural waste

Some inert waste, including concrete pads and footings, may be buried within the waste landforms at the time of decommissioning. All other waste and infrastructure will be removed at completion of the Project, unless determined and agreed to be significant for cultural and/or tourism value through appropriate dialogue with stakeholders.

Hydrocarbons and hazardous materials

All dangerous goods and hazardous materials including explosives and hydrocarbons will be handled, stored and used in accordance with the requirements of relevant legislation. Sources of potential hydrocarbon spills generated from the Project include:

- Machinery and vehicles;
- Fuel storage and dispensing areas;
- Power generation (during initial phases of the Project when diesel generators may be used for power supply); and
- Workshop/maintenance areas.

All hazardous and industrial wastes, such as oils, greases, lubricants, batteries and tyres, will be collected and stored separately in accordance with the site's DEC licence, before being collected by a licensed waste contractor for offsite disposal or recycling.

Controls will be implemented to prevent hydrocarbon contamination of the environment and to respond to hydrocarbon spills. These will include:

- Provision of appropriate bunding consistent with AS 1940:2004 (or any subsequent revisions of this standard) at fuel storage and dispensing areas;
- Interception and treatment of hydrocarbon-contaminated run-off prior to discharge;
- Routine inspections of workshops and fuel storage/dispensing areas by the site's environmental officer;
- Periodic inventory checks and reconciliation;
- Maintaining spill response capability and equipment.

The workshop supervisor and the site's management team will ensure that workshop procedures are followed and that they meet site standards and licence conditions. Waste hydrocarbons and hydrocarbon contaminated materials (including oil filters, rags, soil, recovery mats and litter etc) will be disposed of to an approved facility. Waste oil will be collected for recycling by a licensed contractor.

If an accidental spillage of hydrocarbons occurs the area will be immediately bunded to prevent spread of the hydrocarbon. All material capable of being collected will be placed in drums for transport to a recycling processor and the spill area deep ripped to promote aeration and breakdown of the material. If necessary, a bacterial oxidant or other activated remediation medium will be spread to assist hydrocarbon breakdown.

Other chemicals which may be used on site include modest quantities of degreasing or cleaning agents, corrosion inhibitors, lubricating agents and similar industrial chemicals conventionally found in heavy equipment workshops. Minor quantities of chemical reagents would be used in the package plants used for potable water treatment and septic waste treatment. The transport and use of hazardous chemicals and dangerous goods for the Balla Balla operation is unlikely to significantly impact the environment with appropriate management actions in place. Management of dangerous goods and hazardous substances will be addressed within the EMS for the Project.

Process reagents

The processing of magnetite ore is primarily a mechanical process, involving minimal use of process reagents. The reagents employed in mineral processing are non-hazardous liquid and solid flocculants to assist settling in the thickeners. An anionic polymer supplied in 25kg bags will be used for flocculation at the Balla Balla plant and port sites. The estimated usage rate of the reagent will be about 179kg/day for the concentrate and filter feed thickeners each and 608kg/day for the tailings thickener. The flocculant is consumed at a dosage solution strength of 0.25%. The storage tanks used to contain the flocculant solutions have individual volumes of about 71m^3. As the flocculant(s) exhibit a very low order of toxicity they are not classed as dangerous goods.

In the event that an oxalic to nitric acid solution is employed to automatically wash the dewatering filters, the mixing and storage facility will be designed and constructed to Australian Standards, with the chemicals held within a bunded area.

6.2.9. Public risk and safety

The Project will manage public health and safety by complying with EPA criteria and DoIR requirements to manage risk in respect to public health and safety. Risks from the Project arise from unauthorised access to mine or port operations areas, from increased heavy vehicle traffic and from access to the area after mine closure.

FMA will ensure that the social surroundings are not adversely affected by traffic activities arising from the Project; and that the public that risk is as low as reasonably practicable (ALARP) and complies with appropriate legislation and standards, including:

- EPA Guidance for Risk Assessment and Management: Off-site Individual Risk from Hazardous Industrial Plant No. 2 (2000);
- Australian Code of Practice for the Transport of Dangerous Goods by Road and Rail 1992;
- Dangerous Goods Regulations 1992; and
- Standards Australia AS/NZS ISO 14001 (1996).

At mine closure, safety bunding around mine pit will be maintained to limit access and ensure public safety.

7. FLORA AND VEGETATION

7.1. Description

The Project Area is located within the Fortescue Botanical District of the Eremaean Province (Beard 1990). The Eremaean Botanical Province is typified by plants from the families *Mimosaceae* (*Acacia* sp.), *Myrtaceae* (*Eucalyptus* sp.), *Myoporaceae* (*Eremophila* sp.), *Chenopodiaceae* (Samphires, Bluebushes, Saltbushes), *Asteraceae* (Daisies) and *Poaceae* (grasses). The Fortescue Botanical District covers over 175,000km^2 and comprises tree-steppe and shrub-steppe communities with *Eucalyptus* trees, *Acacia* shrubs, *Triodia pungens* and *T. wiseana.*

The Fortescue Botanical District, is divisible into nine different physiographic units (Beard 1975), and it is within one of these, the Abydos Plain, that the Project Area occurs. The Abydos Plain extends from Cape Preston in the south to Pardoo Creek, east of the De Grey delta in the north. To the east it is bordered by the Chichester and Gorge Ranges. The Project Area lies on the alluvial plains that parallel the coastline and primarily consist of red earthy sands with extensive areas of red earths and hard red soils along creek lines (Beard 1975).

Impacts currently affecting vegetation communities over the Project Area include altered fire regimes, cattle grazing and weed invasion. The Project Area is subject to frequent fire, with approximately one fire occurring every year. The area has historically been extensively grazed by cattle and *Cenchrus ciliaris* (Buffel grass) is widespread within the drainage systems. Four other weed species have been recorded in the mine-site area.

Two flora and vegetation surveys have been conducted over the mine-site area to date. Astron Environmental Services (Astron) conducted a flora and vegetation survey in November 2005. However, the vegetation survey occurred during the dry season so the ability to describe the vegetation of the Project Area and provide a comprehensive and reliable flora list was limited due to the senescence of ephemeral and many annual species. Therefore, a second flora and vegetation survey was conducted by Mattiske Consulting Pty Ltd (Mattiske) in June 2006. The Mattiske flora and vegetation survey was undertaken after one of the wettest periods in recent times in the Pilbara and the coverage of the flora was considered to be high. The Mattiske (2006) survey area, within which the mine-site area is located, covered leases M47/297, M47/312, M47/298, M47/360, M47/541, M47/311, M47/361, M47/804, G47/1229, L47/171 and L47/168, L 47/174, L 47/175 **(Figure 14).**

A flora and vegetation survey was conducted over the proposed pipeline corridor, including the several pipeline options at the western and eastern sections of the corridor, in April 2008 by Mattiske. These studies complemented earlier work conducted by Dames and Moore in 1993 as part of baseline studies for the Pilbara gas pipeline as a substantial portion of the Balla Balla pipeline corridor runs parallel to, and lies within (in close proximity to), the corridor of the Pilbara gas pipeline.

Copies of the three botanical studies conducted over the mine-site area and pipeline corridor are provided in **Appendix A**.

7.1.1. Vegetation types

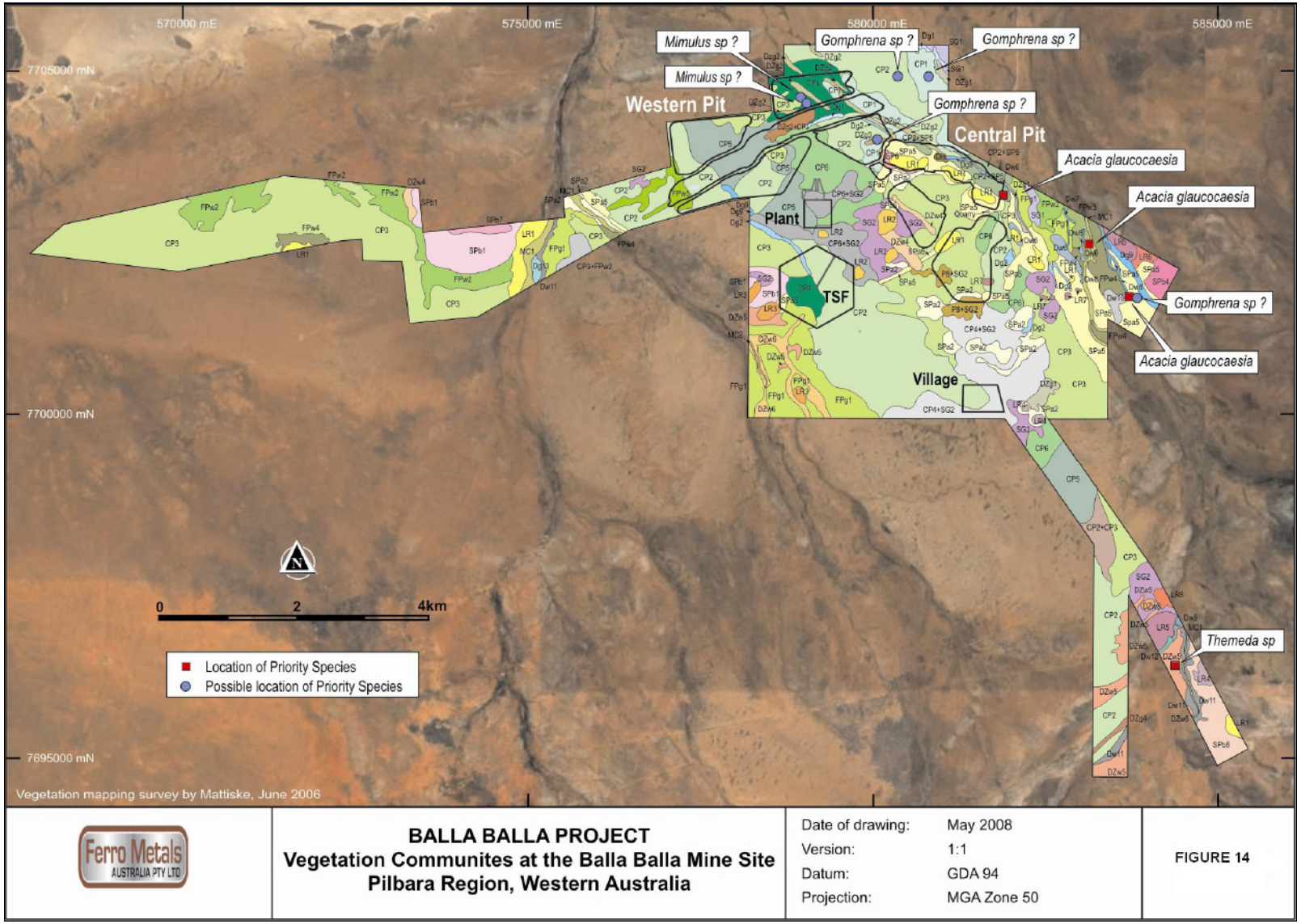
The Mattiske (2006) survey found a total of 50 vegetation communities (and seven mosaic communities) within the survey area, parts of which extended beyond the area proposed for mining and related operations **(Figure 14).** This includes the 41 communities that were defined in the previous survey by Astron (2005) and an additional 9 communities that were defined in the Mattiske survey in 2006.

Within the Project Area, Mattiske identified and mapped 31 vegetation communities (and five mosaic communities). All vegetation communities in the mine-site area are well represented in either the Horseflat land system or the Pilbara region generally. Mattiske concluded that, despite the use of the land for cattle grazing, the majority of the plant communities within the Project Area were in good condition, with minimal weed invasion or erosion.

Flora and vegetation surveys along the proposed pipeline corridor from Balla Balla to Port Hedland (Mattiske, a2008) found a total of 14 vegetation communities (**Appendix A**). These included eight different Hummock Grasslands communities of *Triodia* species with variable emergent stands of *Acacia* species and *Corymbia* species; one Woodland of *Eucalyptus camaldulensis* and *E. victrix* on major creeklines and river beds, three Tall Shrublands of *Acacia* species on variable sandy soils and two *Melaleuca* shrublands and woodlands on seasonal flats and flow lines. A further four mapping units defined for tidal flats, open estuarine water, mangroves and seasonal lakes. These latter units, to the extent that they fall within the proposed pipeline corridors, lie almost entirely within the PHPA area. These sections of the Project will be developed and managed by the PHPA as part of its proposed Utah Point development. As such, no additional disturbance to vegetation will occur as a result of the Balla Balla pipeline construction.

None of the pipeline corridor vegetation communities mapped by Mattiske in 2008 are listed by the DEC as TEC's. Also, none of the vegetation assemblages recorded along the proposed pipeline corridor were listed under the EPBC Act. The condition of vegetation along the pipeline corridor varied from completely degraded (in previously cleared areas) to degraded (grazed areas and those affected by weed infestation) to very good. Regular fires in the area have also had adverse impacts on vegetation along the pipeline corridor.

Figure 14 Mine site vegetation



Regional representation

The regional significance of the vegetation communities was determined by comparison with Van Vreeswyk et al (2004), Payne and Tille's (1992) description of the Horseflat land system, and Beard's (1990) broad vegetation mapping of Western Australia. According to Payne and Tille, the vegetation in the Project Area is relatively widespread both locally and within the Pilbara region along the coastal plains (Astron, 2005). The Horseflat land system is well represented from Regnard Bay to Balla Balla based on broad-scale surveys (Astron, 2005). At the more detailed survey level, Astron recorded similar vegetation associations within the Roebourne plains coastal grasslands during a vegetation survey conducted further to the west on Sherlock Station in 2004. These communities are considered to be in fair condition but the trend indicates their condition is declining due to grazing pressure, feral animals and exotic weeds (McKenzie et al, 2003).

Three vegetation communities considered 'locally significant' have been identified within the mine-site area. The major channel community (MC1) which is present along the two watercourses that run through the Project Area (Balla Balla River and Salt Creek) could be considered as 'locally significant' because a small population of priority species *Themeda* sp. Hamersley Station was recorded in this community. Similarly the MC1 community is poorly represented in the Horseflat land system (<1%) and provides habitat for fauna such as birds nesting in tree hollows. The woodland communities (DZw4 and DZw8) are located in the drainage zones and could be considered locally significant. These communities are not closely matched with the communities defined by Van Vreeswyk et al (2004); therefore their regional significance could not be attested (Mattiske, 2006).

Conservation significance of vegetation types

No Threatended Ecological Communities (TEC's) for Roebourne subregion (PILS) as defined by the EPBC Act or by the DEC were located in the any of the three surveys. However, Astron (2005) noted that the Roebourne plains coastal grasslands and Sherlock Station are both listed as "ecosystems at risk" and therefore a high priority for its conservation. The reservation status of vegetation on the Project Area, Beard Vegetation Code 629 "Mosaic: Short bunch grassland – savannah/grass plain (Pilbara)/hummock grasslands, grass steppe:hard *Triodia wiseanna* is classified as high – meaning there is currently none of this vegetation being protected by reserve, therefore its conservation value is similarily high (Astron, 2005).

The Clay Plains communities located in the Project Area (designated by CP prefix) support a few species in common with the Roebourne Plains coastal grasslands. The species in common include *Eragrostis xerophla* (CP2, CP3, CP4 and CP6), *Aristida contorta* (CP3 and CP6), *Chrysopogon fallax* (CP3), *Dactylocetenium radulans* (CP6), *Dicanthium serceium* subsp. *humilius* (CP2, CP3, CP4 and CP6) and *Sporobolus asutralasicus* (CP2, CP3, CP4 and CP6) (Mattiske, a2008). It could not be established with certainty whether the Clay Plains communities in the Project Area are PEC Roebourne Plains coastal grasslands, based on one or two common species as these communities have been subjected to grazing

and burning which has modified the range of species (Mattiske, a2008). These communities have been defined as tussock grasslands on gilgaied and non-gilgaied clay plains and are characteristic of the Horseflat land system. All vegetation communities are well represented in either the Horseflat land system or the Pilbara region (Mattiske, 2006). However, as part of the precautionary principle applied by FMA, following advice from DEC, Clay Plains communities CP1, CP2 and CP3 are discussed in **Section 7.5** in terms of the potential to PEC Roebourne Plains coastal grasslands.

Priority Flora

A search of the Priority Flora species list (CALM, 2005) was conducted by Astron (2005). The search indicated that two Priority Flora had been previously recorded within the Project Area. These are:

- *Gomphrena cucullata (P2). This* taxon is retricted to the Pilbara.
- *Acacia glaucocaesia (P3).* This taxon extends along the Pilbara coast up to the Kimberly coast, and inland. There are 11 known records.

A further seven Priority species are known to occur between Karratha and Port Hedland and could potentially be found in the Project Area:

- *Mimulus clementii (P1).* An annual herb that is a poorly known taxon;
- *Ptilotus appendiculatus var. minor (P1).* This taxon is known from one record near Boodarie;
- *Euphorbia clementii (P1).* This taxon occurs as scattered populations in the Pilbara area;
- *Gomphrena pusilla (P2).* This taxon is restricted to the Pilbara and known from 8 records;
- *Goodenia pascua (P3).* This taxon is restricted to the Pilbara and known from 27 records*;*
- *Abutilon trudgenii ms (P3).* This taxon is no longer a Priority species according to DEC2008a FloraBase; and
- *Gymnathera cunninghamii (P3).* This taxon occurs inland of the coast within the Pilbara region and also north and south of the Pilbara.

The Priority 3 species *Acacia glaucocaesia* was recorded in three vegetation associations during the Astron 2005 survey (**Figure 14**). These specific floodplain habitats are defined as:

- River flats between river branches with red alluvial silts;
- Low flat silty plains with some stone (dominated by hummock grassland); and
- Outer limits of flood plain and associated creek branch floodplain, with brown silts and stones.

However, *Acacia glaucocaesia* was not found during the Mattiske 2006 survey. During the 2005 survey, all of the shrubs were located east of the Balla Balla Road, in association with flood plains. Shrubs appeared to have regenerated with vigour on fire impacted flood plain areas (Astron, 2005). This species is known from some 32 records in the Pilbara and occurrences extend northwards and eastwards within

the Pilbara regions. This taxon is not under immediate threat from any developments associated with this Project (Mattiske, a2008).

Mimulus and *Gomphrena* genera recorded during the Astron survey could not be determined at species level as the specimens had senesced. This is because the Astron survey was undertaken during the dry season in November 2005. While it was possible to identify many plants without their flowering or fruiting organs, the die-off of herb species was seen as a major limitiation because this genera accounted for two Priority taxa for the Project Area (Astron, 2005). Therefore, it could not be determined whether this genus contained any Priority species. In response to this, FMA are committed to undertaking further targeted work after post-cyclonic rains to determine whether these Priority species can be located in the Project Area.

Themeda sp. Hamersley Station was found during the Mattiske 2006 survey in vegetation community MC1 **(Figure 14**) but not found during the previous Astron survey, possibly due to the dry conditions in November 2005. There are seven known records of this taxon which extends from the coast to the inland Pilbara region.

7.2. Potential impacts

Potential impacts of the proposal to flora and vegetation over the Project Area include:

- Direct clearance or disturbance of vegetation and flora;
- Disturbance to the 'locally significant communities' MC1 (drainage channel community), DZw4 and DZw8 (woodland communities occurring in drainage zones), Priority species; and potentially Roebourne Plains PEC;
- Impacts to riparian vegetation associated with modifications to site hydrology;
- Impacts to ground water dependant vegetation from potential changes to groundwater levels due to pit de-watering and groundwater abstraction;
- Effects of dust;
- Potential to introduce or facilitate the establishment of weeds and exotic species; and
- Secondary impacts, such as off-road vehicles and increased fire.

7.3. Project objectives

Project objectives include:

- Minimise adverse impacts on the abundance, species diversity, geographic distribution and productivity of plant communities.

- Protect Declared Rare Flora (DRF), consistent with the provisions of the *Wildlife Conservation Act 1950*.

- Protect flora listed under the Schedules of the EPBC Act.

- Minimise adverse impacts to other flora of conservation significance (e.g. Priority Flora species listed by DEC, undescribed taxa, range extensions, outliers).

7.4. Relevant legislation and standards

Environmental Protection Act 1986.

Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

Environmental Protection and Biodiversity Conservation Act 1999.

Wildlife Conservation Act 1950.

EPA Position Statement No. 2 (Environmental Protection of Native Vegetation in Western Australia, December 2000).

EPA Position Statement No. 5 (Environmental Protection and Ecological Sustainability of Rangelands in Western Australia), November 2004.

EPA Position Statement No. 9 (Environmental Offsets, January 2006).

EPA Draft Guidance Statement No. 19 (Environmental Offsets, June 2007).

EPA Guidance Statement No. 6 (Rehabilitation of Terrestrial Ecosystems, June 2006).

EPA Guidance Statement No. 51 (Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, June 2004).

7.5. Assessment of potential impact

Mine site area - direct clearance or disturbance of vegetation and flora

The proposal will result in clearing of a maximum 1010ha from a total of 3594ha within the mine-site. This represents 28% of the mine-site area. FMA has attempted to design the mine-site layout around minimising disturbance to significant local vegetation communities and Priority Flora where ever possible. Most clearing, including that for the pit, tailings storage facility, plant site, camp, and waste landforms will be of the tussock grassland vegetation communities which are widespread are well represented in the Horseflat System. While there is some debate on whether CP1, CP2 and CP3 are PEC Roebourne Plains grassland vegetation or the widespread hummock grasslands, these community types are well represented within the Project Area. Only 25% of CP1, CP2 and CP3 will be cleared for mining activities (refer **Figure 14**). Further avoidance could not be achieved because these communities are above the Central pit. Essential infrastructure such as the ROM pad and processing plant have been located on CP5 and CP6 which are not considered significant vegetation communities.

Estimated areas and percentages of vegetation communities affected by the clearing of vegetation at the mine-site are shown below in **Table 12.**

Table 12 Proposed vegetation clearing within mine-site area

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type Proposed Disturbance subtotal (ha)	Total Area Mapped (ha)	% of Area to be disturbed
CP1	Open tussock grassland (10-30%) of *Eragrostis xerophila* (dormant) with ephemeral grasses *Aristida contorta* and *Sporobolus australasicus* over low open herbland of *Gomphrena* sp. (dead).	30		90	33
CP2	Tussock grassland (30-70%) of *Eragrostis xerophila* and dense ephemeral *Dichanthium sericeum* subsp.*? humilius* grassland. Scattered herbs.	269		726	37
CP2+CP3	Mosaic.	4.7		29	16.5
CP3	Tussock grassland (30-70%) of *Eragrostis xerophila* with regular silty scalds with dense ephemeral grass *Dichanthium sericeum* subsp*. ? humilius* and *Aristida contorta* with ephemeral herbs and grasses.	139.5		882	16
CP4	Closed low ephemeral grassland (30-70%) of *Dichanthium sericeum* subsp*. ? humilius* withopen (10-30%) tussock grassland of *Eragrostis xerophila* and sometimes dwarf open shrubland (2-10% <0.5 m) of *Stemodia glabella* sometimes scattered *Acacia inaequilatera, Acacia bivenosa* or *Acacia pyrifolia.*	64		77	83
CP4+SG2	Mosaic.	19		158	12
CP5	Tussock grassland (30-70%) of *Eragrostis xerophila* and *Sorghum plumosum* and dense patches of *Dichanthium sericeum* subsp*. ? humilius* on scalds. Sometimes open (2-10%) dwarf shrubs of *Stemodia glabella*.	111		177	63
CP6	Mosaic grassland of *Eragrostis xerophila* and *Eriachne benthamii* on weakly to deeper gilgaied clays with *Aristida contorta* on large scald areas. There are scattered to open (<2 – 2.5%; 1.2 m) shrubs of *Carissa spinarum, Acacia inaequilatera* or *Acacia pyrifolia*.	72		138	52
CP6+SG2	Mosaic.	62		82	76
Tussock grassland on non- gilgaied clay plains.			***771.2***	***2360***	
Dg1	Open hummock grassland (10-20%) of *Triodia epactia* with patchy *Cenchrus ciliaris*. There are scattered (<2%) lianes (*Ipomoea muelleri*) and shrubs *Acacia farnesiana* and *Cullen lachnostaychs.*	2.9		6	48
Dg2	Mixed hummock and tussock grassland of *Triodia epactia* and *Eriachne benthamii* over open to scattered dwarf shrubland (<2-2.5%; <0.5 m) of *Stemodia glabella* over dense annual herbland of *Ptilotus murrayi* var. *murrayi*. Scattered *Acacia farnesiana* (and dead *Sesbania cannabina*).	4.7		16	29
Dg9	Mixed tussock grassland of *Eriachne benthamii* with patchy *Eragrostis xerophila* over ephemeral herbland of *Ptilolus murrayi* var. *murrayi*.	3.2		13	24

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type Proposed Disturbance subtotal (ha)	Total Area Mapped (ha)	% of Area to be disturbed
Shallow Drainage Lines - Grassed			***10.8***	***35***	
Previously disturbed		1.99	***2.0***	***2***	***100***
Dw11	Low woodland (10-30%; <10m) of *Corymbia h* over a scrubland (10-30%; 1-2m) of *Acacia tra* and/or *Acacia stellaticeps* over a mixed humm of *Triodia epactia* and *Triodia wiseana*.	3		27	10.5
Dw12	Low woodland (10-30%; <10m) of *Corymbia flavescens* and *Corymbia hamersleyana* over an open scrub (30-70%; >2m) of *Acacia holosericea* and *Acacia inaequilatera*.	0.33		1.6	21
Dw6	Tall shrubland (10-30% >2 m) sometimes heath (to 40%) of *Acacia inaequilatera, Acacia pyrifolia, Carissa spinarum,* with occasional *Dichrostachys spicata*, over mixed grassland of *Triodia epactia, Eriachne benthamii* and some *Cenchrus ciliaris* and *Cenchrus setigerus*. There are scattered (<2%) *Corymbia candida, Owenia reticulata* and *Eucalyptus victrix.*	2.3		15.6	15
Shallow Drainage Lines – Wooded			***5.6***	***44***	
DZg1	Tussock grassland (30-70%) of *Eriachne benthamii* with patchy *Chrysopogon fallax*, often over herbland (10-30%; <0.5 m) of *Centipeda minima.*	0.2		15.5	0.1
DZg2	Open dwarf shrubland (2-10%) or dwarf shrubland (10-30%; <0.5 m) of *Stemodia glabella* over open tussock grassland (2-10%) to dense (30-70%) *Eriachne benthamii* over annual herbland (10-30%) of *Gomphrena* sp.1 and *Centipeda minima*.	16		24	66
DZg2+CP3	Mosaic	13.5		13.5	100
DZg3	Annual grassland (30-70%) of *Dichanthium sericeum* subsp. *? humilius* (dead) over annual herbland (30-50%) of *Ptilotus murrayi* var. *murrayi* (dead). Can be scattered *Stemodia glabella*.	2.3		2.3	100
DZg4	Open heath (30-70%; 1-2m) of *Acacia ancistrocarpa* over a hummock grassland of *Triodia epactia*. Scattered *Acacia inaequilatera*.	0.3		4	7.5
Drainage Zones – Grassed			***32.3***	***59***	
DZw4	Open tall shrubland (2-10%) sometimes scattered (<2%) of *Carissa spinarum* with occasional *Acacia inaequilatera* over mixed hummock grassland of *Triodia wiseana* with *Triodia epactia.*	14		23	60
DZw5	Tall shrubland (10-30%; >2 m) of *Acacia inaequilatera, Dichrostachys spicata*, and *Hakea lorea* subsp. *lorea* over low shrubland (10-30%; 1-2 m) of *Acacia orthocarpa*, *Acacia ancistrocarpa* and *Carissa spinarum* over hummock grassland of *Triodia wiseana* and *Triodia epactia.*	6		68	9

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type Proposed Disturbance subtotal (ha)	Total Area Mapped (ha)	% of Area to be disturbed
DZw6	Open low woodland (2-10%; <10 m) of *Corymbia candida* and *Ehretia saligna* over tall shrubland (10-30%; >2 m) of *Acacia pyrifolia* with *Carissa spinarum* and *Acacia inaequilatera* over mixed tussock grassland of *Chrysopogon fallax*, *Cenchrus ciliaris* and hummock grassland of *Triodia epactia*.	1.2		39	3
DZw8	Low open forest (30-70%; <10m) of *Corymbia flavescens* over a tussock grassland (70-100%; <1m) of *Eulalia aurea* and *Eriachne flaccida* with scattered *Carissa spinarum*, *Acacia holosericea* and *Acacia ampliceps*.	0.5		2.5	20
Drainage Zones – Wooded			***21.7***	***132.5***	
MC1	Low woodland (10-30%; <10 m) of Eucalyptus camaldulensis over scattered to open shrubland (<2-5%) of Acacia trachycarpa and Acacia coriacea over tussock grassland of Cenchrus ciliaris.	0.1		32	3
MC2	Low woodland to low open forest (10-30%; <10 m) of *Eucalyptus camaldulensis, Acacia coriacea* and *Hakea lorea* subsp. *lorea* over shrubland (10-30%; 2 m) of *Carissa spinarum* and *Acacia pyrifolia* over tussock grassland of *Cenchrus ciliaris*.	0		2	0
Major Channels – low woodland			***0.1***	***34***	
FPg1	Hummock grassland of *Triodia epactia* with patches of tussock grasses *Eragrostis xerophila* with patchy *Eriachne benthamii* and *Chrysopogon fallax*. There are scattered but sometimes small thickets of *Acacia inaequilatera*, *Carissa spinarum* and *Acacia glaucocaesia*.	13.5		185	7
FPw5	Mixed open scrub (30-70%; >2m) of *Acacia inaequilatera*, *Acacia sclerosperma* subsp. *sclerosperma* and *Hakea lorea* subsp. *lorea* over grassland of *Aristida contorta* with patchy *Chrysopogon fallax*.	14		30	47
Floodplain - Mixed grassland and shrubland.			***27.5***	***215***	
LR1	Hummock grassland of *Triodia epactia* with some *Triodia wiseana*. There are very scattered <2% shrubs, *Acacia pyrifolia, Acacia inaequilatera* and herbs.	24		67	36
LR2	Scattered to very open low shrubland (2-5%; 1 m) of *Acacia stellaticeps* over hummock grassland of *Triodia wiseana*.	7		15	45
LR3	Low shrubland of *Acacia orthocarpa* and *Acacia ancistrocarpa* over hummock grassland of *Triodia wiseana*.	4.5		13	35
LR4	Hummock grassland (30-70%) of *Triodia wiseana* and *Triodia* sp.1 over annual herbland. There are scattered *Acacia inaequilatera* and *Carissa spinarum*.	0.2		8.5	2

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type Proposed Disturbance subtotal (ha)	Total Area Mapped (ha)	% of Area to be disturbed
LR5	Open low woodland (2-5%; <10 m) of *Corymbia hamersleyana* over tall shrubland (2-10%; 1-2 m) of *Grevillia pyramidalis*, *Acacia bivenosa* and *Hakea lorea* subsp. *lorea* over low shrubland (2-15%; 1 m) of *Acacia stellaticeps* over hummock grassland of *Triodia wiseana*.	1.7		26	6.5
LR7	Scattered to open shrubland (<2-5% <5 m) of *Ficus opposita, Ehretia saligna, Grevillea pyramidalis* over scattered dwarf shrubs of *Indigofera rugosa, Triumfetta appendiculata*, herbs and *Triodia epactia* hummocks.	0.7		3.5	20
Low Hill Rises with Hummock grassland			***38.1***	***133***	
Existing quarry		0.25	***0.2***	***0.3***	***96***
Spa2+SG2	Mosaic	9.3		22	42
SG2	Ephemeral low herbland of *Aristida contorta*, fringed sometimes by *Triodia wiseana* and very open herbland.	33		110	30
SP6	Hummock grassland (30-70%) of Triodia epactia with small thickets or stands of shrubland of Carissa spinarum	3.5		4	88
SPa2	Hummock grassland of *Triodia wiseana* and *Triodia* sp.1 over herbs. There are scattered *Acacia inaequilatera* and *Dichrostachys spicata.*	10.2		82	12
SPa5	Hummock grassland (30-70%) of *Triodia epactia* (sometimes 'open' (10-30%)) on stony scalds and recently burnt areas with scattered (<2%) *Acacia pyrifolia*, *Acacia farnesiana* and *Acacia glaucocaesia.*	36		205	18
SPb1	Open tall shrubland (2-10%; 2 m) of *Dichrostachys spicata*, *Acacia inaequilatera* over low shrubland (10-20%; 1 m) of *Acacia ancistrocarpa* over hummock grassland of *Triodia wiseana.*	10.8		95	11
Stony Plains grasslands and shrublands			***102.8***	**496**	
TOTAL (not including existing disturbed areas shown above)			**1010**	**3594**	

Pipeline corridor

The preferred pipeline corridor route was selected to provide the closest contact with the existing PEL pipeline corridor to mininimse impacts to undisturbed vegetation. Up to an additional 505ha of vegetation may be disturbed during construction of the slurry and water pipeline corridor (**Table 13**). This pipeline corridor consists of a 40m wide, 110km long corridor, as well as borrow pit and pipe laydown areas. A working width of approximately 40m is required during installation. This includes lay down areas for pipe delivery which will not be required as a continuous width cleared, but about every 800m. Most of the route would require approximately 6m of clearing one side of the trench for spoil and approximately 14m the other side for access, pipe joining and safe working conditions. It is not intended to clear the full 40m

corridor width. However, the full corridor width has been used in estimating disturbance and in assessing potential impacts.

Approximately 83% of the area within the proposed pipeline corridor lies within Hummock Grassland communities. A further 12% of the preferred pipeline corridor occurs within Tall *Acacia* Shrubland communities. The other vegetation types intersected along the preferred pipeline corridor include *Eucalyptus* woodland (~4%), previously disturbed land (~3%) and tidal flats (~1%). The area of "tidal flats" lies within the area proposed to be developed as part of the PHPA Utah Point development and does not represent additional disturbance arising from the Balla Balla Project.

Olearia dampieri was recorded on the northern flowline of the Yule River where the pipeline crosses the major creekline. According to Mattiske (a2008), a conservative approach should be taken with this specimen which would be to reconfirm the specimen held at Mattiske and then undertake further studies in the field following seasonal rains.

Table 13 Summary of estimated vegetation disturbance – Balla Balla pipeline

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type subtotal (ha)
A1	Tall Shrubland of *Acacia pyrifolia*, *Acacia dictyophleba*, *Acacia sclerosperma* and *Acacia trachycarpa* over subshrubs on sandy valley floors and floodplains.	34.20	
A2	Tall Shrubland of *Acacia bivenosa*, *Acacia pyrifolia*, *Petalostylis labicheoides* over *Triodia pungens* on minor gullies and flow lines.	5.12	
A3	Tall Shrubland of Acacia bivenosa, Acacia ampliceps, Acacia stellaticeps and Melaleuca glomerata over low shrubs including Frankenia ambita and Halosarcia species on clays and sandy-loams near estuarine areas.	18.81	
Tall Acacia shrubland subtotal			***58.13***
E1	Open Woodland of *Eucalyptus camaldulensis*, *Eucalyptus camaldulensis var. obtusa* and *Eucalyptus victrix* over a range of Acacia, Melaleuca and Tephrosia species on sandy creeklines and water courses.	21.73	
HG1	Hummock Grassland of *Triodia pungens* and *Triodia wiseana* on shallow clay soils and slopes of low undulating hills with emergent A*cacia bivenosa* and *Acacia pyrifolia.*	11.29	
HG2	Hummock Grassland of *Triodia pungens* on sandy and clay loam soils and extensive lower slopes and flats with emergent patches of *Acacia ampliceps, Acacia ancistrocar*pa, *Acacia arida*, *Acacia bivenosa*, *Acacia pyrifolia* and *Acacia stellaticeps* with range of low subshrubs.	138.90	
HG3	Hummock Grassland of *Triodia pungens*, *Triodia epactia* and T*riodia schinzii* on sandy and clay loam soils and extensive lower slopes and flats with denser patches of *Acacia ampliceps*, *Acacia ancistrocarpa, Acacia arida*, *Acacia bivenosa*, Acacia dictyophleba, *Acacia sericopylla*, *Acacia pyrifolia* and *Acacia stellaticeps* with range of low subshrub	190.46	
HG4	Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on sandy and clay loam soils and extensive lower slopes and flats with emergent patches of Corymbia species over *Acacia ancistrocarpa*, *Acacia arida*, *Acacia dictyophleba*, *Acacia sericopylla, Acacia pyrifolia* and *Acacia stellaticeps* with range of low subshrubs.	37.54	
HG5	Hummock Grassland of Triodia pungens on sandy and clay loam soils and extensive lower slopes and flats with emergent patches of dense Acacia ancistrocarpa, Acacia arida, Acacia dictyophleba, Acacia sericopylla, Acacia pyrifolia and Acacia stellaticeps with range of low subshrubs.	1.06	
HG6	Hummock Grassland of Triodia pungens and Triodia epactia with emergent Corymbia hamersleyana over Acacia ancistrocarpa, Acacia pyrifolia, Acacia stellaticeps, Ptilotus obovatus var. obovatus and Indigofera monophylla with range of low subshrubs.	4.74	

Vegetation Communities	Description	Approximate Area of Proposed Disturbance (ha)	Community type subtotal (ha)
HG7	Mosaic of mixed Grasslands dominated by a range of species including Eulalia aurea and Chrysopogon fallax and Hummock Grassland of Triodia pungens and Triodia epactia on sandy and clay loam soils and extensive lower slopes and flats with emergent patches of Acacia ancistrocarpa, Acacia bivenosa, Acacia pyrifolia and Acacia stellaticeps with range of low subshrubs.	20.27	
HG8	Mosaic of mixed Grasslands dominated by a range of species including Chrysopogon fallax and Hummock Grassland of Triodia pungens on sandy and clay loam soils and extensive lower slopes and flats with emergent patches of Acacia ancistrocarpa, Acacia bivenosa, Acacia pyrifolia and Acacia stellaticeps with range of low subshrubs.	14.79	
Hummock grassland subtotal			***440.78***
M1	Woodland of Melaleuca argentea to Tall Shrubland of Melaleuca glomerata over Crotalaria cunninghamii, Acacia pyrifolia and Cyperus vaginatus on fringes of sandy creek lines, water courses and flats.	5.78	***5.78***
D	Disturbed	16.06	***16.06***
MA	Mangroves*	0.56	***0.56***
OW	Open Water in Estuarine areas*	1.56	***1.56***
TF	Tidal flats*	3.55	***3.55***
TOTAL pipeline vegetation disturbance - not including areas within Port Hedland Port Authority Area, ha			**505**

Note: Vegetation types followed by an asterisk (*) lie within areas proposed to be developed by the Port Hedland Port Authority as part of its Utah Point development. These areas have been therefore been subtracted from the overall disturbance estimate.

Direct disturbance to 'significant communities' and Priority species

The Western pit will impact approximately 11ha of shallow drainage line grasses (Dg1, Dg2, Dg9). The Central pit will impact approximately 16ha of open dwarf shrubland (Dz2) which represents 66% of the total impact of this community within the Project Area. This community has not been identified as locally significant vegetation community by Mattiske during the 2006 survey. FMA will endeavour to avoid the clearing of significant vegetation communities on major drainage features. The most locally significant of these are MC1 and MC2. Only 2.9% of this vegetation community will be impacted due to an access road. MC1 is particularily significant as this is where the Priority 3 *Themeda sp* was located. There will be no direct disturbance of *Themeda sp* by the access road.

Gomphrena sp. was recorded in five associations (refer **Figure 14**) during the Astron 2005 survey. Three locations were recorded in shallow drainage line communities and two in the Clay Plains communities. *Mimulus sp.* was recorded in two drainage zones during the same survey. Neither species was recorded during the Mattiske survey in 2006. Although both these genera were recorded, both had senesced so

could not be positively identified to species level. Two of the communities that recorded *Gomphrena sp.* during the Astron survey will be impacted by mining (refer **Figure 14**). Astron recorded both species in low-lying drainage zones with weakly-gilgaied dark brown clays. Astron noted that this area was well grazed and had heavy cattle usage. FMA will undertake further targeted work to locate *Mimulus* sp. and *Gomphrena* sp. post-cyclonic rains to determine whether the species is Priority listed, if found FMA will consult with the DEC to determine appropriate management measures to be incorporated in the Ground Disturbance and Rehabilitation Management Plan. There are currently only eight known occurrences of *Gomphrena pusilla* and it is restricted to the Pilbara; the Balla Balla occurrence could also be *G. cucullata*, of which there are four records.

Approximately 13.82ha of the woodland vegetation community DZw4 (60%) and 0.5ha of woodland vegetation community DZw8 (20%) may be impacted as a result of the Project. DZw4 will be impacted by the TSF, central south dump and access road. DZw8 could be considered locally significant because it is restricted to one isolated population in the study area and is floristically different to the other communities defined. The access road will cross a portion of Dzw8 which could not be avoided. In developing the mine-site layout, every attempt was made to minimise the disturbance of these communities.

The three different associations that recorded *Acacia glaucocaesia* **(Figure 14)** will not be impacted by the Project footprint. However, further targeted surveying will occur prior to construction of the drainage ditches to determine whether the species has returned since last surveyed by Astron (2005). The previous known locations identified range from between 30 m to 2 km away from the proposed diversion ditch to the north of the Project.

The *Themeda sp.* Hamersley Station located in vegetation community MC1 by Mattiske (2006) is located adjacent to the existing access road. This is outside the defined mine-site disturbance area and therefore will not be directly impacted by the Project.

Impacts to riparian vegetation associated with modifications to site hydrology

The Project has the potential to impact riparian vegetation both within the mine-site and pipeline corridor. Several major and shallow drainage lines in the Project Area support *Corymbia hamersleyana* which are surface water dependant rather than ground water dependant. *Corymbia sp* can be found at Salt Creek and the Balla Balla River (MC1) and the more shallow drainage lines associated with upstream Balla Balla River. The flood diversion works required for the Balla Balla Project are unlikely to result in hydrological changes that will affect riparian vegetation either upstream or downstream of the Project. Similarly, the hydrogeological modelling conducted as part of baseline studies has concluded that the extent of the groundwater drawdown cone is unlikely to result in significant reductions in the amount of water available to riparian systems along the Salt Creek or Balla Balla River. The depth to groundwater in the immediate vicinity of the mine pits is likely to be significantly and permanently altered, however the vegetation in that part of the Project Area does not include species that are recognised as phreatophytic.

The impact of dust during construction and operational phases can locally impact vegetation communities primarily by smothering of vegetation.

Groundwater dependant vegetation

The groundwater modelling described in further detail in **Section 10** suggests that with no recharge, over 5 years, the drawdown along most of the length of the Balla Balla River would be generally less than 2m and that the drawdown along Karinha and Salt Creeks would be generally less than 5m. Riparian vegetation along the Balla Balla River (to the east of the proposed mine pits) or along Salt Creek (to the west of the proposed mine pits) could be adversely affected by lowering of the water table. Specifically, there is a risk that the health of River Red Gums (*Eucalyptus camaldulensis*) along water courses could suffer if prolonged, excessive groundwater drawdowns occur or if the rate of decline in groundwater levels is very rapid. River Red Gums obtain water from three main sources; ground water, rainfall and river flloding. It is river flooding which enables the species to survive in semi-arid areas (CSIRO, 2004).

Hydrogeological modelling suggests that any variation in groundwater levels near the parts of the Balla Balla River which support riparian vegetation will not adversely affect groundwater dependent species, as the magnitude of change in groundwater levels matches the scale of normal seasonal variation in the depth to groundwater. Groundwater level rises in response to rainfall recharge can be significant and were measured by FMA at a number of bores between December 2005 and September 2006 (GRM 2008). The measured rises over this period ranged from 0.6m to 5.5m after a total rainfall of 774mm (GRM 2008). Assuming that the scale of these rises is within the bounds of normal yearly fluctuations, local vegetation communities are presumably adapted to tolerate this rate and magnitude of groundwater fluctuation. Thus, a drawdown of 5m over 5 years is not considered an unreasonable threat to the health of riparian vegetation.

There are no clear guidelines available on what magnitude of drawdown, or what rate of change in water table levels are likely to be tolerated by River Red Gums and other groundwater dependent vegetation. Given this, and the uncertainty associated with hydrogeological modelling, FMA will closely monitor the health of these communities and the adjacent groundwater levels in consultation with DEC and DoW.

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

Weed invasion at the mine-site area is currently considered minimal (with the exception of the aggressive *Cenchrus* spp.). Only five weed species were identified during baseline vegetation studies in the Project Area (*Cenchrus ciliaris*, *C. setigerus Aerva javanica, Malvastrum americanum,* and *Melochia pyramidata*) (Mattiske Consulting, 2006; Astron Environmental Services, 2005). The potential to introduce, or exacerbate the effects of, weeds species is likely to increase with an increased human presence and greater vehicle movements over the Project Area. Weeds will be managed in accordance with the weed management strategy detailed in the Ground Distrubance and Rehabilitaton Management Plan.

Secondary impacts, such as off-road vehicles and increased fire.

An increased human presence over the Project Area has the potential to cause secondary impacts as a result of off-road vehicle use (spinifex communities are particularly susceptible to vehicle damage and may take many years to recover) and increased fire.

7.6. Management and mitigation

Mine site area

Further targeted seaches will be undertaken to determine whether any Priority Flora communities occur within the Project Area.

All clearing of vegetation over the mine-site area will be kept to a minimum, and clearing boundaries will be well defined. Creek line systems in general will be avoided.

Both topsoil and cleared vegetation will be stockpiled and returned to landforms and disturbed areas during rehabilitation earthworks. To the extent practicable, the area will be contoured to resemble the naturally occurring terrain in the north Pilbara coastal plain, although parts of the mine operations area will necessarily have a different landform to the pre-mining topography. Local provenance seed material will be used for seeding in rehabilitation works. Progressive rehabilitation of disturbed areas will be implemented with the aim of attaining a resilient and ecologically functional system as soon as possible. Livestock will be excluded from new rehabilitation areas. Additional discussion of decommissioning and rehabilitation works of the Balla Balla Project is provided in **Section 12**.

The vegetation in the Project Area is expected to have some tolerance for dusty conditions given the area routinely exceeds the NEPM standards for fine particulates (DoE, 2004). Standard dust management practices will be adopted to ensure that excessive amounts of dust are not generated along haul roads, in the vicinity of the plant or near the waste landforms and TSF.

Vehicles will be prohibited to traverse ‘off-road’ without appropriate authorisation and disturbance to flora and vegetation communities will be avoided where ever practicable. Prevention of fire over the Project Area will be a key priority for FMA operations, especially in consideration of highly flammable spinifex vegetation and the impact of frequent fire on habitat quality. A fire prevention and management strategy will be implemented to exclude fire from the Project Area. A regional approach will be adopted for fire management and suppression in liaison with neighbours, including the local pastoralist and DEC, and FESA.

An induction and ongoing education program for FMA staff will reinforce awareness of flora protection and all staff will be trained in the prevention and management of fire.

If earthworks are required to take place in areas with existing weed populations, precautions will be taken to prevent weed contaminated material being transported to uncontaminated areas. Material containing weeds will not be used for rehabilitation, and machinery operating in areas of known weed contamination will be cleaned before leaving the area.

If significant populations of weeds are identified during mine operations spot spraying with Glyphosate (herbicide) will be undertaken with a backpack spray device. The services of a contractor for weed spraying may be employed if weed populations become too large to effectively manage and/or they threaten vegetation success on rehabilitated areas. This weed control program will be maintained throughout the life of the operation.

An induction and ongoing education program for FMA staff will reinforce awareness of procedures to prevent and control the spread of weeds.

Pipeline corridor

Prior to excavation, vegetation and topsoil will be removed from the corridor and stockpiled separately, adjacent to the source. Important habitat trees will be marked and avoided where feasible. The trench excavation and surrounding work areas will be progressively reinstated during pipeline construction. The only areas that will remain unrehabilitated at the end of construction will be minor areas required as access tracks for use during pipeline inspections and maintenance (approximately 10m wide). About 130ha of the easement will remain permanently cleared of all tall trees and shrubs to accommodate pipeline access and infrastructure.

Before excavation, topsoil and root material will be stripped to an appropriate depth (usually between 15cm and 30cm) and windrowed for later use in revegetation. Up to 15km of topsoil will be removed in front of the trenching, and up to 20km of trench will be open for pipe-laying and backfilling activity at any one time. The progressive nature of the pipeline construction schedule means the area of active disturbance will be limited (PEL, 1993). Revegetation along the pipeline corridor will closely follow construction, to minimise the barrier effects. The pipeline will not encroach on any National Park or existing or proposed conservation reserves recommended in the Conservation Reserves Western Australia – Systems, 4,8,9,10,11,12 (EPA, 1975).

7.7. Predicted outcomes

Two types of local significant woodland drainage vegetation will be impacted by the Project. Approximately 13.82ha (60%) of the woodland drainage vegetation community DZw4 and 0.5ha (20%) of woodland vegetation community DZw8 will be impacted. The three different associations that recorded *Acacia glaucocaesia (P3)* in the 2005 survey but not recorded in the 2006 survey will not be impacted by the project footprint. The *Themeda* sp. Hamersley Station located in vegetation community MC1 by Mattiske (2006) is located adjacent to the existing access road outside the defined mine-site disturbance

area, and therefore will not be directly impacted by the Project. FMA will undertake a targeted search of *Gomphrena* sp. and *Mimulus* sp. post cyclonic rains to determine whether these Priority species have returned to the Project Area since last recorded in 2005.

All of the habitat types affected by the pipeline are common and widely distributed across the Pilbara in comparison to the area of disturbance. No Priority Flora or Threatened Ecological Communities have been found along the pipeline corridor. It is considered that direct loss of vegetation through clearing for construction and operation of the pipeline corridor will not have a significant impact on vegetation, as the disturbance is narrow in extent and will be promptly rehabilitated in accordance with the Rehabilitation Strategy detailed in **Section 12.**

8. TERRESTRIAL FAUNA

8.1. Description of factor

Ten main fauna habitats were recognised within the Balla Balla Project Area and pipeline corridor, and the 'low woodland over shrubland along major drainage lines' habitat as described by Bamford (2006, 2008), was considered significant due to its restricted occurrence within the study area and the large number of fauna expected to utilise it, particularly for breeding purposes.

Fauna surveys were undertaken in the Project Area in 2006 and and along the pipeline corridor in 2008. Both the mine-site and the infrastructure corridor were assessed using an extended site inspection approach, which falls somewhere between a Level 1 and a Level 2 assessment as described by DEC guidelines (Bamford, a2008). The extended site inspection approach focuses on identifying significant species, habitats and ecological processes that may be impacted by a proposal. The inspections identified 67 significant species which may occur (at least occasionally) in the study areas. The species of conservation significance included:

- Conservation significance 1 (Species listed under State or Commonwealth Acts) – 43 species;
- Conservation significance 2 (Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by the DEC) – 10 species;
- Conservation significance 3 (Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution. This level of significance may contribute to the preservation of biodiversity at the genetic level (EPA 2002)) - 4 species.

The species of conservation significance which may occur in the Project Area (including the pipeline corridor) are listed in **Table 14.**

Impacts currently affecting fauna communities over the Project Area and pipeline corridor include:

- Altered fire regimes,
- Degradation of habitats as a result of cattle grazing and weed incursion, and
- Predation by exotic species such as the fox and cat.

The fauna in the Project Area has probably suffered local extinction of mammal species due to predation by foxes. The effect of cats is uncertain (M.J. and A.R. Bamford, 2006).

Table 14 Fauna of conservation significance

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
Mammals							
Northern Quoll (*Dasyurus hallucatus)*	*Schedule 1*		Endangered		X	X	This species is often associated with rocky areas in the Pilbara but also occurs along watercourses and therefore may be present in the Project Area. This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.
Lakeland Downs Mouse (*Leggadina lakedownensis)*		Priority 4			X	X	Populations of the Lakeland Downs Mouse appear to fluctuate dramatically, probably in response to environmental conditions and food availability. The Pilbara subpopulation, which may represent a distinct taxon (Strahan, 1995), has a preference for sandy and cracking clay/gilgai soils (M. Bamford, pers. obs.). This habitat is well represented both inside and outside the Project Area.
Mulgara (*Dasycercus cristicauda)*	*Schedule 1*		Vulnerable			X	This species is often associated with rocky areas in the Pilbara but also occurs along watercourses. No evidence of the species was found during baseline fauna studies but some suitable habitat was present in the general locality, notably in

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
							the low hills near Whim Creek (these are unlikely to be impacted by the proposal).
Bilby (*Macrotis lagotis)*	*Schedule 1*		Vulnerable				Extant populations of this species are restricted to a variety of "tall shrublands, open woodlands...hummock grassland and sparse forb-lands" (Maxwell et al, 1996). Some scattered populations occur across the northern Pilbara, including close to Port Hedland. No evidence of the Bilby was found during baseline studies for the Balla Balla project, but suitable habitat was present in parts of the pipeline corridor, notably in the dense *Acacia* on sandy plain habitat.
Spectacled Hare-wallaby (*Lagorchestes conspicillatus)*		Priority 3				X	Within Western Australia, this species is now restricted to a few small isolated patches in the Pilbara and Kimberley. No evidence of the species was found during baseline studies. Grazing in the area and frequent fires may reduce the suitability of habitat for the species.
Ghost Bat (*Macroderma gigas)*		Priority 4				X	This species was not located during baseline fauna surveys and no caves or old mines suitable for roosting were found in the Project Area or along the pipeline corridor. Despite this, individuals may over-fly the area.

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
Orange Leaf-nosed Bat (*Rhinonicteris aurantius)*	*Schedule 1*		Vulnerable			X	This species was not located during baseline fauna surveys and no caves or old mines suitable for roosting were found in the Project Area or along the pipeline corridor. Individuals may over-fly the area or may use tree hollows for roosting during the wet season.
Common Brushtail Possum *(Trichosurus vulpecula)*				✓		X	Although this species can occupy a range of habitats, it is considered unlikely to be present in the pipeline corridor.
Western Pebble-mound Mouse (*Pseudomys chapmani)*		Priority 4				X	This species generally occurs on the lower slopes of rocky hills, where it uses small stones to build its distinctive mounds (Strahan, 1998). The low hills near Whim Creek appeared to be suitable habitat but no mounds were present. Old mounds persist so it may be that the species is absent from the area and has not occurred there in recent decades.
Birds							
Great Egret (*Ardea alba)*			Migratory (JAMBA/CAMBA)		X	X	This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
Marsh Sandpiper (*Tringa stagnatalis)*			Migratory (JAMBA/CAMBA)		X		This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.
Common Greenshank (*Tringa nebularia*			Migratory (JAMBA/CAMBA		X		This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.
Wood Sandpiper (*Tringa glareola)*			Migratory (JAMBA/CAMBA		X	X	This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.
Common Sandpiper (*Tringa hypoleucos)*			Migratory (JAMBA/CAMBA)		X	X	This species may occur occasionally as a seasonal visitor around riverine habitats within the general Project locality.
Oriental Pratincole (*Glareola maldivarum)*			Migratory (JAMBA/CAMBA)		X		This is an aerial species that occurs largely independent of terrestrial habitat types and is expected to over-fly the Project Area without specifically utilising any habitat present.

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
Fork-tailed Swift (*Apus pacificus)*			Migratory (JAMBA/CAMBA)		X	X	This is an aerial species that occurs largely independent of terrestrial habitat types and is expected to over-fly the Project Area without specifically utilising any habitat present.
Rainbow Bee-eater (*Merops ornatus*			Migratory (JAMBA/CAMBA)		X	X	The Rainbow Bee-eater is a federally-listed migratory species, migrating between Australia and north to the southern islands of Japan. At least some birds are resident in northern Australia so the species may occur in the Project Area throughout the year. It occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. Due to the broad habitat tolerances of this species, and the fact that it is common in the bioregion, the proposal is unlikely to significantly impact this species. The observation during the survey was an opportunistic one involving a single bird overflying the area.
Peregrine Falcon (*Falco peregrinus)*			Migratory		X	X	This species occurs in a variety of habitats and may breed in the study area, possibly utilising tree hollows in the riverine habitat (Johnstone and Storr, 1998).
Grey Falcon (*Falco*	Schedule 4				X	X	This species appears to have a distribution centred around drainage lines and may breed in the study area, utilising old

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
hypoleucos)							nests of other species situated in the tallest trees along the river systems (Garnett and Crowley, 2000).
Australian Bustard *(Ardeotis australis)*		Priority 4			X	X	This species is associated with a variety of grassland, grassy woodland and shrubland habitats. These habitats are well represented both within and outside the Project Area.
Bush Stone-curlew (Burhinus grallarius)		Priority 4			X	X	In the Pilbara, the Bush Stone-curlew is often associated with woodlands and shrublands along watercourses (M. Bamford, pers. obs.). Although it was not recorded during the site inspection, suitable habitat is present along the riparian systems within the study area.
Star Finch (*Neochmia ruficauda)*		Priority 4			X	X	This species may frequent the woodland and grassland habitats near water within the Project Area. Some suitable habitat is present along the larger watercourses. Any changes to stream flows could be a concern for this species.
Osprey (*Pandion haliaetus)*			Migratory			X	Mainly frequents tidal environments, possibly including coastal area that lie nearby but outside the Project Area.
White-bellied Sea Eagle			Migratory			X	Mainly frequents tidal environments, possibly including coastal area that lie nearby but outside the Project Area.

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
(*Haliaeetus leucogastar)*							
Night Parrot (*Pezoporus occidentalis)*	*Schedule 1*		Vulnerable			X	This is a poorly known species, unlikely to occur in the Project Area or along the pipeline corridor.
Rufous-crowned Emu-wren (*Stipiturus ruficeps)*				✓		X	This species is patchily distributed in the Pilbara and has declined in some areas. Some suitable habitat is present in the Project Area, although it is not certain if the species is present. The development is unlikely to affect this species unless it results in an increase in fire frequency
Striated Grasswren (*Amytornis striatus)*				✓		X	This species is patchily distributed in the Pilbara and has declined in some areas. The Grasswren is associated with spinifex, particularly if tall, dense and long-unburnt. Some suitable habitat is present in the Project Area, although it is not certain if the species is present. The development is unlikely to affect these species unless it results in an increase in fire frequency
Reptiles							
A skink lizard *(Ctenotus*				✓	X		The skink appears to have restricted distributions. The skink has a number of small sub-populations along the western and

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
rufescens)							northern Pilbara coast, and is associated with "red sand dunes and adjacent (clayey) flats vegetated with spinifex" (Wilson and Swan, 2003; Storr *et al.,* 1999). Suitable habitat for this species is widespread both within and outside the Project Area.
A blind snake *Ramphotyphlops pilbarensis*				✓	X		The blind snake is noted as occurring where there is shrubland over spinifex in the catchment of the Yule and De Grey Rivers (Wilson and Swann 2003).
A skink (*Notoscincus butleri)*		Priority 4		✓		X	This species has a restricted range along the coastal area of the Pilbara, commonly occurring in spinifex dominated areas adjacent to riparian habitats (Wilson and Swann, 2003). It is almost certainly present habitats along the pipeline corridor.
A skink (*Lerista quadravincula)*		Priority 1				X	This skink is known only from a site south-east of Karratha so may not be present in the Project Area. The only information on the site where it has been found is that it is "arid northwest coastal plain" (Storr *et al.* 1999), which describes much of the Project Area and pipeline corridor.
Woma (*Aspidites ramsayi)*						X	Within the Project Area, however, the northern population is at the western limit of its distribution. The species can therefore be considered of local conservation significance. The Woma

	Classification under *Wildlife Conservation Act* 1950	DEC Conservation Category	Classification under EPBC Act 1999	Local Significance ?	Possible inhabitant or visitor to habitats recorded during baseline studies?		Occurrence
					Mine-site area	Pipeline corridor	
							is most likely to occur in areas of sandy soils.
Pilbara Olive Python (*Liasus olivaceus barroni)*	Schedule 1		Vulnerable			X	According to Kendrick and Stanley (cited in McKenzie *et al*. 2002), this subspecies is not threatened or likely to be, but is widespread, common, not declining and therefore shouldn't be listed. This subspecies is often recorded near waterholes (Wilson and Swann, 2003). Although not observed during baseline fauna studies, it is expected to occur within the rocky hills and gullies that border the Project Area to the south.
Amphibians							
Glandular (Toadlet *Uperoleia glandulosa)*				✓	X		The Glandular Toadlet has a restricted distribution within the northern Pilbara. It is probably associated with rocky areas so may not occur within the study area.

Notes:

1. Species of conservation significance which may frequent habitats of the kind found in the study area have been listed (see **Appendix G** for further details). Not all of the habitats in the wider study area are found within the defined Project Area.
2. Western Australia *Wildlife Conservation Act 1950*
   Schedule 1 Fauna which is rare or likely to become extinct.
   Schedule 2 Fauna which is presumed to be extinct.
   Schedule 3 Birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
   Schedule 4 Fauna in need of special protection that is not listed in Schedules 1, 2 or 3.
3. Western Australia Department of Conservation and Land Management (CALM – now part of DEC) Priority List.

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	Taxa in need of monitoring.

4. Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Critically endangered	A native species is eligible to be included in the extinct category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Migratory	CAMBA - The China Australia Migratory Bird Agreement; JAMBA - The Japan Australia Migratory Bird Agreement.

8.2. Vertebrate fauna species and habitat

Mine-site

The key results of baseline fauna studies carried out for areas near the proposed mine operations area at Balla Balla are summarised below.

The extended site inspection recorded 62 vertebrate fauna species in the mine-site area. A review of databases, literature and habitats present indicated that a total of 272 vertebrate fauna species may inhabit or visit the study area. The 272 vertebrate fauna species comprised 11 species of freshwater fish, eight frog species, 76 reptile species, 146 bird species and 31 mammal species (including 27 native and four introduced species). Of the 272 vertebrate fauna species that may inhabit or visit the study area, there are potentially 20 fauna species that are of conservation significance. The 20 vertebrate fauna species of conservation significance include: one frog species, three reptile species, 14 bird species and two mammal species. These 20 species of conservation significance and their likelihood of occurring within the mine-site area have been described in **Table 14**. Of the 20 conservation significant species that may occur in the mine-site area, only the Rainbow Bee-eater (*Merops ornatus)* was recorded during the site inspection. The Rainbow Bee-eater is listed in Schedule 3 of the *Wildlife Conservation Act 1950* and as a migratory species under the EBPC Act. The species is widespread in grassland and open woodland.

Five main fauna habitats were recognised within the study area:

1. Tussock and hummock grasslands on gilgaied soils.
2. Tussock and hummock grasslands on non-gilgaied soils.
3. Mixed scattered shrubland over tussock / hummock grassland on low hill rises.
4. Mixed scattered shrubland over tussock / hummock grasslands on floodplains.
5. Low woodland over shrubland along major drainage lines.

Only the “low woodland over shrubland along major drainage lines” habitat is considered significant. The significance of this habitat unit relates to its restricted occurrence within the study area and to the number of fauna species expected to utilise it. Some of the fauna which exploit this habitat may be restricted to such areas for breeding purposes, i.e. species that require moderate to large trees for either tree-hollows or to support nests. However, none of the major drainage lines in the study area supporting this habitat unit, including Balla Balla River and Salt Creek, are located in the defined mining impact area. Only minor drainage lines, such as Marnipurl Creek, occur within the mine-site footprint. Most of the minor drainage lines have areas that are moderately to highly degraded (**Plates 7 and 8**). As such, they are considered

to be a less significant fauna habitat compared to that along ephemeral drainage lines (M. Bamford, a2008).

Several additional mammal species of conservation significance occur in the general region, but the absence of suitable habitiat means that these are unlikely to regularly use the study area. For example, the Ghost Bat *Macroderma gigas* and the Orange Leaf-nosed bat *Rhinonicteris aurantius* are both of conservation significance and are patchily distributed in the Pilbara, but the study area and surrounds have no suitable roost sites (deep caves) for these species (Bamford, 2006).

A number of mammals of conservation significance are almost certainly locally extinct, including the Golden Bandicoot *Isodon auratus*, Bilby *Macrotis lagotis*, Boodie *Bettongia leasueur* and Spectacled Hare-Wallaby Lagorchestes conspicillatus (Bamford, 2006). During the 2006 survey, no evidence was found indicating the presence of these mammals.

The Northern Quoll which is often associated with rocky areas in the Pilbara but also occurs along water courses and therefore may have been present in the study area (Bamford, 2006). However, none of the drainage lines that could support the Quoll habitat are impacted by the mine-site area.

Based on the habitats present, the study area is unlikely to support large populations of any of the 20 conservation significant species, except perhaps for the skink *Ctenotus rufescens* (Conservation Significance 3*)*. However, extensive habitat for *C. rufescens* is available both within and outside the study area.

Pipeline corridor

The key results of baseline fauna studies carried out for areas along the proposed pipeline corridor between Balla Balla and Port Hedland are summarised below. Details of fauna studies carried out in connection with the proposed Balla Balla pipeline (Bamford, 2008) are provided in **Appendix G**.

Seven main fauna habitats were recognised within the study area. Four of these were similar to habitats encountered during studies of the Balla Balla mine operations area. They were:

1 Spinifex stony plain: *Triodia* sp. dominated hummock grassland with isolated mixed *Acacia* shrubs. This was the dominant habitat type encountered along the proposed pipeline corridor. It is similar to the system previously described as “tussock and hummock grasslands on non-gilgaied soils”.

2 Flood plain: cracking clay/loam soil with mixed grasses, scattered *Acacia* and other shrubs, and isolated *Corymbia* sp. (bloodwood) trees to 5 m. Similar to mine site habitat described as “mixed scattered shrubland over tussock/hummock grasslands on floodplains.”

3 Low rocky hills with vegetation consisting of hummock grassland, dominated by *Triodia* spp., with scattered mixed *Acacia* shrubs to 2m. Similar to mine site habitat described as “mixed scattered shrubland over tussock/hummock grassland on low hill rises”.

4 Ephemeral creek lines, densely vegetated with eucalypts (to 10m)

Three habitat types encountered along the proposed pipeline corridor differed to the habitats previously encountered during studies in the proposed Balla Balla mine operations area. They were:

5 Open short grass plain, with mixed perennial and semi-perennial grasses. Scattered *Acacia* shrubs occur in Gilgai depressions. Similar to, but not identical with, the system described as “tussock and hummock grasslands on gilgaied soils”.

6 Major watercourses typified by tall eucalypt and melaleuca trees (to 10m) and *Acacia* shrubs (to 4m). They have broad expanses of deep sand in the bed of the water channels. No equivalent habitat on the Balla Balla mine site.

7 Dense *Acacia* sandy plain: sandy loam soil with mixed grass and low shrubs; dense *Acacia* shrubs to 4m. No equivalent habitat on the Balla Balla mine site.

On the basis of a database and literature review, the area including the proposed pipeline corridor may support 354 vertebrate species (excluding vagrants): 9 freshwater fish, 8 frogs, 102 reptiles, 184 birds and 51 mammals. This assemblage potentially includes 66 species of conservation significance occurring in the study area. Of these, 43 are of high significance (Conservation Significance Level 1), being listed under legislation, 10 are of moderate conservation significance (Conservation Significance Level 2), being listed as Priority species by the Department of Environment and Conservation, and 3 are of local significance (Conservation Significance Level 3), because they have restricted distributions.

Following an extended inspection of the site, fauna specialists concluded that the number of significant taxa that are likely to occur in or near the pipeline corridor is in the order of 27 (Bamford, 2008). The significant species likely to occur in the Project Area include: 4 reptiles, 14 birds and 9 mammals. No fish or amphibians of conservation significance are expected to occur in the area.

The site inspection and targeted survey recorded two native terrestrial mammal species, one introduced mammal species, fifty-four bird species and six reptile species within the survey area. Of the 27 conservation significant species that may occur in the Project Area, only the Rainbow Bee-eater (*Merops ornatus)* was recorded during the site inspection. The Rainbow Bee-eater is listed in Schedule 3 of the *Wildlife Conservation Act 1950* and as a migratory species under the EBPC Act. The species is widespread in grassland and open woodland. No evidence of short range endemic invertebrates was found during the 2008 site inspections of the pipeline corridor. The habitats observed during the site inspection were generally not consistent with the presence of such taxa.

8.3. Potential impacts

Potential impacts on fauna of the construction and operation of the mine and associated infrastructure, including the pipeline corridor, include:

- Death/injury of fauna during clearing, grading and pipeline construction;
- Entrapment of fauna in open trenches, boreholes, water storages and tailings storage facilities;
- Fauna injury and mortality as a result of impacts with vehicles/machinery;
- Obstruction (e.g. pipes on ground, roads) to the movements of terrestrial fauna;
- Disturbance associated with light, blasting vibrations and noise;
- Loss or fragmentation of habitat (clearing);
- Impacts to riparian and aquatic habitats as a result of changes to surface or groundwater flows;
- Increased predation or competition as a result of increase in the abundance of exotic species; and
- Loss of habitat or direct mortality as a result of increase in the frequency of fire.

8.4. Project objectives

Project objectives include:

- Minimise impacts on abundance, species diversity, geographical distribution and productivity of vertebrate fauna.
- Protect fauna species listed under the Schedules and the International Union for the Conservation of Nature and Natural Resources (IUCN) Categories of the *Wildlife Conservation Act 1950*.
- Protect fauna species listed under the IUCN Categories of the EPBC Act.
- Protect migratory species listed under the EPBC Act.
- Minimise impacts to fauna species listed under the DEC Priority Fauna List.
- Minimise impacts to other fauna species of particular conservation significance (e.g. undescribed taxa, range extensions, outliers, distribution pattern, etc.).

8.5. Relevant legislation and standards

- *Environment Protection and Biodiversity Conservation Act* 1999.
- *Environmental Protection Act* 1986.
- *Wildlife Conservation Act 1950*.
- EPA Position Statement No. 3 (Terrestrial Biological Surveys as an Element of Biodiversity Protection, March 2002).
- EPA Guidance Statement No. 56 (Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, June 2004).

8.6. Assessment of potential impact

Impacts on the majority of significant species with possible habitats along the route are expected to be low because of the temporary nature of disturbance during construction, the fact that the pipeline will be

mostly subsurface, the narrow width of corridor disturbed and the demonstrated lack of long term significant impact related to the existing gas pipeline. Impacts on all other significant species are expected to be low, assuming management such as minimising the disturbance footprint is carried out.

Pipeline construction is unlikely to have a significant impact on fauna because the development consists of a linear construction with a narrow, largely temporary footprint. The pipeline route follows an existing, previously disturbed infrastructure corridor over most of its alignment and lies in a landscape made up of widespread habitat types and lacking in unusual habitat features. It will nonetheless be import to implement management procedures that will prevent direct mortality of fauna through entrapment in temporary trenches during construction.

The main potential impact on fauna of the Balla Balla Project relates to clearing of vegetation. Overall, the environmental significance of impacts associated with the Balla Balla Project is considered to be low, provided that habitat loss is controlled in key habitat areas including riparian zones along ephemeral creeklines and major watercourses. The dense *Acacia* sandy Plain habitat may provide suitable habitat for some mammals of conservation significance, notably the Lakeland Downs Mouse, the Bilby and the Spectacled Hare-Wallaby. However during the baseline surveys no evidence of any of these species was observed and it is possible that recent fires and grazing disturbance in this habitat unit along the proposed pipeline corridor have made the area less suitable for these fauna.

8.7. Management and mitigation

The management measures proposed to limit the adverse impacts of the Project on fauna and their habitats are summarised:

8.7.1. Direct impacts: injury, mortality and avoidance/attraction of fauna

Direct mortality of common species is unavoidable during clearing and construction operations, but can be minimised with careful planning and management. Very high levels of mortality can have significant local impacts on populations. Direct mortality of rare species, and ongoing mortality such as due to road kill, can also have a significant local impact on species such as the Woma and the Pilbara Olive Python. Direct mortality can result if trenches are left open for long periods and animals become trapped and die in the trench either as a result of exposure, starvation or predation.

The length of trench open at any one time will be controlled so that it does not exceed 20km at any time. A specific fauna clearing team' will be established for the duration of the pipeline construction. The entire length of open trench will be inspected within 3 hours of sunrise so that any trapped animals can be removed before animals become too hot and die from heat stress. Construction of the pipeline will not occur from November to March (inclusive) when reptiles are most active. Potential fauna mortality from

heat stress will also be reduced by using fauna shelter boxes and soil plugs (ramps) placed in the trenches at regular intervals to provide shelter and escape for trapped fauna. FMA will report the fauna species collected to the DEC on a regular basis. Specific management details will be further developed in consultation with DEC Karratha prior to construction and further documented in the Construction Environmental Management Plan.

Off-road vehicle use will be strictly controlled over the Project Area with no driving permitted off designated routes. Strict speed limits will apply over the Project Area and on all haul roads, with 50km/hr limits around the processing and administration areas; 60km/hr on plant access roads, and 80km/hr on all haul roads. All vertebrate fauna deaths over the Project Area will be reported annually in an Annual Environmental Report.

Impacts of light and noise upon fauna are difficult to predict. The death of very large numbers of insects has been reported around some remote mine-sites and this can attract other fauna (including introduced predators), as well as presumably reducing the populations of insects in surrounding habitats. Residential and plant areas of the mine-site will be designed with directed and, where appropriate, low intensity or motion-activated lighting to minimise light spill and energy wastage.

8.7.2. Alteration and loss of habitats, reduction in habitat connectivity

There are a number of ways in which activities associated with the Balla Balla Project may reduce the extent, the quality or the connectivity of available terrestrial fauna habitat. These include:

- Direct clearing of or mechanical damage to vegetation;
- Disruption of hydrological regimes;
- Significant alterations of groundwater levels, which may affect vegetation patterns;
- Changes in fire frequency; and
- Construction of permanent or temporary barriers (trenches, roads, other surface structures) which may hinder the movement of animals.

Vegetation clearing

A summary of the main habitat types in the Balla Balla Project Area and pipeline corridor is presented in **(Table 15)** together with an estimate of the likely extent and significance of project impacts on each. Ten main fauna habitats were recognised within the Balla Balla Project Area and pipeline corridor, and the 'low woodland over shrubland along major drainage lines' habitat as described by Bamford (2006, 2008), was considered significant due to its restricted occurrence within the study area and the large number of fauna expected to utilise it, particularly for breeding purposes.

A key impact to fauna from the Balla Balla Project will be the direct loss of fauna habitat due to the clearing of vegetation. The proposal will result in approximately 1515ha of vegetation clearing to accommodate the infrastructure footprint. Of this approximately 39ha will occur on the riparian systems.

All clearing of vegetation will be kept to a minimum over the Project Area and pipeline corridor. Riparian systems will be avoided wherever possible, either by modifying the layout of project infrastructure, or where this is impossible, by adopting designs and construction methods (such as directional drilling for installation of pipelines near major watercourses) that minimises disturbance. Where drainage diversion works are required, sufficient culverting will be installed to maintain surface water flows. Appropriate setbacks will provide adequate buffers between riverine vegetation communities and the waste landforms and tailings storage facility.

Progressive rehabilitation of disturbed areas will be implemented with the aim of reflecting the pre-disturbance state as closely as possible. Rehabilitation is discussed in further detail in **Section 12**. Engineered landforms (for example flood diversion ditches) will be designed using appropriate natural systems (ephemeral creekline systems) as analogs, so that the built systems will provide similar ecological functions to the systems that have been displaced.

Table 15 Summary of key habitat types and likely impacts

Habitat type	Representation	Conservation significance	Possible impact of project	Significance of impact
Spinifex stony plains	Widespread in region although degraded in places by livestock grazing.	Stony plains likely to be used by significant species such as the Australian Bustard at low population densities, so conservation significance is low.	Only a small proportion of habitat likely to be affected during pipeline construction.	Low because habitat is widespread and area of potential impact is small, relative to extent of available habitat.
Open short grass plain	While the extent of this vegetation/landform type is uncertain, it does not appear to be widespread.	May be suitable for the Lakeland Downs Mouse. Slightly unusual environments such as this must be assumed to support elements of biodiversity that might not occur elsewhere. This may include invertebrates that are beyond the scope of most fauna assessments.	Slight disturbance associated with pipeline construction; however pipeline corridor follows existing infrastructure.	Low as area of loss will be very small.
Dense Acacia on Sandy Plain.	Widespread in the project area and in the region.	May be suitable for the Bilby and Mulgara, although the distinctive burrows of these species were not found. Even if these species are only potentially present, this potential makes the habitat important.	Slight disturbance associated with pipeline construction: corridor follows existing infrastructure.	Low as area of loss will be very small.
Floodplain	This habitat is moderately extensive in the project area and the near-coastal bioregion.	May be suitable for a range of significant species (eg. Bilby, Mulgara, Lakeland Downs Mouse), and is a distinctive, occasionally damp and productive habitat.	Small area of habitat loss, but possibility of hydrological changes may need to be considered.	Low, assuming hydrological impacts are negligible.
Rocky hills	Rocky Hills are well represented throughout the south-western area of the Balla Balla pipeline corridor.	The Western Pebble-mound Mouse may be present although was not encountered; and the mounds are usually easy to find. The hills are also important as they represent the catchment area of minor watercourses. Gorges and gullies are often a highly significant feature of rocky hills in the Pilbara, but are not present within the Project Area.	Most of the proposed development lies outside the areas of rocky hills and therefore disturbance to these areas should be minimal.	Minimal on a local scale; negligible on a regional scale, as the habitat is well-represented.
Creek lines	Small creeklines are very widespread in the Pilbara and in the Balla Balla Project, Linear Infrastructure	Small creeklines with their associated vegetation and soils are a distinctive habitat that is small in area and linear, thus providing corridors for movement of fauna across the landscape. They may also include seasonal pools. As a result, they are likely to be areas of high or unusual biodiversity. The Lakelands Downs Mouse may occur along minor watercourses and other species of	Some ephemeral drainage lines may be directly affected by the proposed development, or may be affected by changes in hydrology.	Low to moderate on a local scale because only a small proportion of the habitat within the Balla Balla Project, Linear Infrastructure Corridor

Habitat type	Representation	Conservation significance	Possible impact of project	Significance of impact
	Corridor.	significant fauna may be present. The small area, linkage function, concentration of biodiversity and possibility of at least some species of conservation significance make ephemeral drainage lines moderate to high in conservation significance.		will be affected. On a regional scale the habitat is well-represented.
Major watercourses*	Major watercourses are distinctive but rare across the Pilbara. The infrastructure corridor crosses two major rivers (the Turner and Yule Rivers), with both being crossed in areas where the rivers are broad, shallow and seasonal.	Major watercourses are of high conservation significance, being rare and with very distinctive environments, such as distinctive soils, riparian vegetation, and seasonal and permanent pools. They are likely to areas where biodiversity is high and where water-dependent fauna (particularly some invertebrates, frogs, birds and mammals) concentrate. Associated vegetation and soils are a distinctive habitat that is small in area and linear, thus providing corridors for movement of fauna across the landscape. Degradation by cattle is currently a major factor affecting these habitats.	There should be no direct impact but incidental disturbance of pools and fringing vegetation may need to be managed.	Low: while the habitat is very significant, direct impacts should not occur and indirect impacts should be negligible.

Note: Habitat types followed by and asterisk (*) occur both in the mine site locality and also along the pipeline corridor. Habitat types without an asterisk occur only along the pipeline corridor. Impact assessment is based upon advice contained in Bamford (2006) and Bamford (2008) – **Appendix G**.

Altered hydrology

Interruptions of hydro-ecological processes can have considerable effects because they underpin primary production in riparian ecosystems. Roads, trenches, flood control/drainage diversion works, pit dewatering and water abstraction borefields may alter both surface and sub-surface hydrology. Only one subcatchment area will experience significant changes to surface water flows as a result of the development of the Balla Balla Project. That is the Marnipurl Creek subcatchment, which is likely to experience significant reductions in catchment water discharge due to interception of runoff in mine pits and related structures (**Tables 16 and 17).** The extent of significant groundwater drawdowns is likely to extend for a distance of less than about 1.5km from the mine pit voids (**Figure 16)** and is not predicted to affect either the Balla Balla River or Salt Creek systems. Therefore, it seems unlikely that mine site activities (including pit dewatering, flood diversion works or water abstraction) will result in unacceptable impacts to fauna habitats.

Pipeline construction works near major river crossings will require careful management to minimise disturbance to watercourse beds and banks. In the main, this will be achieved by use of horizontal directional drilling at major crossings. Methods used to minimise habitat disturbance in locations where the pipeline crosses minor, ephemeral drainage lines were described in **Section 7.2**. Once the pipe trench has been backfilled, the disturbed area will be rehabilitated. Neither the trench nor the buried pipelines are likely to result in discernible alteration to surface water or groundwater flows following completion of pipeline installation.

Fire

Fire is a natural feature of the environment in the Balla Balla Project Area (including the pipeline corridor). However, frequent, extensive fires may adversely impact some fauna, particularly mammals. Trenching and other construction activities may lead to fires, but conversely the operation could result in control of some fires.

Prevention of fire over the Project Area will be a key priority for the Balla Balla operation, especially in consideration of highly flammable spinifex vegetation and the impact of frequent fire on habitat quality. Fire management will be addressed in the Project's Environmental Management System and will be based upon fire exclusion within the Project Area. A regional approach to fire management and suppression will be developed in liaison with other land managers, including the local pastoralist, DEC, and FESA.

Barriers to faunal movements; habitat fragmentation

Pipeline construction and installation will leave a bare strip of ground and minor access tracks that may present a barrier for the movement of small fauna. Natural regeneration may occur, (as demonstrated by the gas pipeline adjacent to the proposed route) but this will need to be monitored and where necessary supplemented by targeted revegetation.

Potential to introduce or increase number of exotic species

Introduced species, including the feral Cat, Fox and Cattle (the latter two of which are known to occur in the Project Area), may have adverse impacts upon native species. In particular, several mammal species expected in the area are sensitive to predation by foxes. Foxes (and feral cats) can increase in abundance in remote areas due either to the inadvertent increase in food supply from scraps, or to deliberate feeding by personnel. They can also learn to forage in the open trench during pipe-laying. Cattle degradation was evident along many of the ephemeral drainage lines in the pipeline corridor (particularly on the plains) and near major watercourses.

An increased human presence and greater number of vehicle movements over the Project Area has the potential to introduce other exotic species, or to exacerbate the effects of existing feral or introduced animal populations. Similarly, if waste disposal is not appropriately managed there is the potential to increase populations of feral predators (cats and foxes), thereby impacting local vertebrate populations.

Management over the Project Area will ensure that feral animals, as well as native animals, cannot access food scraps. No pets will be allowed in the mining accommodation areas. FMA will cooperate with other land managers (local pastoralist, DEC, Department of Agriculture) in implementing feral animal control measures in the Project Area. Cattle will be excluded from the Project Area throughout the life of the operation. Upon closure, cattle will be excluded from rehabilitation areas until vegetation is sufficiently well established to withstand some grazing pressure.

8.8. Terrestrial invertebrates

FMA was aware, through previous mining interests in the Balla Balla region, that endemic land snails may occur in the area near the proposed mine site. Although the snail fauna of the flatter coastal parts of the Pilbara are generally considered to exhibit a lower degree of species-level endemism than hilly regions of the interior parts (WAM, 2005), FMA commissioned a survey of the land snail fauna of a larger study area, which included the proposed mine-site. The survey was carried out by staff from the Western Australian Museum ("WAM") in September 2005 (**Appendix G**). The survey included sampling at twenty locations, some of which fell within the proposed mining areas and other which were located in areas of similar landform and vegetation outside the Project Area.

Four species of land snails were identified during the survey. These species were:

- The moderately large camaenid species: *Rhagada richardsonii*;
- Two smaller pupillid species, (*Pupoides* sp. aff. *P. beltianus* and *Pupoides contrariu);*
- The succineid species, *Succinea* sp.

These species occur within and outside the Project Area and are distributed widely throughout the region. The species are not considered as being vulnerable to small-scale disturbance because of their extensive distributional areas, and so are not listed under the *Wildlife Conservation Act* 1950, as DEC Priority species or under the EPBC Act (Slack-Smith, 2005).

The report prepared by the Western Australia Museum commented that the specimens of the taxon *Pupoides* sp. aff. *P. beltianus* (a possible variant of the known species *P. beltianus*) were the northern-most yet collected to that time and that it was therefore possible (although not certain) that the northern limit of the species' distributional range coincides with the Balla Balla Creek area. Alternatively, it was suggested, the apparent absence of *Pupoides* sp. aff. *P. beltianus* north of the Project Area could reflect a lack of survey effort in other areas.

Further advice on the likely distribution of *Pupoides* sp. aff. *P.* beltianus was sought from the Western Australian Museum in early 2008. In its response (**Appendix G**) the WAM cited evidence from a recent (2008) examination of records of three *Pupoides* species (*P. lepidulus*, *P. pacificus* and a possible variant of *P. beltianus*) in the collections of the Western Australian Museum, combined with published data (Solem 1986, 1988). Available information appears to suggest that three Pupoides taxa have overlapping distributional ranges in the northeast Pilbara. This would mean that the specimen from near Balla Balla identified as *Pupoides* sp. aff. *P. beltianus* is unlikely to be at the extreme limit of its range. The WAM also noted that there are only subtle differences in shell morphology between these three species (particularly when juvenile) and identification to species level can be difficult.

A further survey for short-range endemic (SRE) invertebrate fauna was undertaken by Bamford during the survey of the infrastructure corridor between 19 and 22 April 2008. This involved micro-habitat searching that targeted areas likely to support SRE invertebrates, such as the edges of creek lines. Searching involved raking through leaf litter, breaking into dead trees, looking under bark, digging up burrows and turning over rocks, logs and dead Spinifex (M. Bamford, b2008.). No taxa likely to be SRE species (e.g. land snails, isopods, millipedes, pseudoscorpions) were found. At the time, the conditions were dry and not ideal for the collection of species. Therefore, an assessment of the suitability of habitat for SRE species was undertaken along with an assessment of risk to SRE's from the infrastructure corridor.

The assessment concluded that habitat potentially suitable for SRE invertebrates were primarily found along watercourses, and therefore the proportion of habitat loss is likely to be low (M. Bamford, b2008). Habitat potentially suitable for SRE invertebrates in the mine-site area was also considered limited. FMA acknowledges the importance of the management of hydrological processes to SRE's and will specifically manage potential impacts through the Balla Balla Project Water Management Plan and Ground Disturbance and Rehabilitation Management Plan.

8.9. Predicted Outcomes

Impacts upon fauna due to the construction and operation of the Project are likely to be from localised loss of habitat, with potential impacts from roadkill and changes in hydrology, the fire regime and the abundance of introduced predators. Riparian habitats along the Balla Balla River and Salt Creek are locally significant due to the high concentration of species they support and their restricted occurrences. FMA have developed a monitoring programme to ensure that the riparian vegetation is not impacted from

groundwater drawdown. The proposal will result in approximately 1515ha of vegetation clearing to accommodate the infrastructure footprint. Of this approximately 39ha will occur on the riparian systems which is predominantly from the unnamed Creek and Marnipurl Creek.

Impacts to fauna as a result of the Project are expected to be low. Of the 20 fauna species that are of conservation significance in the mine-site area, based on the habitats present, the area is unlikely to support large populations of these species except for the skink *Ctentotus rufescens*. However, there is extensive habitat available for *C.rufescens* both inside and outside the Project Area. Construction of the slurry pipeline is not expected to result in a high fauna mortality rate due to the management measures that will be implemented during construction.

9. SUBTERRANEAN FAUNA

Stygofauna are obligate groundwater dwellers that spend their entire life-cycle below ground. Typical groundwater habitats for stygofauna are megavoids, mesocaverns in karst and basalts, and the interstitial spaces of alluvial aquifers.

Stygofauna diversity is generally higher within classic karst systems and, until recently stygofauna was thought to be confined to these environments. It has since been revealed that calcrete aquifers associated with palaeovalleys of the Australian arid zone contain a diverse stygofauna community (Humphreys 2006; Karanovic 2004).

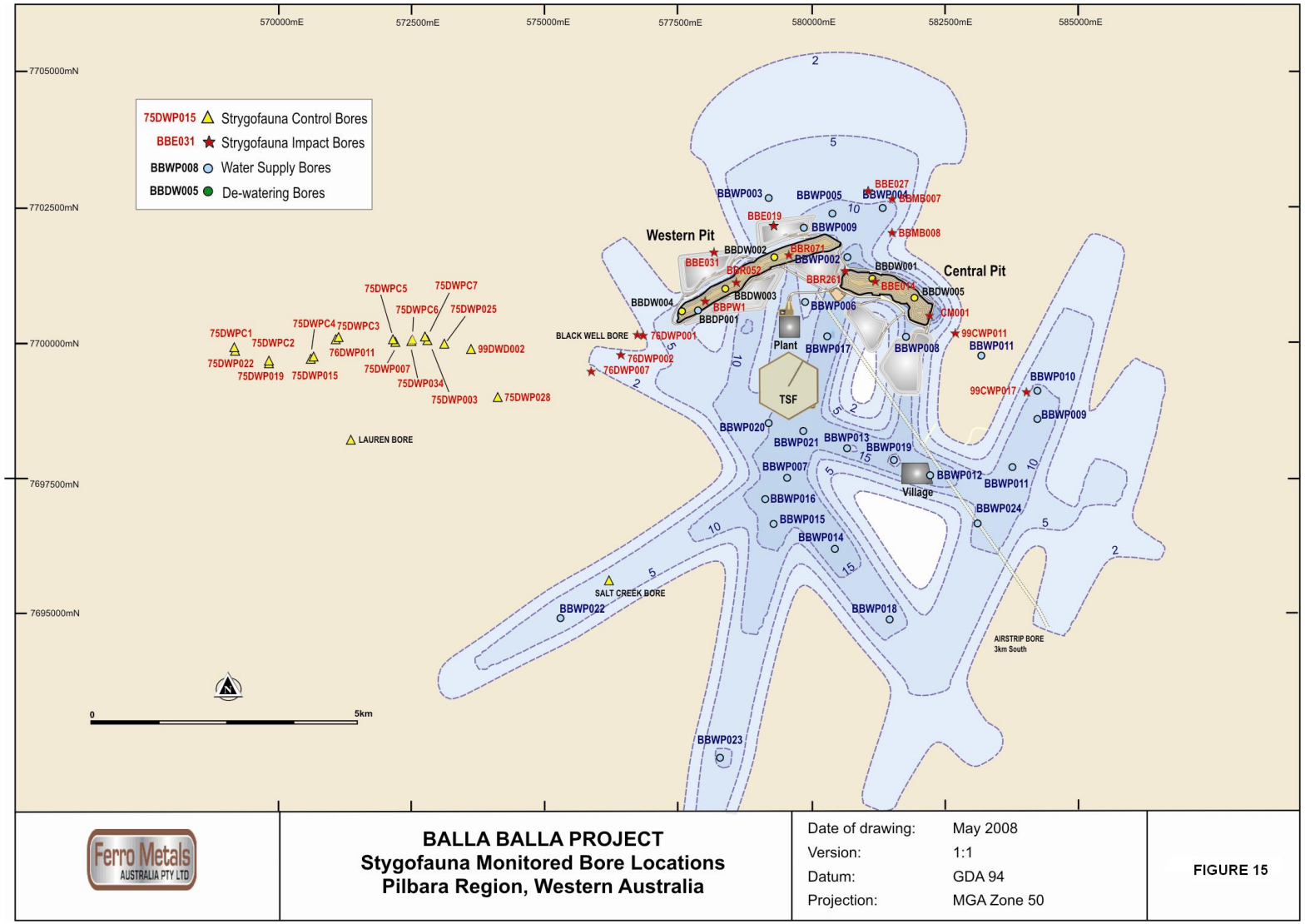
9.1. Description

Repeated investigations in the Project Area have found the area is rich in stygofauna and that the site has been well characterised in terms of stygofauna diversity. The two stygofauna surveys of the Balla Balla Project Area, completed by Outback Ecology for FMA have shown the area to support a diverse and abundant stygofauna population. From the 72 bores sampled (40 impact and 32 control), 56 stygal taxa were identified across seven taxonomic groups (refer to **Figure 15** for sample locations). The taxa identified were typical of the Pilbara region (Outback Ecology, 2008; **Appendix H**).

The stygofauna recorded in the Balla Balla area were either widely distributed in the drainage basin associated with the Project Area, in the Port Hedland Coastal Basin, or within the Project Area, species recorded from the potential impact zones were also recorded outside these areas. A few species were only located from bores within the impact zone. These were not considered species with conservation significance as they had been recorded previously from areas outside the Project Area within the Port Hedland Coastal Basin. Some new species were identified during the 2008 monitoring event in the Project Area, however all of the specimens representing new taxa were recovered from control bores and not only from areas that may be impacted by mining activities.

The Balla Balla Project Area is not considered suitable habitat for troglofauna based on geomorphological characteristics. The Project Area is located on a flat plain with a surface layer of silty sandy clay up to 2.5m deep which is underlain with a coarse grained, decomposed, igneous rock layer (gabbro) (Outback Ecology, 2008). With the ground water table rising to about 5 -7m in the area, the gabbro layer would be more or less saturated and therefore unsuitable for troglobites. The clayey nature of the surface layer would also not represent potential troglobitic habitat as the fine grain would not support the persistence of stable interstitial spaces (Outback Ecology, 2008). Although shallow calcrete deposits do occur within the clayey soil, these deposits lie within and just above the water level and so would be mostly inundated. The magnetite exists at approximately 30m and is compacted, lacking fractures or fissures and therefore unsuitable for troglofauna.

Figure 15 Stygofauna monitoring bore locations



9.2. Potential impacts

Potential impacts to stygofauna within the Project Area may occur as a result of habitat loss from mining and groundwater drawdown from dewatering activities or as a result of alteration to water quality.

Alteration to the groundwater levels may arise as a result of:

- Pit dewatering;
- Abstraction of water from production bores; and
- Mounding of water beneath the tailings storage facility.

Aspects of the Balla Balla proposal that have the potential to affect groundwater quality include:

- Seepage of water containing elevated salts, metals or acidity from the tailings storage facility; and
- Increased salinity, acidity or metals concentrations in water in the pit void as the pit re-fills at cessation of mining.

9.3. Objective

To maintain the abundance, diversity, geographic distribution and productivity of stygofauna species through the avoidance or management of adverse impacts and improvement in knowledge.

9.4. Relevant legislation and standards

Relevant legislation and standards include:

- *Environmental Protection Act 1986*.
- *Environment Protection and Biodiversity Conservation Act* 1999.
- *Wildlife Conservation Act 1950*.
- EPA Guidance Statement No. 54 (Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia, December 2003).
- EPA Draft Guidance Statement 54a (Technical Appendix – Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia, August 2007).
- EPA Guidance Statement No. 56 (Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia).

9.5. Assessment of potential impact

9.5.1. Survey methods

To obtain sufficient data on the stygofauna, two surveys were conducted in 2007 (Stage 1) and 2008 (Stage 2) in the Balla Balla Project Area. Sample bores were classified as control or impact according to

their locations relative to the proposed pit voids, tailings storage facility and predicted groundwater drawdown curve. Sample sites are shown in **Figure 15**. A total of 72 bores were sampled: 41 bores in Stage 1 (21 impact and 20 control bores) and 31 bores in Stage 2 (21 impact and 20 control bores). Some bores were repeated between Stages.

The accumulation curves from Stage 1 indicated the sampling effort was already strong and that it was unlikely that any new orders will be found. The results of the 2007 and 2008 sampling program have shown that the sampling effort and design applied to the Project has adequately assessed the stygofauna community in the Project Area and has provided a strong basis on which to implement appropriate management plans.

9.5.2. Habitat loss

The groundwater system in the vicinity of the Balla Balla Project comprises a confined to semiconfined series of aquifers. In the existing northern bores the aquifer depths generally extend to depths between 30 to 40m within weathered and fractured gabbro. South of the planned mine, aquifers extend to depths of between 40 and 80m within weathered and fractured granitic rocks. The increased aquifer depths in the granitic terrain are commonly associated with deeper zones of fracturing adjacent to dolerite dyke or lithological contacts (GRM 2006).

Although the groundwater system comprises a number of aquifers, they are contiguous. This is supported by the quality of the groundwater in the Project vicinity which is generally brackish (less than 4 000mg/L TDS) (Outback Ecology 2008). Given this consistency in the groundwater system, it is considered unlikely that the groundwater in the Balla Balla Project Area represents a unique environment for subterranean fauna and the effects on biodiversity of habitat loss are acceptable.

9.5.3. Changes in groundwater levels

The model used to predict groundwater drawdown in the Project Area assumes no recharge to the aquifer from rainfall or streamflow over the life of the Project. It should be recognised that this scenario is unlikely and that this assumption is overly conservative. It is known that intense rainfall events, particularly those associated with cyclonic activity, result in sizeable rises in groundwater levels (up to 5.5m measured over the 2005/2006 wet season) (GRM 2008). It is judged likely that such rises in groundwater levels will off-set drawdown impacts from groundwater abstraction. Especially in the vicinity of the Balla Balla River, where preferential recharge associated with infiltration of surface water to the groundwater system whilst the river is flowing, an intense rainfall event is expected to result in periodic full recovery of the adjacent groundwater levels.

Drawdown adjacent to pits and borefields

The predicted groundwater level drawdown from dewatering activities and pumping was based on a scenario of recharge every five years with an 80th percentile recharge event (GRM 2008).

In order to construct a preliminary assessment of the effects of groundwater drawdown on subterranean habitat, FMA has assumed that any drawdowns that exceed one-third of the aquifer thickness would potentially constitute a significant loss of habitat (Outback Ecology 2008). Areas with such drawdowns are discussed as "impact zones". The trigger levels for stygofauna management will be set independently of this assumption, following consultation with the Department of Water. Generally, throughout the pit and northern borefield areas the aquifer thickness is approximately 30m and 60m beneath the proposed southern borefield.

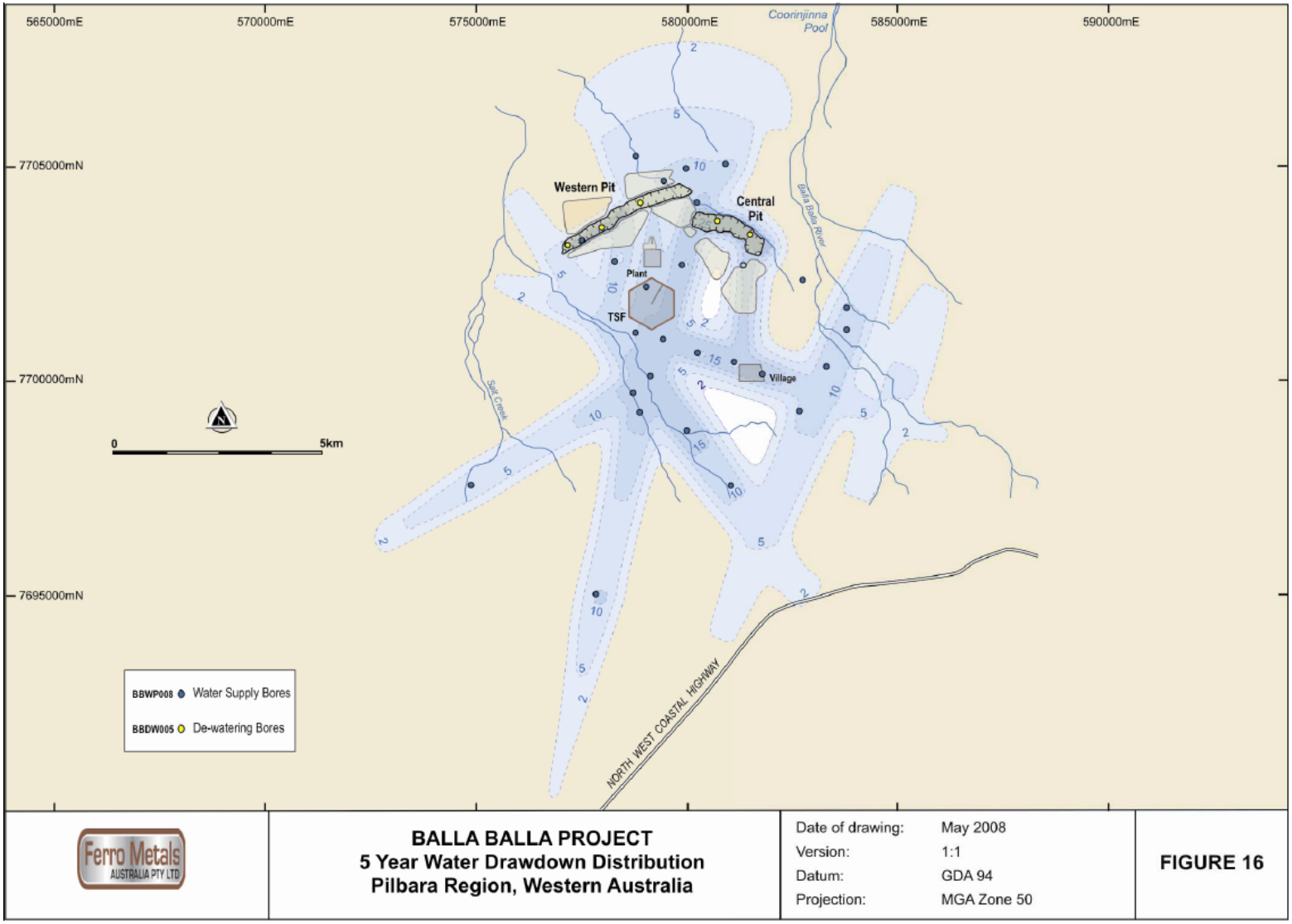
The impact zones adjacent to the pit and borefield areas for 5 years into the mining project are shown in **Figure 15.**

Drawdown at Balla Balla River and Salt Creek

Groundwater in the area flows seasonally in saturated layers of floodplain sediments and in localised, narrow river channel deposits (GRM 2008). Drawdown beneath river channel systems has the potential to impact stygofauna that are restricted to these types of habitat - the three new species observed were confined to the Salt Creek drainage area along the creeklines.

The Balla Balla River and Salt Creek are the most significant alluvial drainage systems near the Project Area. Neither of these systems fall within the impact zones shown in **Figure 16**. Modelling shows that drawdown near the Balla Balla River, in areas to the north and east of the proposed mine site is expected to be less than 2m over the first five years of the Project, and 4m over the life of the mine, assuming no recharge during this period (GRM 2008). The drawdown along Karinha and Salt Creeks is predicted to be generally less than 5m along the creek lines after 5 years and to range from about 20m in the vicinity of the production bores to about 10m or less along the creek lines by the completion of mining, assuming no recharge (**Figure 16**). The drawdown at Coorinjinna Pool is expected to be minimal at the completion of mining.

Figure 16 Groundwater drawdown over 5 years (no recharge)



9.5.4. Changes in groundwater quality

The potential impacts on groundwater quality include:

- Seepage of water containing elevated salts, metals or acidity from the tailings storage facility.
- Increased salinity, acidity or metals concentrations in water in the pit void as the pit re-fills at cessation of mining.
- Groundwater quality impacts from leakage/spills of magnetite slurry.
- Adverse impacts to groundwater quality as a result of spillage or poor management of hydrocarbons or reagents.

The risk associated with each of these potential impacts is discussed in detail in **Section 11.4.2**.

9.5.5. Management and mitigation

The key actions proposed to ensure that subterranean habitats are protected are to:

- Monitor groundwater drawdowns to validate hydrogeological model predictions;
- Monitor water quality; and
- Implement an annual stygofauna monitoring programme.

The monitoring and management of groundwater levels and quality are discussed in **Section 11**. Trigger levels for the implementation of management actions are contingent upon abstraction rates and quantities, to be decided upon in consultation with the Department of Water. Trigger levels for stygofauna management will be set alongside those for groundwater management, following this consultation.

Stygofauna monitoring programme

The stygofauna monitoring programme has been developed and incorporated into the groundwater monitoring plan to enable threats to the stygofauna habitat to be detected early enough to allow for intervention. The monitoring programme will consist of an annual survey of the Balla Balla Project Area and involve the sampling of twenty designated bores. Ten will be control bores and ten will be impact bores. The impact bores will include bores located near the TSF in the Southern Borefield and in areas of varying drawdown to allow for the detection of any changes to the stygal community due to habitat alteration. The annual sampling will continue for the life of the mine to ensure adequate protection and conservation of the stygal community. Sampling methodology will be consistent with the EPA Draft Guidance Statement No.54A. The monitoring results will be reported in the Annual Environment Report for the Project. This will ameliorate potential impacts to ensure conservation of the stygofauna.

The monitoring programme for the stygofauna will consist of an annual survey of the Balla Balla Project Area, and involve the sampling of twenty designated bores (**Appendix 4B of the Water Management Plan**). Ten of these will be control bores and ten will be impact. The impact sites are to include bores located near the TSF in the Southern Borefield and in areas of varying drawdown to allow for the

detection of any changes to the stygal community due to habitat alteration. The annual sampling will continue for the life of the mine to ensure adequate protection and conservation of the stygal community.

9.6. Predicted outcomes

Available information on the hydrogeology and stratigraphy of the Balla Balla Project Area does not point to any obvious spatially-linked variation in subsurface conditions that would correspond to distinctive subterranean habitat. Although the groundwater system in the Project Area comprises a number of aquifers, i.e. there is no single aquifer across the site, they are contiguous and interconnected. This is supported by the consistency of the groundwater chemistry, the surficial geology and the distribution of particular taxa, especially those adapted to interstitial life such as the Amphipoda and Copepoda. There are some differences in the basal geology across the Project Area, with the northern parts of the Project Area being more mafic in character and those further to the south more felsic. However this variation does not appear to relate to readily observable differences in subsurface chemistry, porosity or permeability. This consistency and continuity in the groundwater system make it unlikely that the subterranean habitat affected by the mine and borefields are unique in comparison to unaffected habitats.

Given the connectivity of the subterranean habitat in and around the Project Area, the wide distribution of the majority of species found and the relatively small loss of habitat, it appears unlikely that either the direct impacts of mining or the effects of dewatering and water abstraction will result in unacceptable impacts on subterranean fauna.

10. SURFACE WATER

10.1. Description of factor

The Balla Balla Project (mine, pipeline and port facilities) lies within the hydrological unit known as the Port Hedland Coastal Drainage Basin (drainage basin 709, Water and Rivers Commission, 2000). Surface water flow in the region occurs almost exclusively as a direct response to rainfall. Accordingly, flows are extremely variable and seasonal. None of the watercourses in the drainage basin flow throughout the year, most flow for less than half the year. Mean annual runoff rates typically amount to less than 20% of annual rainfall. The rivers within the Port Hedland Coastal Drainage Basin characteristically have dendritic drainage patterns which become less defined as they flow northwards across the flat coastal plain.

Alluvial deposits along drainage lines are predominantly recharged by surface runoff in the river channels during significant rainfall events. However, some recharge may also originate from subsurface seepage. Some of the rivers in the drainage basin contribute significant recharge to groundwater through localized flow into the alluvial sediments that line the watercourses. This is particularly the case in those parts of the drainage basin where the depth to groundwater is in the order of 5m or less. However, where depths to groundwater are greater (eg > 10m), surface water runoff only has a small effect on groundwater levels (Water and Rivers Commission, 2000).

The general topography of the region is related to the underlying geology and is characterised by gently undulating grassy coastal plains. The Project site is located in a low-lying broad valley that falls from a maximum elevation of approximately 200m AHD in the headwaters of Balla Balla River to sea level over a 35km stream leng (i.e. an average gradient of some 0.6%). The existing ground elevation in the vicinity of the Project site th is in the order of 15 to 25m AHD.

The Balla Balla River and Whim Creek are located to the east, and Salt Creek and Karinha Creek (a tributary of Salt Creek) are located to the west of the mine-site area. Marnipurl Creek lies within the mine-site area (**Figure 2**). With the exception of the spring-fed Corrinjinna Pool, located in the lower reaches of the Balla Balla River, approximately 10km northeast of the proposed mine, all of the local watercourses are ephemeral and are likely to carry runoff only following significant storm events during the summer months from January to March when the potential exposure to high intensity cyclonic rainfall is greatest. A review of the daily rainfall record for eight local rainfall stations found that some 90% of the wettest days on record, with daily rainfall amounts ranging from 474mm to 259mm, occurred between mid-December and end of March as a result of tropical cyclones. Consequently, runoff will report intermittently to the watercourses in the vicinity of the mine-site area. On occasion, these flows may be very high, particularly in the Balla Balla River.

The Balla Balla River, Whim Creek and Salt Creek drain runoff from a combined catchment area of approximately 132km^2 to the south of the North West Coastal Highway towards the Project site. Runoff from an approximately 217km^2 catchment area to the north of the Highway then reports to these rivers and creeks and several other small creeks and watercourses, including Marnipurl Creek, before leaving the Project site and draining towards the tidal flats into Forestier Bay.

The pipeline corridor will cross several creeks and rivers. These include:

- Balla Balla River
- Poverty Creek
- Whim Creek
- Steel Star Creek
- Peawah River
- Yule River
- West Yule River
- Turner River West
- Turner River

All of the rivers are located in the lower catchments fed by the Chichester Ranges. They flow northwards towards the Indian Ocean. As with the rivers in the Project Area, none of the rivers, creeks and streams that transverse the pipeline corridor flow continuously. They also require substantial rainfall events to produce flowing conditions.

10.2. Potential impacts

Development of a mine-site and related facilities at Balla Balla has the potential to affect hydrological flow regimes and surface water quality as a result of the following activities:

- Redirection of surface flows through the construction of roads, flow diversion works, surface storages of mine waste rock and other structures;
- Loss of catchment area as a result of mining;
- Changes in surface characteristics which may influence rainfall infiltration and runoff;
- Release of sediment from disturbed areas including, but not limited to, built landforms.

Other possible impacts of the Project on surface water quality could arise through:

- Overspill from tailings storage facilities;
- Leakage from the tailings pipeline;
- Leakage from process pipelines;
- Spillage / runoff of process overflow.

Potential impacts of the magnetite slurry pipeline construction, operation and maintenance on surface water systems may include:

- Stream channel or stream bank disturbance during pipe installation.

10.3. Project objectives

- Maintain the quality of surface water to ensure that existing and potential users, including ecosystem maintenance, are protected.
- Maintain the integrity, function and environmental values of natural surface water drainage.
- Minimise the transport of salt, sediment and other pollutants from mine areas.
- Establish stable, sustainable post-mining landforms consistent with the existing landscape, so as to maintain pre-disturbance flow regimes.

10.4. Relevant legislation and standards

- *Environmental Protection Act* 1986.
- Unauthorised Discharge Regulations, 2004.
- *Soil and Land Conservation Act* 1945.
- *Country Areas Water Supply Act* 1947.
- *Rights in Water and Irrigation Act* 1914.
- Australian and New Zealand Water Quality Guidelines (ANZECC 2000).
- EPA Position Statement No. 5 (Environmental Protection and Ecological Sustainability of Rangelands in Western Australia), November 2004.
- EPA Guidance Statement No. 6 (Rehabilitation of Terrestrial Ecosystems, June 2006).
- Strategic Framework for Mine Closure (ANZMEC/MCA 2000).
- Water and Rivers Commission River Restoration Manual 10 (Stream stabilisation, February 2001).
- Water and Rivers Commission River Restoration Manual 18 (Stream channel and floodplain erosion, September 2002).

10.5. Assessment of potential impact

Mine-site

Alterations to surface hydrology

Hydrological studies of the mine-site area have found that a number of the local surface water catchments will be impacted by the proposed Project due to loss and/or modification of the catchment areas. The affected catchments include those discharging to the Balla Balla River and Marnipurl and Karinha/Salt Creeks and to an unnamed drainage line located below the proposed TSF **(Figure 2).**

The range of catchment loss/modification varies from relatively minor in the case of Balla Balla River and Karinha/Salt Creek catchments, to quite significant in the case of Marnipurl Creek and the area collecting from the unnamed drainage line. Most of the subcatchment area drained by the unnamed drainage line will be removed due to mining or construction of mine facilities. The extent of significant hydrological modification of the catchments in the Project Area is summarised in **Tables 16 and 17.**

Balla Balla River – Baseline hydrological studies of the Project Area concluded that the greatest flooding risk to the proposed Project facilities relates to the Balla Balla River and the flooding that would occur if it were to spill over-bank downstream of its confluence with the Whim Creek, approximately one kilometre north-northwest of Caine Well. If this were to occur due to extremely high flows or channel blockage or impediment, it is possible that floodwater from the Balla Balla River could spill over-bank and enter the Marnipurl Creek or one of the other unnamed onsite watercourses and report to the proposed mine pits. Alternatively, due to the flat topography over the mine-site area, such an event could cause widespread flooding over the proposed mine services and process plant areas.

Karinha/Salt Creek - The majority of flood flow in Karinha/Salt Creek will likely pass safely to the west of the mine-site area and flooding from these creeks is not considered to be a significant risk to the mine facilities at start-up.

Marnipurl Creek – 33-34% of peak streamflow will be lost due to the partial diversion of the streamflow around the mine-site and loss of subcatchment areas as the Western Pit is developed and the associated waste dumps are constructed.

10.6. Management and mitigation

Alterations to surface hydrology

Balla Balla River - The construction of proposed flood protection berms, diversion ditching and other flood protection measures to protect facilities on the eastern, northern and southern side of the mine-site area will have the effect of diverting an approximately 0.9km^2 of catchment area to the Balla Balla River (an increase of about 0.55%). This diversion will have a minimal effect on streamflow in the Balla Balla

River, given that the existing catchment area for this river is in the order of 164km^2. Peak discharges in the relatively undisturbed Balla Balla River catchment for the 2, 10 and 100-year ARI events are essentially unchanged.

Karinha/Salt Creek – As flooding is not considered a significant risk from these rivers, flood protection measures will be limited to raising the proposed camp on an earthwork fill platform above the existing ground level and armouring the south-western toe of the TSF. The Karinha/Salt Creek catchment area will be increased by some 2.4km^2 of the TSF Creek catchment as a result of construction of the diversion ditch and flood protection berms. This will cause only a very slight increase in streamflow in the Karinha/Salt Creek, given that its existing catchment is in the order of 144km^2. Peak discharges in the relatively undisturbed Karinha/Salt Creek River catchment for the 2, 10 and 100-year ARI events are essentially unchanged.

Marnipurl Creek – 33-34% of the Marnipurl peak streamflow Marnipurl will be lost due to mining. The remaining catchment will be diverted around the mine.

Impacts on surface water quality

The most significant risk to surface water quality associated with the Balla Balla proposal relates to the possible increase in turbidity and/or sedimentation in watercourses which may occur as a result of erosion during rainfall events. The following surface water management measures are proposed to reduce the risk and impacts of erosion:

- Existing sections of the Marnipurl Creek and the unamed creek and all other on-site minor unnamed watercourses will be maintained to the greatest extent possible and reused to divert undisturbed water off-site.
- The flood protection berm provided along the eastern side of the mine-site area will not only serve to keep floodwaters from Balla Balla River away from the mine facilities, but will also serve to prevent potentially turbid runoff from leaving the mine-site area.
- Diversion berms, ditches and brush barriers will be used to reduce the potential for off-site discharge of sediment-laden runoff.
- Minor channel realignment and entrance treatments will be required where existing creek and drainage lines join the diversion ditch. In order to reduce flow velocities and minimise erosion of the channel sides, invert and rock check dams will be installed along the steeper parts of the ditch, where the gradient exceeds 1%. Similarly, a stabilised basin with riprap lining will be provided at ditch outfalls.
- Run-off from undisturbed areas outside the process plant but within the Project boundaries will be diverted around the proposed project facility into existing natural creeks or drainage lines by providing diversion drains sized for the 1 in 10 Year ARI event with a minimum 500mm freeboard. Flow velocities along diversion drains will be limited to minimise erosion and the generation of sediment.

Surface water quality

Other possible impacts of the project on surface water quality could arise through:

- Overspill from tailings storage facilities;
- Leakage from the tailings pipeline;
- Leakage from process pipelines;
- Spillage/runoff of process overflow.

The following management measures are proposed to prevent or control contamination from these sources:

- Ample freeboard is provided to ensure that overtopping will not occur at the tailings storage facilities. These facilities will be designed to maintain a freeboard of 500mm above the one in 100 year 72 hour ARI event.
- The tailings pipeline will be located within a graded swale. In the unlikely event of spillage, tailings will be restricted to the swale and will not enter the wider environment. The tailings pipeline will be fitted with isolation valves and air bleed valves at appropriate intervals along the pipeline, and the pump will be equipped with pressure sensors to cease operations in case of pipeline failure.
- All process pipelines will be located over sealed and bunded areas; any leakage will be directed to the stormwater pond for return to the process circuit.
- Process overflow will report to the process pond. The process water pond will be an above ground facility, fitted with lining and a clay base liner. The process water pond will be designed to maintain a sufficient freeboard and in accordance with the DoIR and DEC requirements.

Drainage management for hydrocarbon and reagents

FMA has adopted a drainage management strategy that incorporates elements to address potential contamination issues associated with hydrocarbons, reagents and entrained sediment in the Project Area. Project facilities will be segregated into the following areas for the management of stormwater:

- Process areas within plant site;
- Non-process areas within plant site;
- Hazardous material storage areas within plant site;
- Disturbed areas; and,
- Undisturbed areas.

Rain falling within process areas, e.g. milling and thickening areas, will be collected and returned to the process, as it could be impacted by the process. Provision will be made for the return of such flows to the process by means of bunding, drains, launders, sumps, pumps etc.

Two water management ponds will be provided to manage water in the plant site area. One pond will receive runoff from the plant site in general and one will be used for handling potential oily water from the truck wash, workshops, fuel storage and bowsers etc. The pond used for potentially oily water will have

an oily water separator placed upstream of the pond inlet. Both water management ponds will have diversion structures constructed at their inlets to pass flows of greater than 10 Year ARI magnitude around the ponds and off-site.

All chemical, oil and other hazardous material storage areas will be bunded in accordance with the relevant codes and standards. Water collected within the bunds will be assessed prior to release. If no leaks or spills are evident and the quality of the collected water is suitable, then the area will be drained to the closest on-site non-process drain that reports to a water management pond. Water collected within the bunds that is assessed and is found to be impacted will either be returned to the process or disposed of appropriately (for example, by irrigation at the hydrocarbon treatment facility or by offsite disposal to an approved liquid waste facility).

Runoff from non-process areas within the process plant area e.g. roads, roofs, yards, stockpiles, ROM area etc. will be captured in open drains which will report to a water management pond, before being returned to the process **(Figure 10).** Non-process drains reporting to the water management pond will be sized for the 10 Year ARI event as a minimum. Open drains will have a minimum freeboard of 500mm and flow velocities along such drains will be limited to minimise erosion and the generation of sediment.

Additional information on the engineering design parameters for site drainage control is provided in **Appendix D.**

Pipeline corridor

The pipeline corridor crosses two water resource protection areas – the Yule River water reserve and the Turner River water reserve. The Yule River has a high conservation value as public drinking water supply area. The Yule River water supply area draws water from borefields, rather than making direct withdrawals from surface flows and forms part of the water supply for Port Hedland and South Hedland. The Turner River bore field was closed in the 1980's due to high operational costs and low yields, although the water reserve has not yet been de-proclaimed. The Yule River is also the longest and largest river in the Port Hedland Coastal Drainage Basin with a catchment area of 8430km². The mouth of the Yule River supports mangroves which are designated "Regionally Significant" in the EPA Guidance Statement for protection of tropical arid zone mangroves along the Pilbara Coastline (No.1). Construction of the pipeline will not significantly impact the rivers. Both the Yule and the Turner Rivers have conservation significance for riparian vegetation. These ephemeral rivers support *eucalypt* woodland in their floodplains, providing fauna habitat.

The significant habitats on the three Yule and Turner River crossings associated with the slurry pipeline are the narrow bands of riparian vegetation which are generally less than 10m wide on each bank. The pipeline intersects these habitats at near-perpendicular angles, so the impacts are restricted in area. In the unlikely event that HDD could not be used then the worst-case scenario for maximum disturbance of the riparian vegetation would be 1,200m². This has been calculated from impact to a 20m wide swathe

perpendicular to the watercourse, resulting in a maximum of 200m² impact for each bank for all three crossings.

Since this habitat is well represented in undisturbed areas, ecological impacts are considered to be small and manageable, especially as post-construction rehabilitation will return significant ecosystem function to most of the disturbed area. For short-range endemic biota, the relatively uniform habitat provided by the full longitudinal extent of the riparian ecosystem indicates little impact.

None of the rivers, creeks and streams traversed by the pipeline corridor flow continuously and most require substantial rainfall events to produce flowing conditions. There are a number of springs and permanent water pools in the region, but these are not large enough to permit constant river flow (Pilbara Energy Limited, 1993).

10.7. Predicted outcomes

The Balla Balla Project will not impact off-site surface water quality as there will be no discharge of excess or disturbed water. Run-off from undisturbed areas within the Project Area will be diverted around the facility via diversion ditches.

Construction of the slurry pipeline is unlikely to cause disturbance to surface water as construction will not occur during the summer months when the Yule and Turner Rivers flow due to cyclonic and summer rains.

Prior to development, the combined Marnipurl and unnamed drainage line subcatchment area is some 16.4km^2. Approximately 13.3km^2 of this catchment will be impacted. The pre-development flow regime of both the Marnipurl and unnamed drainage line will therefore be significantly modified. Given the relatively small contribution of the Marnipurl Creek to hydrological function in the Project Area, the predicted reductions in streamflow will likely have a negligible overall effect and are not expected to significantly impact the receiving environment.

For Salt Creek, the hydrological modelling predicts a modest reduction in peak discharge from high frequency (1 in 2 year) storm events of up to about 3.3% (reduction from 90m^3/s to 87m^3/s). For low frequency (1 in 100 year storm events), the Salt Creek catchment peak discharge will be reduced by about 4.8%.

Predicted impacts on the Marnipurl Creek catchment will be much more pronounced. For Marnipurl Creek, the hydrological modelling predicts a significant increase in average annual runoff (from about 381ML to 826ML. However, because the runoff water will report to pits and other areas from which water is harvested for ore processing, the changes to the catchment will not result in increased streamflow. Rather, the modelling predicts a 33% reduction in peak discharge from high frequency (1 in 2 year) storm

events (from about 15m^3/s to 10m^3/s). For low frequency (1 in 100 year storm events), the Marnipurl Creek catchment peak discharge will be reduced by about 43% (predicted reduction from 310m^3/s to 178m^3/s).

Salt Creek and Balla Balla River are known to have surface water dependant vegetation *(Corymbia).* Ongoing monitoring will be required to ensure there are no long term impacts to vegetation as a result of surface water flow displacement. Vegetation along Marnipurl Creek is highly degraded from cattle grazing and is well represented in the region.

Table 16 Summary of mine site hydrology - predisturbance

Catchment	Catchment Name/Description	Undisturbed Area	Disturbed Area	Average Annual Rainfall	Undisturbed Runoff Factor	Disturbed Runoff Factor	Average Annual Runoff	Peak Discharge for Average Recurrence Interval (m^3/s)		
		(km^2)	(km^2)	(mm)	(%)	(%)	(ML)	2 Yr	10 Yr	100 Yr
1	**Salt Creek**	158.52	N/A	320	15	N/A	7,609	90	371	2100
	Catchment Total	**158.52**		**-**	**-**	**-**	**7,609**	**90**	**371**	**2100**
2	**Marnipurl Creek**	7.93	N/A	320	15	N/A	381	15	60	310
	Catchment Total	**7.93**		**-**	**-**	**-**	**381**	**15**	**60**	**310**
	Catchment Total	**166.45**		**-**	**-**	**-**	**7,990**	**105**	**431**	**2,410**

Table 17 Summary of mine site hydrology – post-disturbance

Catchment	Catchment Name/Description	Undisturbed Area	Disturbed Area	Average Annual Rainfall	Undisturbed Runoff Factor	Disturbed Runoff Factor	Average Annual Runoff	Peak Discharge for Average Recurrence Interval (m^3/s)		
		(km^2)	(km^2)	(mm)	(%)	(%)	(ML)	2 Yr	10 Yr	100 Yr
1	**Salt Creek (less 5.81 km2 diverted to Project Area plus 0.43 km2 diverted from Marnipurl Creek)**	153.14	N/A	320	15	N/A	7,351	87	360	2000
	Catchment Total	**153.14**		**-**	**-**	**-**	**7,351**	**87**	**360**	**2000**
2	**Marnipurl Creek (plus 5.81 km2 diverted to Project Area less 0.43 km2 diverted to Salt Creek)**	4.85	N/A	320	15	N/A	233	10	37	178
2a	*Central Pit*	N/A	0.77	320	N/A	95	234	**-**	**-**	**-**
2b	*TSF*	N/A	2.65	320	N/A	0	-	**-**	**-**	**-**
2c	*Roads, Service Areas, Laydown, Yards, etc.*	N/A	0.60	320	N/A	40	77	**-**	**-**	**-**
2d	*Process Plant- Reused in process*	N/A	0.06	320	N/A	0	-	**-**	**-**	**-**
2e	*Process Plant- Released via sed pond*	N/A	0.18	320	N/A	60	35	**-**	**-**	**-**
2f	*ROM and Oxide Stockpile*	N/A	0.11	320	N/A	30	11	**-**	**-**	**-**
2g	*Southern Waste Dump*	N/A	0.85	320	N/A	30	82	**-**	**-**	**-**
2h	*Uncleared areas within flood berm*	N/A	3.24	320	N/A	15	156	**-**	**-**	**-**
	Catchment Total	**13.31**		**-**	**-**	**-**	**826**	**10**	**37**	**178**
	Project Area Catchment Total	**166.45**		**-**	**-**	**-**	**8,177**	**-**	**-**	**-**

11. GROUNDWATER

11.1. Description

Approximately 7.80GLpa of fresh to brackish water is required for the processing plant operations on-site, reducing to 5.90GLpa, as clarified water is returned from the dewatering operations at the port. An additional 0.56GLpa is required for dust suppression and for plant and mine equipment washdown.

Process water will be sourced from a combination of mine dewatering and groundwater abstracted from bores located in **Figure 9**. Groundwater in the Balla Balla Project Area is relatively shallow (typically less than 10m below surface). In the mine site area, the groundwater depth is around 7 m below ground level, with water occurring in floodplain sediments, weathered rock and fractured rock zones. The gradient is flat with a low northerly hydraulic gradient towards the coast. The water quality is typically brackish and neutral to alkaline. The water quality is generally of an adequate standard for processing purposes, but not of a potable quality for human consumption (due to its predominantly brackish nature).

FMA has developed a groundwater abstraction philosophy aimed at preserving the groundwater resource and minimising drawdown where possible. This has been done by making provision for approximately 38 production bore sites spread over a wide area to promote minimal drawdown by preventing between-bore interference effects. This water supply approach will assist in safeguarding the resource for the duration of the Project, while reducing the likelihood of impacts on subterranean fauna or groundwater dependent vegetation. Once completed, bores will be equipped with electric submersible pumps. Water will be transported to the processing plant water storage pond via a polyethylene pipe that will be buried in sections to accommodate site access requirements.

Two hydrogeological investigations have been undertaken in the Balla Balla Project Area based on data obtained from two exploration drilling programmes and one test pumping programme. A hydrogeological investigation was completed by Groundwater Resources Management (GRM) in 2007 (**Appendix C**). This was undertaken as part of the Bankable Feasibility Level Study and based on the production of 3Mtpa of magnetite ore requiring water demands of 90L/s sourced from the borefield north of the deposit. An additional hydrogeological investigation was completed by GRM in September 2008 **(Appendix C**) based on the production of 6Mtpa of ore with water demands of 200L/s. The additional water supplies required to meet the increased demand will be drawn from groundwater sources located south of the deposit (southern borefield).

The construction and operation of the slurry and water pipelines is not expected to discernibly alter groundwater levels because the pipelines will be installed above the level of the groundwater table

and no dewatering is proposed during pipeline installation. However, the slurry pipeline has the potential to impact groundwater quality should a rupture or leakage occur during operation.

11.2. Project objectives

The Project objective is to maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected.

This overall objective will be achieved by:

- Maintaining the quality of surface water and groundwater by controlling the transport of salt, sediment and other pollutants from mine areas;
- Maintaining the function and environmental values of natural surface and subsurface water flows; and
- Establishing stable, sustainable post-mining landforms, so as to maintain pre-disturbance flow regimes.

11.3. Relevant legislation and standards

- *Environmental Protection Act 1986*
- *Country Areas Water Supply Act 1947*
- *Rights in Water and Irrigation Act 1914*.
- *Rights in Water and Irrigation Regulations 2000*.
- Australian and New Zealand Water Quality Guidelines (ANZECC 2000).

11.4. Potential impacts

The Balla Balla Project has the potential to impact both groundwater levels and water quality:

11.4.1. Groundwater levels

Groundwater levels may be altered as a result of pit dewatering, abstraction of water from production bores and mounding of water beneath the tailings storage facility. Potential impacts of these changes include:

- Reduction in quantity of water available to terrestrial vegetation communities, subterranean fauna, and to existing groundwater users.
- Reduction in baseflow to the Balla Balla River and to the Coorinjinna Pool.
- Changes to the plant communities surrounding the TSF.

11.4.2. Groundwater quality

Potential impacts include:

- Seepage of water containing elevated salts, metals or acidity from the tailings storage facility.
- Increased salinity, acidity or metals concentrations in water in the pit void as the pit re-fills at cessation of mining.
- Groundwater quality impacts from leakage/spills of magnetite slurry.
- Adverse impacts to groundwater quality as a result of spillage or poor management of hydrocarbons or reagents.

11.5. Assessment of potential impact

The assessment of the potential impact to groundwater levels is based on groundwater modelling carried out by GRM (2008). The modelling to predict the likely extent and distribution of groundwater drawdown allowed for infrequent recharging of the groundwater system adjacent to the Balla Balla River. The model scenario assumed that recharge from the river to the groundwater system would occur only during the 80 percentile wettest year. Analysis of a composite rainfall dataset made up of daily readings from five nearby meteorological stations showed that the return period for the 80 percentile wettest year is approximately 4.5 years. For the purposes of the model, it was assumed that recharge to the groundwater system only occurs once every five years, which is a conservative scenario.

11.5.1. Groundwater levels

Groundwater modelling

It is known that the intense rainfall events in the Balla Balla area, particularly those associated with cyclonic activity; result in sizeable rises in groundwater levels (up to 5.5m measured over the 2005/2006 wet season). It is judged likely that such rises in groundwater levels will off-set (in some measure) drawdown impacts from groundwater abstraction. This is especially the case in the vicinity of the Balla Balla River, where preferential recharge associated with infiltration of surface water to the groundwater system whilst the river is flowing, is expected to result in periodic full recovery of the adjacent groundwater levels.

To enable periodic recharging of the groundwater system adjacent to the river to be accounted for in the model results, it was decided to limit the model simulation time to reflect the number of years between river flow events. Unfortunately, flows in the Balla Balla River are not measured, preventing the direct estimation of the return period between years when the river flows. In view of this, it has been assumed that the Balla Balla River flows only in years where rainfall totals are high. A nominal annual rainfall total equivalent to the 80 percentile wettest year was selected as a threshold between flow years. Effectively, this means that the model was run assuming that recharge only occurs during

the 20 percent highest wet seasons and that no recharge occurs if the amount of rainfall received is less than this.

Analysis of rainfall data from five nearby meteorological stations has identified that the return period for the 80 percentile wettest year is approximately 4.5 years. For the purposes of this report a non-recharge period of 5 years has been adopted in estimating maximum groundwater level drawdowns in the vicinity of the Balla Balla River. This return period is also consistent with the cyclone swept path analysis completed as part of the hydrological studies for the BFS, which identified that on average one cyclone will pass within 50km for the proposed mine-site every 6 years.

The predicted groundwater level drawdown from dewatering activities and pumping from the original production bores after 5 years of operation is shown in **Figure 16**. A run-time of 12 years was also undertaken with the same model parameters, in order to test the unlikely scenario of no recharge for the life of the Project. It is considered overly conservative to assume no recharge over the planned life of mine (GRM 2008): Under these conditions (GRM 2008),

- The drawdown along most of the length of the Balla Balla River would be 4m or less after 12 years.
- The drawdown along Karinha and Salt Creeks would range from about 20m in the vicinity of the production bores to about 10m or less along the creek lines.
- A number of stock watering bores close to the Project Area on Sherlock Station would be adversely affected by drawdown impacts from borefield pumping.
- The drawdown at Coorinjinna Pool would be expected to be minimal.

Subterranean fauna and existing groundwater users

Eight bores have been identified within 5km of the planned pits, using the WIN database operated by the Department of Water. The bores are used primarily for stock watering purposes and may be affected by drawdowns from dewatering and water supply activities during and immediately after mining. At locations where water supplies are still required for stock watering over this period FMA will provide an alternative water source of suitable quality.

Potential impacts on subterranean fauna are discussed in **Section 9.5.3**.

Vegetation, the Balla Balla River and Coorinjinna Pool

The Coorinjinna Pool is located in the lower reaches of the Balla Balla River, approximately 10 km northeast of the proposed mine. The pool is believed to be generally groundwater fed and protected from tidal influences at its downstream end by a rock bar which acts as a low permeability barrier. Groundwater dependant vegetation in the area to the east of the proposed mine-site comprises a line of River Red Gums that are associated with the Balla Balla River. It is likely that these trees source shallow groundwater within the channel sediments.

Any impacts upon the pool or upon riparian vegetation east or northeast of the proposed mine would be predominantly from pit dewatering or from operation of the water supply bores located north of the mine. The abstraction of water from borefields to the south of the mine is unlikely to result in any discernible impact in groundwater levels at the Coorinjinna Pool or at the Balla Balla River. Accordingly, the results of the hydrogeological investigations (GRM, 2008) and BFS groundwater modelling (GRM, 2007) have been used as the basis for assessing likely drawdowns at the Coorinjinna pool and parts of the Balla Balla River upstream of the pool.

The groundwater modelling described above suggests that with no recharge, over 5 years, the drawdown along most of the length of the Balla Balla River would be generally less than 2m and that the drawdown along Karinha and Salt Creeks would be generally less than 5m. There is some risk that if the worst case conditions eventuate, or if groundwater levels do not behave as predicted by the modelling to date, riparian vegetation along the Balla Balla River (to the east of the proposed mine pits) or along Salt Creek (to the west of the proposed mine pits) could be adversely affected by lowering of the water table. Specifically, there is a risk that the health of River Red Gums (*Eucalyptus camaldulensis*) along water courses could suffer if prolonged, excessive groundwater drawdowns occur or if the rate of decline in groundwater levels is very rapid.

Hydrogeological modelling suggests that any variation in groundwater levels near the parts of the Balla Balla River which support riparian vegetation will not adversely affect groundwater dependent species, as the magnitude of change in groundwater levels matches the scale of normal seasonal variation in the depth to groundwater. Groundwater level rises in response to rainfall recharge can be significant and were measured by FMA at a number of bores between December 2005 and

September 2006 (GRM 2008). The measured rises over this period ranged from 0.6m to 5.5m after a total rainfall of 774mm (GRM 2008). Assuming that the scale of these rises is within the bounds of normal yearly fluctuations, local vegetation communities are presumably adapted to tolerate this rate and magnitude of groundwater fluctuation. Thus, a drawdown of 5m over 5 years is not considered an unreasonable threat to the health of riparian vegetation.

There are no clear guidelines available on what magnitude of drawdown, or what rate of change in water table levels are likely to be tolerated by River Red Gums and other groundwater dependent vegetation. Given this, and the uncertainty associated with hydrogeological modelling, FMA will closely monitor the health of these communities and the adjacent groundwater levels in consultation with DEC and DoW.

Mounding

Storage of tailings in an above ground tailings storage facility (TSF) has the potential to release seepage water, giving rise to groundwater mounding beneath and surrounding the TSF. If this were to occur, the altered water levels could result in changes to the plant communities surrounding the TSF.

The TSF will be constructed using a staged approach, initially with a traditional hexagonal paddock-style TSF, with options for a second paddock TSF or a proposed integrated waste landform (IWL), pending trials during operations. Details of the TSF constuction are given in **Section 3.5.12**.

Modelling has been carried out to assess the likely rate at which seepage from the TSF could occur (URS, 2008). Three separate scenarios were considered. The scenarios adopted different assumptions about the amount of water that would be held in the pond at the surface of the TSF, as the amount of ponded water will influence the potential for seepage. The model was run to represent both transient (short term) and steady state (long term) conditions. A copy of the modelling report is provided in **Appendix C**.

The modelling shows that even in the absence of an engineered liner system, the rate of seepage during the operating life of the mine is likely to be less than 0.02mm/day (or about 5mm per year) across the area occupied by the tailings storage facility. This rate of seepage is unlikely to result in any discernible change to groundwater levels even in the immediate vicinity of the TSF. Nonetheless, FMA proposes to install an underdrainage system, and monitoring wells around the TSF as a means of ensuring that seepage from the structure can be detected. If necessary, a seepage recovery system, comprising perimeter recovery wells or trenches would be installed to collect seepage so that it can be recycled into the ore treatment process.

Additional geotechnical investigations (including permeabilities within the TSF footprint) have been completed to finalise the detailed design. No liners have been incorporated into the design of the TSF

as it has been assessed that the underlying clay has a permeability classified as “practically impermeable” (Coffey, Sept. 2008). Seepage modelling indicates a long term average of 43m³ from the preliminary TSF design which had an internal footprint within the storage impoundment of 265ha. The actual seepage from Cell 1 only, which has a smaller internal footprint within the general storage impoundment area of 102ha will be in the order of 16.5m³ per day (Coffey, Sept. 2008).

11.5.2. Groundwater quality

- Seepage of water containing elevated salts, metals or acidity from the tailings storage facility.
- Increased salinity, acidity or metals concentrations in water in the pit void as the pit re-fills at cessation of mining.
- Groundwater quality impacts from leakage /spills of magnetite slurry.
- Adverse impacts to groundwater quality as a result of spillage or poor management of hydrocarbons or reagents.

Seepage from the tailings storage facility

The environmental impacts of seepage from the tailings storage facility (TSF) will depend upon the chemical characteristics of the tailings leachate and upon the rate at which leachate seeps from the storage facility. The relatively benign chemical characteristics of the leachate and the predicted slow rate of seepage suggest that the TSF is unlikely to represent a significant source of groundwater contamination.

Testing to evaluate the likely quality of tailings leachate was carried out over a 12-month period from December 2006 to November 2007 using representative composite samples of tailings (**Table 18**). The samples were extracted with water. Details of the testing method are provided in **Appendix I**. The kinetic test results indicate that water passing through the tailings is likely to be somewhat less alkaline and less saline than average groundwater in the Balla Balla area. With the exceptions of arsenic, manganese and molybdenum, most metallic constituents of the leachate fell with the range normally observed in groundwater in the Balla Balla area. None of the leachate samples exceeded the guideline values recommended by ANZECC for water used for watering livestock.

Overall, the relatively benign chemical characteristics of the leachate, coupled with the predicted slow rate of seepage, suggest that the TSF is unlikely to represent a significant source of groundwater contamination. Nonetheless, a groundwater monitoring programme will be put in place to ensure that the TSF is performing as predicted. Details of the TSF monitoring programme will be presented in the TSF operating strategy and will also form part of the overall Project Environmental Management System

Table 18 Summary of tailings leachate test results

	Units	Tailings Composite 1	Tailings Composite 2	Second leach	Third leach	Fourth leach	Fifth leach	Sixth leach	Average concentration, Balla Balla groundwater	ANZECC Water Quality Guidelines - livestock water
		22-Dec-06	22-Dec-06	19-Jan-07	21-Feb-07	23-May-07	21-Aug-07	22-Nov-07		
Cumulative pore volumes leached			**0.50**	**1.00**	**1.70**	**2.30**	**2.80**	**3.30**		
pH	pH unit	7.58	7.8	7.48	7.24	7.22	6.85	7.26	8.1	6.5-8.5
EC	µS/cm	958	312	826	343	57	18	118	4264	~5970
Total alkalinity as $CaCO_3$	mg/L	61	55	65	43	14	8	17	380	--
Sulphate as SO_{4}^{2-}	mg/L	425	81	360	118	12	9	34	125	1000
Chloride	mg/L	61	16	22	2	2	<1	7	7.7	--
Calcium	mg/L	143	39	116	47	7	4	18	143	1000
Magnesium	mg/L	18	4	18	4	<1	<1	1	118	2000
Sodium	mg/L	56	17	42	12	2	<1	3	519	--
Potassium	mg/L	7	2	5	3	<1	<1	1	8	--
Iron	mg/L	<0.05	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	0.11	--
Aluminium	mg/L	0.02	0.03	<0.1	0.1	0.07	<0.1	<0.1	0.02	5
Arsenic	mg/L	0.037	0.008	0.011	0.012	0.006	0.002	0.017	0.005	0.5 to 5
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	0.01
Chromium	mg/L	0.001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.004	1
Cobalt	mg/L	0.005	0.001	0.004	0.006	<0.0001	<0.0001	<0.0001	<0.001	1
Copper	mg/L	0.004	0.002	0.006	0.026	0.002	0.004	<0.0001	0.005	1 (cattle)
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.1
Manganese	mg/L	0.085	0.024	0.083	0.04	0.004	0.006	0.009	0.004	--
Molybdenum	mg/L	0.007	0.005	0.02	0.008	<0.001	<0.001	0.002	0.002	0.15

	Units	Tailings Composite 1	Tailings Composite 2	Second leach	Third leach	Fourth leach	Fifth leach	Sixth leach	Average concentration, Balla Balla groundwater	ANZECC Water Quality Guidelines - livestock water
		22-Dec-06	22-Dec-06	19-Jan-07	21-Feb-07	23-May-07	21-Aug-07	22-Nov-07		
Cumulative pore volumes leached			**0.50**	**1.00**	**1.70**	**2.30**	**2.80**	**3.30**		
Nickel	mg/L	0.004	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	1
Vanadium	mg/L	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010	0.03	--
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0275	20

Final pit void water quality

At cessation of mining, dewatering of mine pits will stop and groundwater will seep back into the pit voids (GRM, 2008). The pit void lakes are predicted to act as a groundwater sinks (that is, groundwater surrounding the pit will flow towards it, rather than flowing in one side and out the other). A water balance and transport model was developed to simulate the development of the pit void lake after mine closure. The balance included the following water inflows and outflows using a daily time step interval and a total 75 year run time, assuming mine closure in January 2025:

Inflows – groundwater seepage (when pit void lake levels lie below the ambient groundwater level), direct rainfall and rainfall runoff;

Outflows – groundwater seepage (when pit void lake levels lie above the ambient groundwater level) and evaporation.

For the purposes of the pit void modelling it was assumed that adequate measures would be taken at closure to prevent the Balla Balla River from breaching its banks and discharging into the pit void lakes. Additional details on the modelling of groundwater levels and water quality in final voids are provided in **Appendix C.**

The results from the model simulations show that:

- Pit void lake levels for both the Western and Centre Pits reach equilibrium within about 75 years.
- Both pit void lakes form groundwater sinks with evaporation exceeding combined inflows.
- Equilibrium pit void lake water levels are about -70 m AHD and -40 m AHD in the Western and Central Pits respectively. These elevations represent water levels about 60 m and 30 m below the pre-mining groundwater levels at the same locations.

After the 75 year simulation time salinities in both pits are continuing to rise, with concentrations of 7,000mg/L TDS and 5,000mg/L TDS in the Western and Central Pits respectively, corresponding to a increase of between 2 and 3 times the pre-mining groundwater salinity.

Assuming that other constituents of groundwater (particularly metals) are concentrated at the same rate as salts, these increases would mean that toxicant concentrations in water in the pit void would remain below the “No Observed Adverse Effect” concentrations identified for a range of aquatic organisms in the ANZECC water quality guidelines (ANZECC, 2000). Accordingly, it seems unlikely that the pit void would become a danger to subterranean fauna over the period described by the model.

Figure 17 Predicted changes in groundwater levels following mine closure.

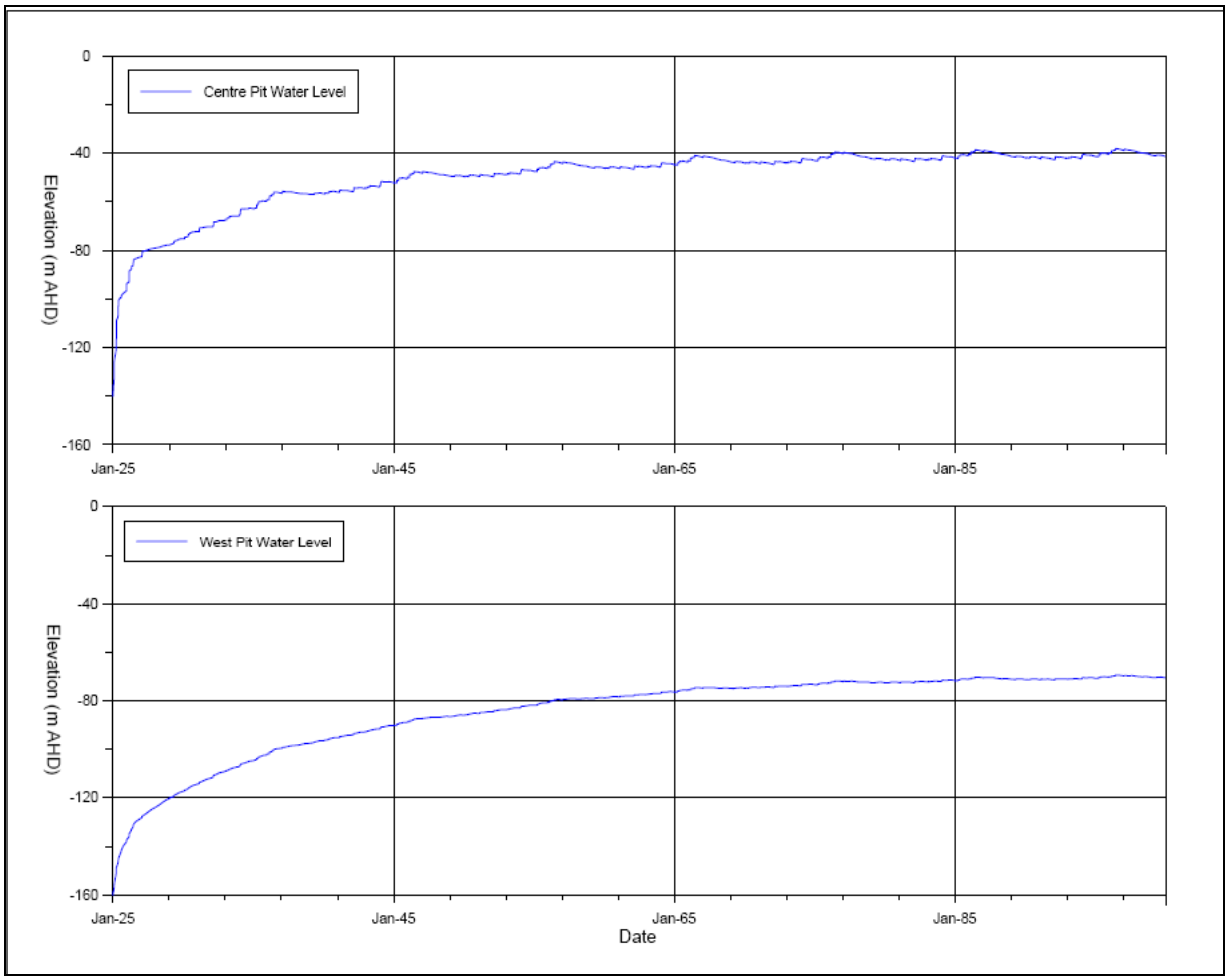
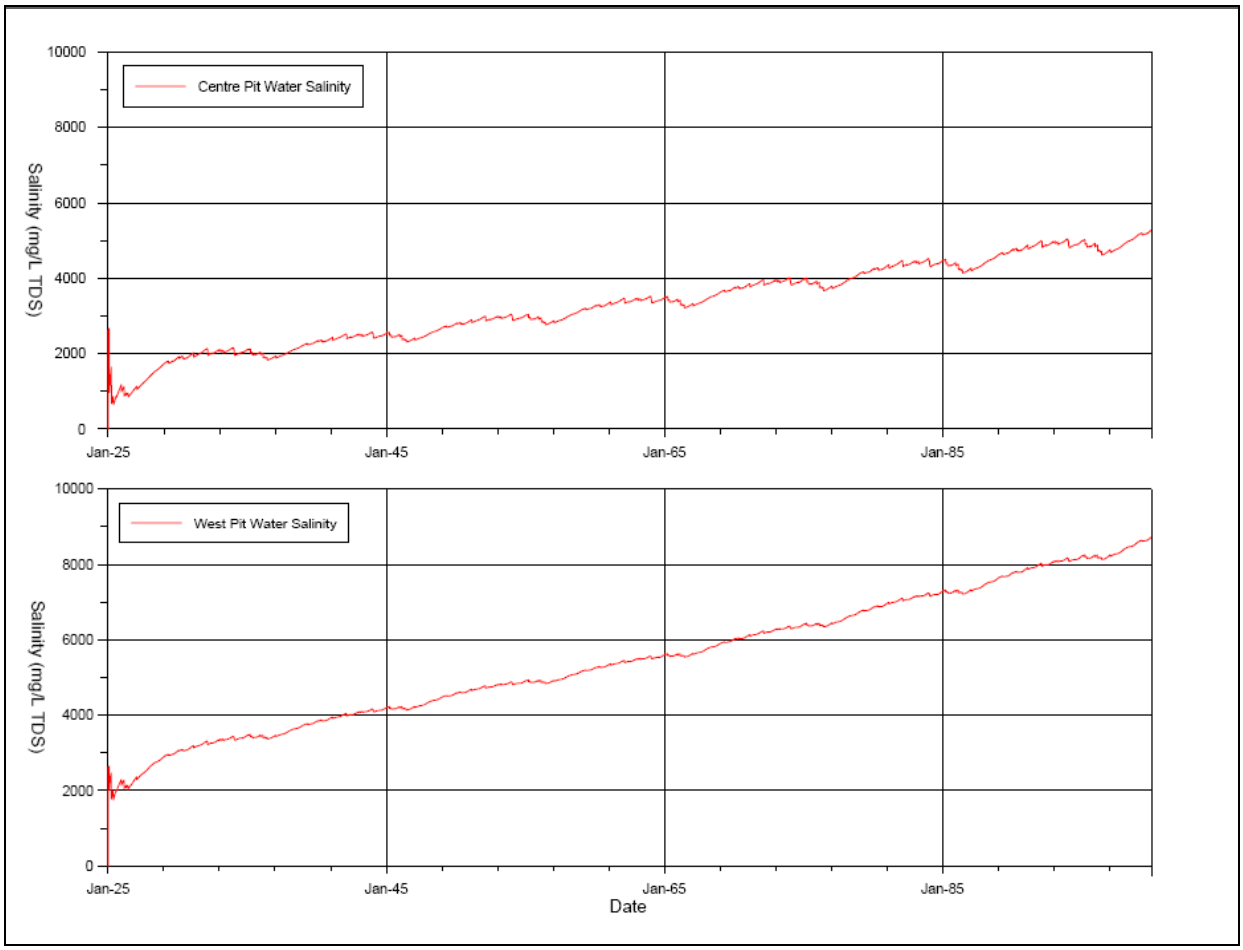


Figure 18 Predicted changes in groundwater salinity following mine closure.



Leakage or spills of magnetite slurry

The proposed corridor for the slurry and return water pipelines traverses or lies in proximity to a number of features which are susceptible to contamination through accidental leaks or spills of product, reagents or fuel. These features include:

- Watercourses (Balla Balla River, Peawah River, Yule River, Turner River);
- Groundwater protection areas (Yule River wellfield, Turner River bore field (now closed));
- Various private water bores;
- Estuarine receiving waters in the area around Utah Point.

The risk presented by construction and operation of the pipeline is a function of:

- The chemical characteristics of materials conveyed in the pipeline or used in maintaining associated infrastructure (reagents, lubricants, etc).
- The location of the pipeline and associated infrastructure relative to receptor.
- The design of the pipeline.
- The effectiveness of leak prevention, detection and response systems.

Chemical characteristics of slurry

The magnetite slurry comprises a low viscosity material which contains approximately 25% iron ore (magnetite) particles by volume. The magnetite is carried in water sourced from the Balla Balla mining area.

No reagents are added to the slurry for the purpose of conveying it to the Utah Point facility and only trace amounts of process reagents will remain in the slurry from the thickening circuit at the Balla Balla plant. The solubility of metallic constituents of the ore to be conveyed in the slurry pipeline have been assessed using the Australian Standard Leaching Procedure (Australian Standards AS4439.2 and 44396.3). The results of leachability tests carried out on a representative sample of magnetite ore are summarised in **Table 19.**

As shown in **Table 19**, the only parameters in ore leachate that exceeded Australian Drinking water guideline values were pH (marginal exceedence) and aluminium. The NH&MRC Drinking Water Guidelines note that "In major Australian reticulated supplies, the concentration of aluminium varies from 0.01mg/L to 0.9mg/L, with typical concentrations of approximately 0.1mg/L for fully treated supplies." On the basis of these results, the solubility characteristics of the slurry are considered non-hazardous and unlikely to result in groundwater contamination even in the highly unlikely event of a spill or leak.

In the event the pipeline requires water flushing to remove the remnant magnetite slurry from the pipe for maintenance or processing purposes, the flushing water remains within the processing circuit loop, and will be returned to the mine-site to be used as process water.

Location of pipeline and associated infrastructure

Figure 3 shows the location of the pipeline corridor relative to the Yule and Turner water protection zones and also to major watercourses. An intermediate pumping station is located at km63. This is approximately 5km east of the Yule River groundwater protection area. Apart from the pipelines, no other infrastructure (pump station, refuelling or fuel storage facilities, temporary camps *etc*.) will be located in the groundwater protection area or within 1km of the major river crossings. The location of the pipelines is compatible with DoW recommended setbacks from wellhead protection zones and private water bores (DoW, 2007).

The steel shell and HDPE or polyurethane lined pipe will be buried in a purpose built trench. The base of the trench will be located above the groundwater table, with the possible exception of the sections of the pipeline which cross major rivers and within about 6km of the Port Hedland dewatering facility. The burial depth at river crossings will be determined by an analysis of river bed scouring potential. The pipe will be laid approximately 1.5m below the estimated scour depth and it may be further anchored with cement blocks to bedrock if detailed engineering suggests that anchoring is

required, or it may be installed under river beds. Storm surge has the potential to affect approximately the last 6km of the pipeline, where it lies at an elevation of less than 5m AHD and it is intended to be constructed in the bund of a new road proposed by the PHPA. Storm surges have generally been recorded at up to 5m AHD along the coast (Department of Fisheries, 2004).

As the pipe will follow the Pilbara Energy Pipeline Ltd (PEPL) corridor for most of its length, the engineering parameters used for the PEPL will be used as a guide for the Balla Balla pipeline. Except for some erosion that occurred (and was repaired) during a storm event in the days immediately after completion of the Pilbara Energy Pipeline, no exposure of the pipeline or other significant erosion has occurred since pipeline completion. This performance record should be seen in the context of the hydrological conditions that have been experienced since the time of pipeline installation: five of the highest twenty rainfall events recorded at the Port Hedland meteorological station since 1942 have occurred since the completion of the Pilbara Energy Pipeline in March 1995. Each of the five events fell within the upper 1% of daily rainfall totals recorded at Port Hedland.

In summary, the pipeline corridor and associated infrastructure will be located with sufficient separation distances (both laterally and vertically) to comply with relevant guidelines and to provide an appropriate reduction in risk in the event of an accidental leak or spill during pipeline operation.

Pipeline design

As described in **Section 3.5.10**, the slurry pipeline will comprise a lined, corrosion-resistant welded steel pipe. Cathodic protection will be provided to further reduce the risk of corrosion. The slurry pipeline will be designed to satisfy relevant requirements of AS2885, the code that applies to petroleum pipelines (as there is no comparable Australian standard for slurry pipelines). Pipelines conveying slurry are internally and externally coated prior to delivery. A small section at the end of the pipe is left uncoated to allow for welding. Once welding is complete, the ends are coated prior to lowering the pipeline into the trench. The pipe design includes an allowance for internal corrosion and external erosion over the life of the Project.

The HDPE or polyurethane return water pipeline will be designed and fabricated to satisfy relevant requirements of ISO 9080 (Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form).

Table 19 Magnetite slurry leachability characteristics (Australian Standard Leaching Procedure)

Parameter	Slurry Leachate Results, mg/L	ANZECC / NEPC Guidelines – Stock Watering[1,2], mg/L	Australian Drinking Water Guidelines[3], mg/L
pH (pH units)	**8.55**	6.5-8.5	6.5-8.5
Aluminium (Al)	**0.59**	5	0.2 [4] (-)
Arsenic (As)	<0.05	0.5	0.007
Calcium (Ca)	7.8	1,000	ND
Cobalt (Co)	<0.005	1	ND
Chromium (Cr)	<0.001	1	0.05 (as Cr(VI))
Copper (Cu)	<0.005	0.5	1[4] (2)
Iron (Fe)	0.02	-	0.3[4] (-)
Magnesium (Mg)	0.4	2000	ND
Manganese (Mn)	<0.001	-	0.1[4] (0.5)
Sodium (Na)	2	-	180[4] (-)
Phosphorus (P)	<0.02	-	ND
Lead (Pb)	<0.01	0.1	0.01
Sulphur (S)	3.0	1000 (as SO_4)	250[4] (as SO_4) (500)
Silica (Si)	0.9	-	ND
Strontium (Sr)	0.01	-	ND
Titanium (Ti)	<0.01	-	ND
Vanadium (V)	0.007	-	ND
Zinc (Zn)	<0.005	20	3[4] (-)

1. ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Livestock Drinking Water*. Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Canberra, ACT.
2. NEPC (1999)b. National Environmental Protection Council. *National Environmental Protection (Assessment of Site Contamination) Measure (NEPC)*. Guideline on investigation levels for soil and groundwater. Groundwater Investigations Levels (Agricultural: Livestock).
3. National Health and Medical Research Council and the Natural Resource Management Ministerial Council (2004) Australian Drinking Water Guidelines, National Water Quality Management Strategy.
4. Values shown in table are based upon aesthetic, not health considerations. Where available, health based guideline values are shown in parentheses.

Spillage or poor management of hydrocarbons or reagents

Sources of potential hydrocarbon spills generated from the Project include:

- Machinery and vehicles.
- Fuel storage and dispensing areas.
- Power generation (during initial phases of the Project when diesel generators may be used for power supply).
- Workshop/maintenance areas.

Other chemicals which may be used on site include modest quantities of degreasing or cleaning agents, corrosion inhibitors, lubricating agents and similar industrial chemicals conventionally found in heavy equipment workshops. Minor quantities of chemical reagents would be used in the package plants used for potable water treatment and septic waste treatment. The transport and use of hazardous chemicals and dangerous goods for the Balla Balla operation is unlikely to significantly impact the environment with appropriate management actions in place. Management of dangerous goods and hazardous substances will be addressed within the Waste Management Plan for the Project.

The processing of magnetite ore is primarily a mechanical process, involving minimal use of process reagents. The reagents employed in mineral processing are non-hazardous liquid and solid flocculants to assist settling in the thickeners. Flocculant use is detailed in **Section 6.2.8**. As the flocculant(s) exhibit a very low order of toxicity they are not classed as dangerous goods.

In the event that an oxalic to nitric acid solution is employed to automatically wash the dewatering filters, the mixing and storage facility will be designed and constructed to Australian Standards, with the chemicals held within a bunded area.

11.6. Monitoring and management

A groundwater monitoring and management regime has been developed, based on two stages of hydrogeological investigations. Strategies to manage unforeseen impacts will constitute part of a Groundwater Operations Strategy to be submitted to the Department of Water as part of the normal regulatory approvals process. The monitoring and management regime will address risks associated with both groundwater levels and quality.

The 2007-08 hydrogeological investigations undertaken by GRM have updated the Bankable Feasibility Level Study groundwater flow model using the most recent testing and monitoring data from the southern bore field area. The updated model has been used to refine the estimated impacts upon the groundwater system from operation of the existing and new production bores and from dewatering activities. This includes a reassessment of the impacts upon the Coorinjinna Pool and the Balla Balla River. These updated groundwater drawdown predictions have been used as the basis for developing a groundwater monitoring and management regime and for the development of appropriate strategies to manage any unexpected or unacceptable impacts upon the Coorinjinna Pool and or on the health of riparian vegetation.

These strategies, which will be documented in a Groundwater Operations Strategy to be submitted to the Department of Water as part of the normal regulatory approvals process and include:

- Installation of groundwater monitoring bores to measure drawdown impacts at nominally three locations between the pool and the northern production bores, thereby providing early warnings of unacceptable impacts.

- Identification of groundwater level trigger values indicative of excessive drawdowns and the management responses required should trigger values be breached.
- Identification of options for mitigating/remediating unacceptable impacts.

11.6.1. Monitoring

The proposed groundwater monitoring regime for the Project is summarised in **Table 22**. A summary of the existing and proposed production bore sites, status and salinity is provided in **Table 20**. A summary of the existing dewatering bores is provided in **Table 21**. Bore locations are shown in **Figure 9**.

Surface runoff and seepage from waste rock storage areas, will be monitored and managed to limit any contamination risk to the immediate and downstream environment. pH and electrical conductivity (EC) of shallow groundwater will be monitored monthly in areas used to store/stockpile waste rock and/or tailings. These parameters will be used as broad indicators to trigger more detailed monitoring, if required. In the event that the runoff or seepage pH is found to decline below 6.5 or the EC exceeds 0.3dS/m (300µS/cm), detailed analysis will be carried out. The further testing programme will include pH, EC, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), acidity/alkalinity, Al (total and soluble), As, Ca, Cd, Cr, Co, Cu, Fe (total and soluble), K, Mg, Mn, Na, Ni, Se, SO_4, V and Zn. These parameters will, in any event, be evaluated at least annually on filtered, acidified and unfiltered, non-acidified water samples recovered from monitoring bores surrounding the surface storages of waste rock and tailings. Results will be submitted to the relevant authorities as part of annual environmental reporting.

Table 20 Summary of Balla Balla Groundwater Production Bore Sites

ID	Easting (m MGA)	Northing (m MGA)	Depth (m)	Calculated Salinity (mg/L)*	Simulated long-term yield, L/s	Status
BBWP01	577538.5	7703391	44.6	1860	7.5	Existing production bore
BBWP02	580204.3	7704271	79	1700	8.1	Existing production bore
BBWP03	578789	7705357	54	2600	8.1	Existing production bore
BBWP04	580918	7705168	33	3000	8.1	Existing production bore
BBWP05	579989	7705057	36.3	2600	8.1	Existing production bore
BBWP06	579453	7704756	32.5	1400	18.5	Existing production bore
BBWP07	579144	7700100	25	2400	4.1	Existing production bore
BBWP08	581374	7702750	34.5	1500	2.9	Existing production bore
BBWP09	583820	7701184	91	1700	7.5	Existing production bore (not tested)
BBWP10	583795	7701741	97	1700	5.6	Existing production bore (not tested)
BBWP11	581811	7700146	-	1100	6	Existing production bore (not tested)

ID	Easting (m MGA)	Northing (m MGA)	Depth (m)	Calculated Salinity (mg/L)*	Simulated long-term yield, L/s	Status
BBWP12	580261	7700637	89.6	2300	6.5	Existing production bore
BBWP13	579987	7698816	-	2500	4.5	Existing production bore
BBWP14	578902	7699216	-	2900	11.1	Existing production bore (not tested)
BBWP15	578728	7699684	-	1900	10.2	Existing production bore (not tested)
BBWP16	581811	7700146	-	2500	5.6	Existing production bore (not tested)
BBWP17	579887	7702763	61	1700	6.6	Existing production bore (not tested)
BBWP18	581028	7697539	-	1500	5.4	Direct circulation groundwater exploration hole.
BBWP19	581111	7700434	-	2300	9	Existing production bore
BBWP20	578395	7701022	-	2000	5.4	Direct circulation groundwater exploration hole.
BBWP21	579435	7700975	-	1200	7.4	Direct circulation groundwater exploration hole.
BBWP22	574847	7697516	-	-	10	RC groundwater exploration hole.
BBWP23	577859	7694781	-	-	7	RC groundwater exploration hole.
BBWP24	582693	7699285	-	1900	10	RC groundwater exploration hole.
BBWP26	574847	7702245	-	2000	7	RC groundwater exploration hole.
BBWP27	578255	7702860	-	1700	8	RC groundwater exploration hole.

Notes: * - salinity is calculated from the field measured electrical conductivity during drilling of the holes and may not be related to the possible long term salinity within the bore.

The hydrogeological report on groundwater studies that have been conducted for mine dewatering and water supply is provided in **Appendix C.** A Licence to Take Water will be sought from the Department of Water (DoW) prior to any groundwater abstraction.

Table 21 Balla Balla Dewatering Bore Sites

Bore ID	Easting (m)	Northing (m)
BBDW01	580742	7703798
BBDW02	578909	7704240
BBDW03	577974	7703638
BBDW04	577175	7703222
BBDW05	581505	7703486

Table 22 Proposed Groundwater Monitoring Programme

Monitoring Site	Parameters	Frequency	Comments
TSF Seepage Assessment			
Four TSF Monitoring Bores (yet to be installed).	Groundwater depth	Monthly	
	EC, temperature and pH	Monthly	
	Full analysis	3 monthly	pH, TDS, EC, major ions, NO3, Fe, Al, As, Sb, B, Cd, Cr, Cu, Hg, Mn, Mo, Ni, Co, Pb, Se, Zn, V and Sr
Coorinjinna Pool Assessment			
Bore BBMB007 and two new bores located between BBMB007 and the pool.	Groundwater depth	Monthly	
Coorinjinna Pool.	Pool water level	Monthly	
	EC, temperature and pH	Monthly	
Balla Balla River Drawdown Assessment			
Bore BBMB006 and BBMB008, plus two new monitor bores located between BBMB008 and the river, and between BBMB009 and011	Groundwater depth	Monthly	
Karinha and Salt Creeks Drawdown Assessment			
Bore BBMB005 and one new bore located south of the TSF.	Groundwater depth	Monthly	
Borefield Assessment			
Monitor bores BBMB007 to 024, and BBMB026 and 027, plus seven new monitoring bores located nearby production bores BBWP001 to 003, and BBWP005 to 008.	Groundwater depth	Monthly	
Production Bores BBWP001 to 0024, and BBWP0026 and 0027.	Groundwater depth	Monthly	Noting if pumps are operating at the time of measurement
	Cumulative pumping rate	Monthly	
	EC, temperature and pH	Monthly	
	Comprehensive analysis	Annually	pH, TDS, EC, major ions, NO3 and Fe

11.6.2. Management

Trigger levels

In order to manage potential impacts on the Balla Balla River and Coorinjinna Pool due to groundwater drawdown, FMA has adopted a maximum *annual* rate of drawdown of 2m per year (measured at a point approximately 500m west of the Balla Balla River) as the "trigger value" that would signal the need to initiate further investigations or management actions to ensure that the health of riparian vegetation is not adversely affected by changes in groundwater levels arising from mining and related activities.

Trigger levels will be established using the pre-disturbance groundwater level monitoring data (to assess natural variations in groundwater and pool levels) and the updated groundwater model. The trigger levels for management responses will form part of submissions to the Department of Water and to the Department of Environment and Conservation for licensing of water abstraction under the *Rights in Water and Irrigation Act 1914* and under Part V of the *Environmental Protection Act 1986*.

It is proposed that the trigger levels for Coorinjinna Pool will be based upon groundwater levels in the three existing monitoring bores and two proposed bores. The trigger thresholds will be identified from the groundwater level baseline data collected prior to the start of operations. The trigger levels for Balla Balla River will be based upon groundwater levels in the three relevant monitoring bores. The trigger levels for the Karinha and Salt Creeks will be based upon groundwater levels in monitoring bore BBMB005. Triggers for project production bores will be based on groundwater levels and salinity measurements in the water supply and equipped dewatering bores. The thresholds will be identified from pre-mining groundwater levels and salinity records detailed in **Table 21.**

Groundwater drawdown

Options for mitigating or remediating the effects of groundwater drawdowns considered an unacceptable risk to vegetation, waterways and pools are likely to include:

- Reduction or cessation of pumping from adjacent production bores.
- Augmentation of groundwater flows to the area.

Hydrocarbons, waste and reagents

All hazardous materials including hydrocarbons will be handled, stored and used in accordance with the requirements of relevant legislation. All hazardous and industrial wastes, such as oils, greases, lubricants, batteries and tyres, will be collected and stored separately in accordance with the site's DEC licence, before being collected by a licensed waste contractor for offsite disposal or recycling. Waste hydrocarbons and hydrocarbon contaminated materials will be disposed of to an approved facility. Waste oil will be collected for recycling by a licensed contractor. Controls will be implemented to prevent hydrocarbon contamination of the environment and to respond to hydrocarbon spills. These are discussed in detail in **Section 6.2.8**.

Drainage management for the prevention and mitigation of impacts of hydrocarbon and reagents on surface and groundwater are addressed in detail in **Section 10.6**.

Slurry pipeline

Spills and leaks from the type of slurry pipeline proposed are extremely rare. The most likely cause of a pipeline rupture is as a result of direct impact from third party interference (for example, unauthorised excavation by heavy excavation plant in the pipeline corridor). Signage will be provided (as is currently the case for the existing gas pipeline) to alert people to the presence of buried pipelines.

To reduce the risk of other causes of leaks or spillage, FMA will:

- Pressure test pipelines with water before commissioning;
- Provide additional cover to protect pipelines in high traffic areas or locations where there is a risk of erosion or heavy surface loads;
- Conduct periodic non-destructive testing during the operational phase of the Project to monitor actual pipe wall thicknesses;
- Operate to a regular maintenance schedule; and
- Regularly audit the maintenance system.

The slurry pipeline pressures will be continuously monitored by means of an automatic pressure management system. In the event of a sudden pressure change, the software system would automatically shut down pipeline operation. The system is able to identify the approximate location of the pressure drop so that leak investigation and response can be initiated promptly and efficiently.

In the unlikely event of a spill or leak, the rheological properties of the slurry are such that the suspended iron ore (magnetite) particles would quickly settle. Laboratory tests on the settling behaviour of the slurry have found that the slurry settles rapidly to form a “fluffy” sediment: it is unlikely that the spillage would travel far from the initial point of release. If a spill were to occur in proximity to a sensitive receiving environment, such as the marine waters off Utah Point, the following contingency actions would be taken:

- Pumping of slurry would cease automatically.
- Relevant agencies would be notified of the release.
- Bunding would be deployed to isolate the spill and prevent flow of entrained magnetite into any surface waters or drains.
- The contents of the pipeline requiring repair may be pumped to the dewatering plant or to the nearest appropriate containment vessel.
- Affected soil and spilt product would be collected and recycled through the ore treatment process.

- The pipeline will be repaired and reinstated after appropriate investigation and pressure testing.

FMA will conduct periodic desktop emergency simulations to ensure that operations staff are familiar with the emergency response procedures and to test the effectiveness of the procedures.

Tailings storage facility

Modelling shows that even in the absence of an engineered liner system, the rate of seepage is unlikely to result in any discernible change to groundwater levels even in the immediate vicinity of the TSF. Combined with the relatively benign chemical characteristics of the leachate, significant groundwater mounding or contamination is unlikely.

An underdrainage system will be installed and positioned at the toe of the upstream perimeter embankment to collect any water seeping from the coarse fraction of the tailings. The presence of the underdrainage system will allow water to be recycled as it will be returned to the plant and will also assist in controlling (lowering) the phreatic surface within the tailings (Coffey, Sept 2008). A network of additional monitoring bores will be developed around the TSF to measure groundwater levels and quality during the mine's operation and rehabilitation. In the event the tailings become acidic over time, local reserves of calcium carbonate are available nearby for neutralisation.

11.7 Predicted Outcomes

Based on groundwater modelling, the predicted groundwater level drawdown from dewatering activities and pumping from production bores after 12 years of operation would be 4 m or less along the Balla Balla River and minimal (<1m) at Coorinjinna Pool. Drawdown along Karinha and Salt Creeks would range from 20m in the vicinity of the production bores to about 10m or less along the creek lines. However, intense rainfall events in the Balla Balla area which are known to result in sizeable rises in groundwater levels (up to 5.5m measured over the 2005/2006 wet season), would be expected to result in the recovery of pre-mining groundwater levels over the longer term.

The Project is not expected to impact groundwater dependant vegetation, specifically River Red Gums (*Eucalyptus camaldulensis*) as local vegetation communities are presumably adapted to groundwater level fluctuations. However, as there are no clear guidelines available on what magnitude of drawdown, or what rate of change in water table levels are likely to be tolerated by River Red Gums and other groundwater dependant vegetation, FMA will closely monitor the health of these communities in consultation with DEC and DoW.

There are not expected to be any impacts from groundwater mounding of the TSF as the underlying clay has a permeability classified as "practically impermeable" and seepage modelling does not

predict any discernible change to groundwater levels. An underdrainage system and monitoring wells will be installed to monitor potential seepage and mounding.

The Project is not expected to impact the groundwater quality from TSF seepage, leakage or spills from the magnetite slurry or hydrocarbons or reagents. The slurry pipeline will be constructed in accordance with Australian Standards for petroleum pipelines and has developed a pipeline spill contingency plan. FMA has developed a Waste Management Plan to ensure the management of dangerous goods and hazardous substances does not result in contamination.

At the cessation of mining, the pit void lakes are predicted to act as groundwater sinks. Pit void modelling predicts that salinity will increase by 2 to 3 times from pre-mining levels.

The groundwater monitoring programme will monitor any potential impacts associated with both groundwater levels and quality above. Trigger levels that would signal the need to initiate further investigations or management actions have been developed and will be finalised as part of the Groundwater Operations Strategy to be submitted to the DoW and licensing requirements under *Part V of the Environmental Protection Act 1986.*

12. REHABILITATION AND CLOSURE

12.1. Description of factor

The Balla Balla Project is designed for a nominal life of mine of 15 years. The Project has been designed to allow progressive implementation of rehabilitation works that will support corporate and statutory closure requirements. This section briefly describes key closure objectives and the actions that will be taken to achieve those objectives. This discussion of rehabilitation and closure considers both planned and unplanned closure. "Unplanned closure" refers to closure resulting before the end of the projected 15-year mine life as a result of significant unexpected events such as changes in commodity prices, changes in market demand or other circumstances that would have the effect of causing an earlier than planned cessation of mining. On the advice of DoIR, FMA have not developed a detailed rehabilitation plan at this stage in the project. During the development and operation of the mine, a detailed rehabilitation plan will be developed through rehabilitation trials and on-site experience. Within the first two years of mining, FMA will commence rehabilitation trials for the integrated waste landform and general waste landform. The final rehabilitation plan will be developed over time. The rehabilitation plan will be developed in consultation with DoIR, DEC and DoW.

12.2. Closure and rehabilitation objectives

FMA's overall objectives for rehabilitation and closure are to:

1. Ensure that public safety and key environmental values will be protected.
2. Ensure that the use of environmental resources by FMA will not result in public cost or liability or significantly constrain the agreed future uses of the land.
3. Minimise disturbance to biophysical systems.
4. Optimise use of valuable resources, including water, energy and topsoil.
5. Attain closure and rehabilitation outcomes agreed with government agencies and other stakeholders.

Planning for rehabilitation and closure will be linked to mine planning to ensure that closure and rehabilitation works are as cost-effective as possible and implemented in a timely manner. Whole-of-project costs and environmental risks will be taken into account when making decisions on the scheduling and allocation of resources for rehabilitation and closure works.

12.3. Post mining land uses

The post-mining land use for the Project Area is proposed to be re-incorporation within the existing Mallina Station and Sherlock Station pastoral activities. It is anticipated that the current level of tourist and other recreational visits to the Balla Balla/Whim Creek locality will continue post-mining. No new land uses are proposed for the site, although alternative uses may be identified during ongoing stakeholder consultation.

12.4. Regulatory and policy context

The closure, decommissioning and rehabilitation of the Balla Balla mine-site, service corridors and facilities at Utah Point will be conducted in accordance with the general provisions of the following key legislation, policy documents and related guidelines:

Mining Act 1978;

Mines Safety and Inspection Act 1994;

Mines Safety and Inspection Regulations 1995*;*

Environmental Protection Act 1986;

Contaminated Sites Act 2003;

Contaminated Sites Regulations 2006;

Chamber of Minerals and Energy: Mine Closure Guideline for Minerals Operations in Western Australia (2000);

DoIR Environmental Notes: *Care and Maintenance* (January 2001);

DoIR Guidelines: Mineral Exploration / Rehabilitation Activities (August 2007);

Department of Industry, Tourism and Resources: *Mine Closure and Completion* (October 2006);

Department of Industry, Tourism and Resources: *Mine Rehabilitation* (October 2006);

Water and Rivers Commission: *Mine Void Water Resource Issues in Western Australia* – Hydrogeological Record Series, Report No HG9 (2003);

Ministerial Council on Mineral and Petroleum Resources and Minerals Council of Australia: *Strategic Framework for Tailings Management* (2003);

EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (2006);

EPA Position Statement No. 5. Environmental Protection and Ecological Sustainability in Rangelands in Western Australia (2004).

12.5. Potential impacts

The key potential environmental impacts of the Project which are relevant to mine rehabilitation and closure are summarised in **Table 23**.

Table 23 Key potential environmental impacts relevant to rehabiltation & closure.

Activity	Potential Impacts
Clearing of vegetation for construction of pits, dumps, roads, tailings storage facilities, other infrastructure.	Loss of vegetation. Potential to spread weedy species in disturbed areas. Loss of habitat. Reduced habitat connectivity. Increased erosion and dust generation.
Disturbance of soil during construction of pits, dumps, roads, tailings storage facilities, other infrastructure.	Compaction of soil. Reduction in soil fertility or viability of seed bank through improper storage of salvaged topsoil. Loss of growth medium/cover material through improper handling or placement of soils.
Establishment of waste landforms (rock dumps, tailings storage, pit voids) and other built features (roads, laydown areas).	Potential for uncontrolled release of materials or contaminants (acidity, salt, metals) to surrounding environment (soil, atmosphere, groundwater or surface water) if insufficient cover materials and/or growth media are available for rehabilitation. Reduced visual amenity and landscape value. Safety risks associated with possible slope instability at TSF or waste dumps; uncontrolled access to pit void.
Mine dewatering, water abstraction from borefield(s).	Changes to groundwater levels as a result of mine dewatering or water abstraction.
Creek diversion(s) and flood protection works.	Modifications to catchment areas, drainage networks and hydrologic flow regimes
Use and storage of fuels and reagents.	Contamination of soil, surface water or groundwater as a result of spillage.

The Project will disturb approximately 1010ha of land within the mine-site over the life of the Project. An additional 505ha will be disturbed for the pipeline construction, which will then be immediately rehabilitated. The disturbance is summarised in **Table 24.**

Table 24 Summary of disturbance – Balla Balla Project

Description of mining disturbance	Area (ha)
Open Pit (including Haul Roads)	165
Waste Dumps	368
Oxide Stockpile	5
Flood Bund	5
Topsoil stockpile	109
Tailings Storage Facility (Cell 1 + Integrated Waste Landform)	174
Process Plant & ROM Pad (including Process Water Ponds)	80
Gas, Slurry and Water Pipelines to PHPA	505
Accommodation Village	21

Access Roads (including Borrow Pits)	35
Historical areas mined by previous operators	1
Exploration (where clearing takes place)	2
Other infrastructure (including Borefields, Pipelines; Explosives Magazines; Core Farm; Communications; Laydown Areas)	45
TOTAL (Disturbed Land)	**1515**
Undisturbed Land	2374
TOTAL (Sum of all land within tenement areas)	3889

12.6. Rehabilitation strategy

The following strategies have been identified as the basis for progressive rehabilitation and closure of the Balla Balla Project:

1. Required closure outcomes will be defined in terms of verifiable completion criteria, which will be developed in consultation with key stakeholders (DoIR, DEC and DoW).
2. FMA will regularly monitor and provide publicly available reports on its progress in achieving rehabilitation and closure outcomes.
3. Project design and operational practices have and will aim to minimize disturbance.
4. Rehabilitation of disturbed areas will be implemented progressively.
5. Double handling of wastes and other materials is to be minimized, and ideally avoided.
6. Built landforms are to be positioned as close as possible to the pits, subject to other constraints (so as to minimize haul distances).
7. Disturbance footprints will be minimized, subject to satisfying design objectives.
8. Built landforms will be constructed using conventional mine earthmoving equipment.
9. Built landforms will be located out of floodplains and away from areas prone to erosion or flooding, or protected by flood protection bunding.
10. Passive drainage, consistent with accepted standards of risk, will be used in preference to active engineered hydraulic structures to manage rainfall incident upon waste landforms or other built landforms.
11. Revegetation of built landforms and disturbed areas will aim to restore a level of botanical diversity and a species mix similar to that which exists in agreed analog systems in the Project region. In some cases, the system developed in the post-mining system may be based upon soil-vegetation assemblages which are not the same as those displaced by mining.
12. The potential for generation of acid leachate or oxidation from tailings will be controlled through the design, construction, maintenance and monitoring of appropriate containment systems and cover design.
13. Mine tailings will be progressively covered and rehabilitated so as to prevent wind or water erosion of stored tailings.

14. The tailings facility embankment walls will be progressively rehabilitated upon embankment lifts.
15. Buildings, roads, equipment and wastes (other than tailings and mine waste/overburden) will be removed from the site as part of mine decommissioning and closure.
16. In the post-closure period access to potentially hazardous areas will be controlled primarily through the provision of physical barriers (fences, bunds) and appropriate signage where necessary.

This strategy will be reviewed throughout the life of mine in consultation with DoIR, DEC and DoW.

Table 25 Stakeholder list

State Government	
Environmental Protection Authority Services Unit (EPASU)	Department of Industry and Resources (DoIR)
Department for Planning and Infrastructure (DPI)	Department of Water (DoW)
Department of Employment and Consumer Protection (DoCEP)	Department of Environment and Conservation (DEC)
Office of Development Approvals Coordination (ODAC)	Department of Indigenous Affairs (DIA)
Main Roads of Western Australia (MRWA)	Western Australian Museum (WAM)
Port Hedland Port Authority (PHPA)	Pilbara Development Commission
Local Government	
Shire of Roebourne	Town of Port Hedland
NGOs and private companies	
Conservation Council of Western Australia	Straits Resources
Progress for Port Hedland Group	Wildflower Society of Western Australia
Indigenous	
Ngarluma Group	Karriyarra Group
Other	
Mallina Station	Sherlock Station
FMA Contractors and Suppliers	FMA Management and Staff

FMA have developed a Ground Disturbance and Rehabilitation Management Plan as part of its Environmental Management System. The rehabilitation strategy will incorporate Ecosystem Function Anyslis (EFA) as the method to measure and monitor on-going rehabilitation. EFA outcomes and results will be reported in the annual environmental review when rehabilitation commences.

12.7. Closure design concepts

12.7.1. Pit voids

The final pit voids will remain as permanent features in the landscape with the main issues being public safety and water quality.

The two pits comprise hard rock pits with limited weathered material below a depth of about 12m. At cessation of mining the central pit will be approximately 160m deep with a crest length of 2000m along its long axis (which runs approximately northwest to southeast) and 500m width in a southwest to northeast direction. The western pit will extend to a final depth of approximately 165m, and will have final dimensions of approximately 3600m long by 350m wide.

The pit voids will be made safe following the cessation of mining, by establishing an abandonment bund to meet the requirements of DoIR's "Safety Bund Walls Around Abandoned Open Pit Mines Guideline" (DoIR, 1997) to prevent inadvertent public access.

GRM predicts the Balla Balla pits to form groundwater sinks over time with depth due to low permeability surrounding the pits. The water quality is expected to remain low in salinity in the upper strata of the pit water layers due to fresh water lenses. The pits have the potential to be flushed with fresh water when the Manipurl Creek flows and with the seasonal low pressure downpours consistent with the Pilbara area.

During operations the pit will be protected by the minor drainage from the Manipurl Creek by the flood protection bund; however post-closure the bund will be removed. A pit water quality investigation, including pit void modelling, has been completed (GRM Sept, 2008). The water quality results indicate that the Coorinjinna Pool water is similar to the regional groundwater in salinity and pH, but shows higher relative concentrations of magnesium and calcium. Anecdotal evidence suggests the pool may be inundated by marine water during peak tides (GRM Sept, 2008). If this occurs then high salinities could be expected in the pit lake from time to time. The groundwater quality exceeds the guideline limits for recreational and stock watering for salinity, sodium, chloride and nitrate at all or most bores. Arsenic and selenium each marginally exceeded the recreational guideline limit at one bore (BBWP026 & BBWP027 respectively) and mercury was exceeded at four bores. This issue will be monitored over the longer-term and considered in more detail in the final mine closure plan.

The level of the final pit void water will prohibit access by feral animals for use as a water source.

12.7.2. Waste dumps

Approximately 270Mt of waste rock will be generated during the 15 year mine life. It is proposed that this waste be distributed between six waste landforms. Two of the waste landforms will be located to the northwest of the western pit, two will be located to the southeast of the western pit and two will lie

to the southwest of the central pit **(Figure 8).** The landforms will be built concurrently, to allow flexibility in placement of materials and to ensure that haul distances can be optimized throughout the active life of the mine.

All six waste landforms will be located outside the 1 in 100 year flood levels of watercourses in the Project Area, and at least 1.25km from the Balla Balla River. Waste landforms are positioned in relatively close proximity to the mine pits, to minimise disturbance and haul distances, to the extent that this is consistent with geotechnical safety considerations and requirements for working room and construction of safety bunds.

The waste landforms will have a nominal maximum height of 55m. The landforms will be constructed with 25m wide berms placed every 20 vertical metres. Face angles of the dumps will be battered down to achieve an average overall slope gradient of approximately 20^{o}.

The cover materials used on waste rock landform side slopes will comprise coarse, rocky waste, to provide erosion resistance. Topsoil will be placed above the rocky armouring layer and ripped to mix the layers and create a suitable environment for moisture retention and plant growth. The conceptual design does not require uniform placement of topsoil: the distribution of topsoil will reflect pre-mining soil distribution in that upper slopes may have relatively thin or discontinuous cover, allowing “islands” of vegetation to establish, whereas lower slopes and flatter areas (including landform tops) may have thicker, more continuous topsoil cover.

12.7.3. Tailings storage facility

The planned operation of the TSF involving perimeter discharge to central decants will produce a surface landform with a gentle dished profile, with the beaches falling about 5m below the perimeter to the centre. Several options have been considered for closure, including the creation of a ‘domed’ profile, so that any excess run-off drains to the perimeter. The ‘dome’ could be created from mine-waste or alternatively for the last year of operation the deposition system could be changed to central discharge, to form tailings beaches grading from the centre out to the perimeter.

In all cases, the final surface is likely to require a multi-layer capping to limit infiltration of the incident rainfall, to minimise oxidation of the tailings, and to enable the TSF to be rehabilitated to conform to the surrounding naturally vegetated environment (Coffey, 2008). The main objectives of the TSF cover will be to:

- Provide a robust long-term cover that will stabilise the surface of the TSF;
- Retain/store rainfall from most precipitation events within the cover system;
- Sustain a vegetated cover over the surface of the TSF;
- Control the flow of any excess surface water across the TSF such that significant erosion does not occur; and
- Reduce long-term infiltration of moisture and ingress of oxygen into the TSF.

The detailed design of the surface capping will be dependent on the geochemistry of the tailings and the geochemical and physical characteristics of the mine waste available at the time of decommissioning. At least 5 years before decommissioning a detailed decommissioning and rehabilitation plan will be initiated to examine the most appropriate method of treatment. A "store and release" cover system is proposed as a means for managing the risk of erosion and seepage at the TSF. The engineered cover system will store the majority of the incident precipitation in the short wet season, and then releases this moisture through evapotranspiration during the prolonged dry season. If designed correctly, a "store and release" cover will limit the risk of the moisture stored in the cover system from infiltrating into the underlying waste, as well as providing optimum conditions for development and maintenance of a vegetative cover.

Given the site conditions of 1) a semi-arid to sub-tropical climate with two distinct seasons - the wet season when rainfall may occur from December to March, and generally dry conditions for the remainder of the year, and 2) tailings which are potentially acid forming (PAF), it has been assumed that a four-layer capping system may be required, comprising (from the tailings upwards):

- A 0.5m thick capillary break layer to limit the potential for acid and soluble metals/salts from the tailings to move by capillary action into the overlying cover and impact vegetation growth. Detailed design, when characteristics of the production tailings and potential cover materials are better defined, may show that this capillary break zone is not required.
- A 0.5m compacted layer which is intended to remain relatively saturated and assist in limiting water infiltration and oxygen ingress into the TSF. This would be selected finer waste rock material, moisture conditioned and compacted, with a target permeability of about 1×10^{-6}m/s.
- A 1.5m protection layer to protect the compacted layer from evapo-transpiration impacts such as drying and cracking, animal activity, or penetration of roots. The protection layer is the primary moisture "store and release" element of the cover system, and provides a layer for root growth. This layer would comprise loosely placed mine waste suitable for the growth of vegetation, with a permeability up to 2 orders of magnitude greater than the underlying compacted layer.
- A 0.1m thick growth layer, to provide a zone for vegetation germination, that could include "rock mulch" or salvaged topsoil.

The above layer thicknesses and characteristics for this conceptual design are based on preliminary numerical modelling design studies recently carried out by URS for a store and release cover for a similar tailings capping scenario in the Pilbara.

Soil and rock material will be salvaged from the initial tails storage area and this will be stockpiled for future closure use. The downstream batters may be progressively rehabilitated as the embankment is raised. The staged upstream raising of the TSF will produce an average downstream batter slope of

about 4H:1V, mainly consisting of a series of 2.5m high 2H:1V slopes separated by 5-6m wide berms. Depending on the observed performance of this "stepped" profile over the years of TSF operation, it can either be permanently retained or reshaped as part of the rehabilitation works to provide a uniform 4H:1V slope. Trials will be undertaken for the initial slope rehabilitation to optimize the effective use of soil and other materials salvaged from the mine disturbance footprint.

The topography and soil water relations of the integrated waste landform will differ significantly from the flat pre-mining terrain. Accordingly, it is unrealistic to aim to reinstate the vegetation assemblages that would have occurred naturally at the TSF location. In any event, the pre-mining conditions in the area that will be occupied by the TSF had been significantly altered by grazing. Rehabilitation trials will be conducted to determine the most appropriate species mix for revegetation of the TSF surface. It is likely that the following species, which are characteristic of sandy hills and near-coastal dunes in the general Project locality will be included in the rehabilitation mix.

12.7.4. Flood diversion works

Flood protection berms and channels are required to protect the eastern, northern and southern limits of the proposed Central Pit and Mine Services/Processing Plant area, tying into the south-eastern corner of the Tailings Storage Facility.

The rehabilitation strategy proposed in relation to the hydrological (surface water changes) that arise from pit development and flood protection works are as follows:

- The flood protection berms and associated perimeter drainage diversion works will be removed and rehabilitated with the exception of maintaining safety bunding around the pit void.
- The constructed channel at the southeast of the TSF and Central pit has been designed to match the flow quantities and flow velocities that characterised the pre-mining hydrology. The creek diversion will be targeted for early rehabilitation efforts. Topsoil salvaged from parts of the disturbed creek alignment within the pit footprint will be used when rehabilitating the new creek alignment. Revegetation of the new creek alignment will seek to match vegetation communities that occur in similar ephemeral systems in the Balla Balla catchment.

12.7.5. Access and haul roads

Unless otherwise agreed with government and other stakeholders, access and haul roads will be decommissioned and rehabilitated at mine closure. Road surfaces will be ripped to reduce compaction and will have topsoil replaced and be re-vegetated.

12.7.6. Plant, camp and other works areas

Unless otherwise agreed with government and other stakeholders all buildings, equipment and infrastructure will be removed from the plant and camp areas at mine closure. Contaminated materials (such as hydrocarbon affected soils) will be removed or treated *in situ* to ensure that the

land is suitable for the agreed post-mining land uses. Any areas used for landfilling of wastes will be capped and re-vegetated to meet applicable state and local government requirements, including those set out in the Environmental Protection (Rural Landfill) Regulations 2002. The locations of any landfills will be notified to the government, consistent with the requirements of the *Contaminated Sites Act* 2003 and any other applicable legislation.

The slurry pipeline will be decommissioned *in situ* in accordance with the Australian Pipeline Association Code of Environmental Practice which is considered to be the environmentally preferable option. The pipeline will be physically disconnected from the pipe system, purged and cleaned and capped at both ends. All above ground structures will be removed and the access track rehabilitated. Monitoring of the pipeline decommissioning and rehabilitation will be managed under the Ground Disturbance and Rehabilitation Plan.

13. SUMMARY OF ENVIRONMENTAL MANAGEMENT COMMITMENTS

Environmental management of the Balla Balla Project will be via the commitments in **Table 26**. The table is a summary of those made in this Referral Document.

Table 26 FMA environmental management commitments

Subject	No.	Commitment
Stakeholder Consultation	1	Consultation with relevant stakeholders will continue throughout the life of the Project.
	2	Pastoralist infrastructure affected as a result of the Project will be replaced and upgraded where necessary.
Flora and Vegetation	3	All clearing of vegetation , in particular riparian systems, will be kept to a minimum over the Project Area.
	4	FMA will endeavour to avoid disturbance of Priority species communities and additional targeted work will be undertaken to locate *Mimulus* sp. *and Gromphrena* sp. post-cyclonic rains.
	5	Further targeted surveys will be undertaken at the Yule River for *Olearia dampieri* post-cyclonic rains.
	6	Mine traffic will be restricted to designated access roads. Vehicles will be prohibited to traverse 'off-road' without appropriate authorisation.
	7	Prevention of fire over the Project Area will be a key priority for FMA operations, especially in consideration of highly flammable spinifex vegetation and the potential impact of frequent fire on habitat quality. A Fire Management Plan will be prepared and based upon fire exclusion within the Project Area. A regional approach will be adopted to fire management and suppression in liaison with neighbours, including the local Pastoralists and DEC, and FESA. An induction and ongoing education program for FMA staff will reinforce awareness of flora protection.
Terrestrial Fauna	8	Pipeline trenching for construction will not occur during the months of November to March (inclusive). No more than 20km of trench will be open at one time and the trench will be cleared within 3 hours of daylight everyday by a designated fauna pipeline clearing crew.
	9	A further short range endemic survey will be undertaken prior to any ground disturbing activity, before the next dry season.
	10	All drill holes will be temporarily capped on completion of drilling and permanently capped as soon as practicable.
	11	Management over the Project Area will ensure that feral animals and dingoes, as well as native animals, cannot access waste products, potentially increasing abundances at the local scale. Workforce training, through site inductions will

Subject	No.	Commitment
		help facilitate waste management and feral animal education.
Subterranean Fauna	12	FMA will implement the stygofauna monitoring programme.
Water	13	Reuse of water will be maximised.
	14	FMA will measure and monitor water usage.
Surface water	15	There will be no discharge of excess or disturbed water off-site and run-off from undisturbed areas within the Project Area will be diverted around the facility via diversion ditches.
Groundwater	16	A comprehensive surface and groundwater monitoring program will be finalised by FMA prior to the commencement of pit dewatering or bore field development or use. FMA will consult with DoW and DEC to determine groundwater trigger values indicative of excessive drawdowns and the management responses required should a trigger value be breached.
Erosion and Sediment Control	17	Erosion and sediment control best management practices (BMPs) will be adopted in the design and construction of surface water management facilities.
Tailings	18	The tailings will be stored in a designated storage facility designed to minimise environmental impacts. The tailings storage facility will be progressively rehabilitated throughout the life of the mine.
	19	Further chemical/geochemical characterisation of materials will be undertaken where necessary.
	20	Water reclaimed from the tailings storage facility will be collected, contained and reused on-site to the maximum extent.
Pollution	21	Dust suppression in high traffic areas including haul roads, access roads, around the plant and offices and other disturbed areas, will be undertaken with water carts, where required during construction and operations. Water used for dust suppression will be monitored periodically to ensure water quality, especially salinity, is acceptable for use.
	22	Dust, plant, blast and exhaust emissions will be estimated and reported in the National Pollution Inventory submitted annually to the DEC.
	23	Noise emissions associated with all mining and processing activities will meet the requirements of the *Mines Safety and Inspection Act 1994*, *Mines Safety and Inspection Regulations 1995* and *Environmental Protection (Noise) Regulations 1997*.
	24	Waste minimisation, reuse and recycling initiatives will be implemented where practicable.
	25	The sewage treatment system will be designed and operated to comply with the Shire of Roebourne and Department of Health regulations. The resulting treated effluent will be utilised in watering gardens or will be disposed of to a series of leach drains.
Closure and Rehabilitation	26	Topsoil and cleared vegetation will be stockpiled and returned to landforms and disturbed areas during rehabilitation earthworks. Local provenance seed material will be used for seeding in rehabilitation works.
	27	Rehabilitation resource stockpiles will be constructed to maximise the materials' longevity and positioned close to where they are intended to be used

Subject	No.	Commitment
		to reduce the necessity for double-handling.
	28	Progressive rehabilitation of disturbed areas will be implemented with the aim of establishing stable, productive ecosystems which are compatible with agreed post-mining land uses. .
	29	Cattle will be excluded from the Project Area throughout the life of the Project. Cattle will be excluded from 'new' rehabilitation areas and these areas will be fenced.
	30	Rehabilitation trials will be conducted to determine the most appropriate species mix for revegetation of the TSF surface.
	31	Unless otherwise agreed with government and other stakeholders, access and haul roads will be decommissioned and rehabilitated at mine closure. Road surfaces will be ripped to reduce compaction and, where available, will have topsoil replaced and be re-vegetated.
	32	Unless otherwise agreed with government and other stakeholders all buildings, equipment and infrastructure will be removed from the plant and village areas at mine closure. Contaminated materials (such as hydrocarbon affected soils) will be removed or treated *in situ* to ensure that the land is suitable for the agreed post-mining land uses. Any areas used for landfilling of wastes will be capped and re-vegetated to meet applicable state and local government requirements, including those set out in the Environmental Protection (Rural Landfill) Regulations 2002. The locations of any landfills will be notified to the government, consistent with the requirements of the *Contaminated Sites Act* 2003 and any other applicable legislation.
Infrastructure	33	The intersection of the Project access road and the highway will be bituminised and constructed to the standard required by the WA Main Roads department. Suitable signage will be provided in accordance with WA Main Roads regulations.
	34	Built landforms will be located out of floodplains and away from areas prone to erosion or flooding, or protected by flood protection bunding.
	35	The pit voids will be made safe following the cessation of mining, by establishing an abandonment bund to meet the requirements of DoIR's "Safety Bund Walls Around Abandoned Open Pit Mines Guideline" (DoIR, 1997).
Dangerous and Hazardous Goods	36	All dangerous goods and hazardous materials including explosives and, hydrocarbons will be handled, stored and used in accordance with the requirements of relevant legislation.
Social	37	No significant anthropological, archaeological or ethnographic sites will be impacted by the Project. FMA will continue to invite consultation with Traditional Owners and the DIA on the management of those identified sites located within close proximity to the Project and create a Cultural Heritage Management Plan, inviting consultation from the Traditional Owners. If a previously unidentified subsurface site or artefact is found during construction, work in the area will immediately cease, and the relevant indigenous people will be advised of the find.

Subject	No.	Commitment
Slurry Pipeline	38	FMA commits to landscaping all stream channel disturbance from the slurry pipeline to a form similar to that prior to pipe laying.
Port	39	FMA commits to assisting with local monitoring of air quality at the port facilities, and relevant Port Hedland surroundings.
Environmental Management	40	Environmental management and monitoring will be carried out within the framework of an integrated environmental management system (EMS). The EMS used at Balla Balla will be compliant with the international standard ISO 14001:2006. The EMS and the plans and procedures that support it are currently being developed by FMA and will be in place prior to the commencement of ground disturbing works.
	41	FMA will identify and comply with the Commonwealth and State legal framework and any standards, policies and guidelines that underpin the environmental assessment process.

14. CONCLUSIONS

FMA has conducted in-depth analysis of the sustainability of a proposed magnetite mining project at Balla Balla, Western Australia. The Project is currently defined as a conventional open pit iron ore mining operation with mining and processing of up to 10.3million tonnes per annum (Mtpa) of magnetite ore to produce 6Mtpa of magnetite concentrate over a 15 year mine life. Concentrate would be conveyed to Port Hedland by means of a buried pipeline. Dewatering of magnetite concentrate would take place at the port, with the majority of water being returned to the minesite for reuse in ore processing.

The baseline investigations conducted to date have involved a wide range of specialist studies. The studies have been informed by FMA's active and ongoing engagement with stakeholders, especially those with a strong interest in, and commitment to, the Pilbara region. FMA has consulted with stakeholders on diverse aspects of the proposed magnetite project for over three years.

The environmental impact assessment presented in this report has identified that:

- The likely effects of the Project on the biophysical environment are consistent with the degree of impact that can be accommodated without putting populations, ecosystems or environmental values at risk;
- The aspects of the Project that give rise to environmental impact – notably land disturbance, use of groundwater, and displacement of surface water – can be readily managed using conventionally available and proven management practices and can be reliably monitored and assessed;
- The Project will not interfere with culturally significant places or features and will not affect existing recreational use and enjoyment of the Balla Balla River.

Accordingly, this assessment concludes that implementation of the Project can be done in a manner that satisfies all relevant regulatory requirements and achieves the environmental objectives of the EPA and the broader Western Australian community.

15. ABBREVIATIONS

Abbreviation	Full Title
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARI	Average Recurrence Interval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
AS/NZS ISO 14001	Australian Standard/New Zealand Standard International Standards Organisation 14001:2004 Environmental management systems - Requirements with guidance for use
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
Bonn Convention	The Convention on the Conservation of Migratory Species of Wild Animals
CALM	Department of Conservation and Land Management (now DEC)
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction Environmental Management Plan
CME	Chamber of Minerals and Energy
dB	Decibel
DEC	Department of Environment and Conservation
DEP	Department of Environmental Protection
DEWHA	Commonwealth Department of Environment, Water, Heritage and the Arts
DIA	Department of Indigenous Affairs
DMA	Decision Making Authority
DoA	Department of Agriculture
DoCEP	Department of Consumer and Employment Protection
DoH	Department of Health
DoIR	Department of Industry and Resources
DoW	Department of Water
DLGRD	Department of Local Government and Regional Development
DPI	Department of Planning and Infrastructure
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
FESA	Fire and Emergency Services Authority
FIFO	Fly In Fly Out
FMA	Ferro Metals Australia Pty Ltd
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for the Conservation of Nature

Abbreviation	Full Title
JAMBA	Japan-Australia Migratory Bird Agreement
LGA	Local Government Area
MCA	Minerals Council of Australia
MRWA	Main Roads Western Australia
NATA	National Accredited Testing Authority
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure (Ambient Air Quality)
NPI	National Pollutant Inventory
NVIS	National Vegetation Information Service
OES	Outback Ecology Services
PAF	Potentially Acid Forming Material
PDC	Pilbara Development Commission
ROM	Run of Mine
SAG	Semi-Autogenous Grinding
SRE	Short-range Endemics
SS	Suspended Solids
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
TWA	Time Weighted Average
UCL	Unallocated Crown Land
UWA	University of Western Australia
WAM	Western Australian Museum

Units	Definition
µS/cm	micro Siemens per centimetre
µg	micrograms
m^3	cubic metre
mg/m^3	milligrams per cubic metre
meq/kg	milli-equivalents per kilogram
mg/L	milligrams per litre

16. GLOSSARY OF TERMS

Term	Definition
A Class Reserve	An area of land or habitat that is set aside for the purpose of protecting their recognised conservation value
Aeolian	Formed by wind action
Anthropogenic	Produced by humans
Alluvia	Plural of alluvium, meaning sediment deposited by flowing water (river bed, floodplain or delta)
Alluvium	Unconsolidated gravel, sand, silt and clay deposited by streams
Ambient Air Quality	External air environment, not including air inside structures or buildings
Ambient Noise	Background noise associated with a given environment. Typically a composite of sounds from many sources located both near and far. No particular sound is dominant.
Amenity	The quality of being pleasant or attractive, a feature that increases attractiveness or value
Archaean	A period of geological time, from approximately 3.8 to 2.5 billion years ago.
Average Recurrence Interval	The average, or expected, value of the periods between exceedances of a given rainfall total accumulated over a given duration. A rainfall or flood event with an average recurrence interval of 10 years would occur, on average, about once every ten years.
Avifauna	Birds
A - Weighting	A noise measurement that has been corrected to reflect the way a human would hear it.
Bioregion	An area constituting a natural ecological community with characteristic flora, fauna, and environmental conditions and bounded by natural rather than artificial borders.
Biota	The plant and animal life
Calcrete	Carbonate deposits that form in the soil or in the vicinity of the groundwater table as a result of the evaporation of soil water or groundwater respectively.
Closure	A whole of mine process which typically culminates in tenement relinquishment and includes decommissioning and mine rehabilitation.
Completion Criteria	An agreed standard or level of performance which demonstrates successful closure of a site.
Cosmopolitan	Of worldwide distribution
Decibel (dB)	Decibel (dB) A logarithmic scale used to denote the intensity, or pressure level, of a sound relative to the threshold of human hearing.
dB(A) or A-weighted decibels	Decibels with the sound pressure scale adjusted to conform with the frequency response of the human ear. A sound level meter that measures A-weighted decibels has an electrical circuit that allows the meter to have the same sensitivity to sound at different frequencies as the average human ear.
Decommissioning	The shut-down, dismantling and removal of assets, infrastructure and equipment from the mine.
Drainage division	Region of major river catchments

Term	Definition
Echo-location	The use of an animal's sonar system to sense and determine distances between itself and other objects
Ecologically Sustainable Development	Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.
Ecosystem	A community of organisms together with their physical environment, viewed as a system of interacting and interdependent relationships and including such processes as the flow of energy through trophic levels and the cycling of chemical elements and compounds through living and nonliving components of the system
Electrical Conductivity (or Conductance)	Measurement of the total concentration of ions in the water. Used as a measure of salinity.
Emergent	General term for a plant growing or protruding above the water surface (e.g. sedges)
Endemic	Referring to organisms that are confined to a particular area or geographical location, restricted in distribution to one region
Exotic species	An organism that is not indigenous to a given place or area
Flora	The plant life characteristic of a region, period, or special environment
Floristic	Pertaining to flowers or flora
Habitat	The place where a plant or animal lives
Herpetofauna	Reptile and amphibian species
Karst	Soluble rock landscape; product of selective chemical dissolution of limestone or other soluble bedrock by natural waters.
Karstic	Soluble rock landscapes; terrain with distinctive hydrology and landforms arising from a combination of high rock solubility and well developed secondary porosity
LA_{10}	The noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the LA_{10} level for 90% of the time.
Macro invertebrate	Larger invertebrates, functionally defined as those >500 µm. Body length usually exceeds 1mm.
Macrophytes	Large plants, represented by submerged, floating and emergent plants
Magnetite	A naturally magnetic form of iron ore
Mesic habitats	A type of habitat with a moderate or well-balanced supply of moisture
Migratory	A species that moves between populations for the purpose of feeding and reproduction
Noise Emissions	Airborne sound radiated by a well- defined noise source
Nomadic	Species that do not 'settle' in one area, but move from habitat to habitat to find optimal conditions
Opportunistic sampling	Method of choosing items arbitrarily and in an unstructured manner
Periphyton	The biota attached to submerged surfaces
pH	A measure of how acidic or alkaline a substance is. A value less than 7 represents acidity, 7 represents neutrality, and more than 7 alkalinity.
Phreatophytic	A deep-rooted plant that is dependent on water from a permanent ground supply or from the water table.
Pristine	Remaining in a clean, pure state
Regolith	The layer of unconsolidated soil and rock material which overlays solid rock. Usually

Term	Definition
	formed by the combination of weathering and erosion.
Rehabilitation	The return of disturbed land to a stable, productive and self-sustaining condition after taking into account beneficial uses of the site and surrounding land.
Riparian zone	Any land which adjoins, directly influences, or is influenced by a body of water. The vegetated corridor along streams and rivers
Riverine	Encompassing the banks of a river; riparian
Shrub-steppe	A type of low rainfall natural grassland where there is sufficient moisture levels for growth of perennial grasses and/or shrubs
Short-range endemics or endemics	Those species with restricted, isolated or fragmented ranges.
Stygal	Referring to groundwater (stygo-)
Stygofauna	Fauna inhabiting various types of groundwater
Subterranean	Beneath the earth's surface
Sustainability	Development which meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).
Taxa	Plural of taxon.
Taxon	A taxonomic group of any rank. (pl. taxa)
Troglobite	Species that do not exist outside of caves
Troglofauna	Terrestrial fauna inhabiting various types of subterranean spaces, from caves to air filled voids
Turbidity	Turbidity is a cloudiness or haziness of water (or other fluid) caused by individual particles (suspended solids)
Vanadiferous	Containing vanadium
Water Regime	The pattern of wetting and drying of the water body.

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Photographic Plates

Plate 1 View of Balla Balla site – proposed Central mine pit location

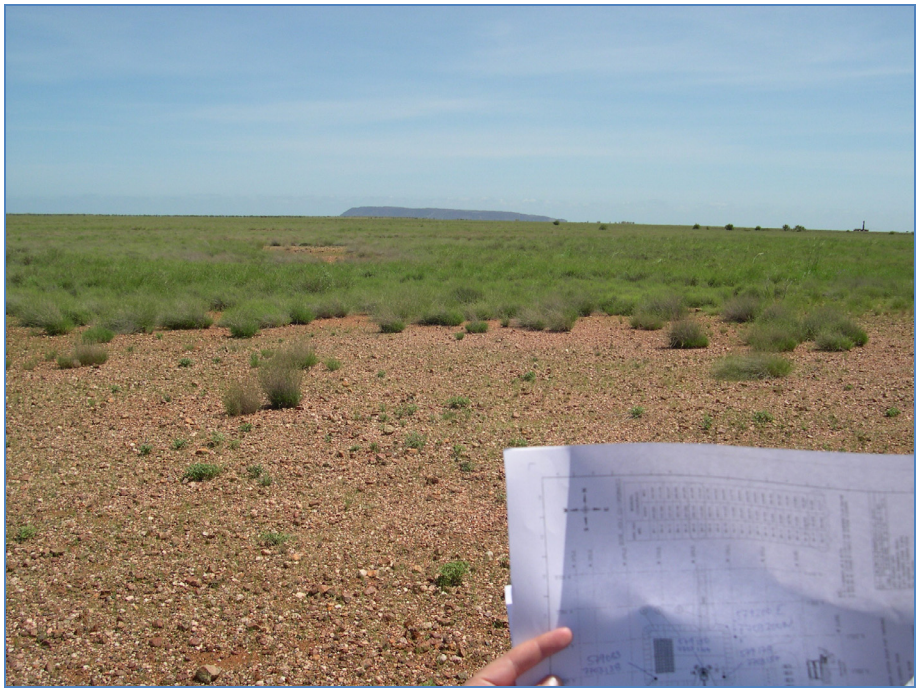

Plate 2 Proposed location of gyratory crusher – Balla Balla

Plate 3 Balla Balla pipeline corridor near Turner River, existing gas pipeline to left of access road.

Plate 4 Utah Point – location of proposed FMA dewatering facility.

Plate 5 Utah Point – location of proposed FMA ore concentrate stockpile.

Plate 6 View to east, toward Tin Hut bore – Marnipurl Creek at centre left.

Plate 7 Close up of Marnipurl Creek at Balla Balla.

Plate 8 Unnamed ephemeral drainage line near proposed TSF location.

Plate 9 Rocky hill – coastal plain southwest of Port Hedland. Model for postmining landforms.