Our Ref: 550IO-EN-0001
Your Ref:

Fortescue
The New Force in Iron Ore

Dr Paul Vogel
Environmental Protection Authority
The Atrium
Level 8, 168 St Georges Terrace
PERTH WA 6000

17 February 2012

Dear Dr Vogel

REFERRAL OF A PROPOSAL TO THE ENVIRONMENTAL PROTECTION AUTHORITY UNDER SECTION 38(1) OF THE ENVIRONMENTAL PROTECTION ACT – PROJECT IO

Fortescue Metals Group Limited (Fortescue) wishes to formally refer Project Io (the Proposal) to the Environmental Protection Authority for assessment under Part IV of the *Environmental Protection Act 1986.* Please find enclosed a completed referral form and supporting information for consideration.

Fortescue considers that the environmental impacts of the Proposal do not warrant assessment and that the Proposal can be managed under the Mining Act and Part V of the Environmental Protection Act.

Should you have any queries regarding the enclosed information, please do not hesitate to contact Sean McGunnigle on 6218 8415 or smcgunnigle@fmgl.com.au.

Yours sincerely
FORTESCUE METALS GROUP

Deidre Willmott

DEIDRE WILLMOTT
Group Manager, Approvals and Government Relations

Enc.
Attachment Io Direct Shipping Ore Project – Referral and Supporting Information

Fortescue Metals Group Limited ABN 57 002 594 872 ACN 002 594 872
ADDRESS Level 2, 87 Adelaide Terrace, East Perth, Western Australia 6004
POSTAL ADDRESS PO Box 6915, East Perth, Western Australia 6892
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IO DIRECT SHIPPING ORE PROJECT

Referral and supporting information

February 2012

Fortescue
The New Force in Iron Ore

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GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

EPA REFERRAL FORM PROPONENT

Referral of a Proposal by the Proponent to the Environmental Protection Authority under Section 38(1) of the Environmental Protection Act.

PURPOSE OF THIS FORM

Section 38(1) of the *Environmental Protection Act 1986* (EP Act) provides that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the Environmental Protection Authority (EPA) for a decision on whether or not it requires assessment under the EP Act. This form sets out the information requirements for the referral of a proposal by a proponent.

Proponents are encouraged to familiarise themselves with the EPA's *General Guide on Referral of Proposals* [see Environmental Impact Assessment/Referral of Proposals and Schemes] before completing this form.

A referral under section 38(1) by a proponent to the EPA must be made on this form. A request to the EPA for a declaration under section 39B (derived proposal) must be made on this form. This form will be treated as a referral provided all information required by Part A has been included and all information requested by Part B has been provided to the extent that it is pertinent to the proposal being referred. Referral documents are to be submitted in two formats – hard copy and electronic copy. The electronic copy of the referral will be provided for public comment for a period of 7 days, prior to the EPA making its decision on whether or not to assess the proposal.

CHECKLIST

Before you submit this form, have you

	Yes	No
Completed all the questions in Part A (essential)	✓	
Completed all applicable questions in Part B	✓	
Included Attachment 1 – location maps	✓	
Included Attachment 2 – additional document the proponent wishes to provide (if applicable)	✓	
Included Attachment 3 – confidential information (if applicable)		**N/A**
Enclosed the CD of all referral information, including spatial data and contextual mapping but excluding confidential information.	✓	

Following a review of the information presented in this form, please consider the following question. (A response is Optional)

DO YOU CONSIDER THE PROPOSAL REQUIRES FORMAL ENVIRONMENTAL IMPACT ASSESSMENT?
YES ☒ NO NOT SURE IF YES, WHAT LEVEL OF ASSESSMENT? ☐ ASSESSMENT ON PROPONENT INFORMATION PUBLIC ENVIRONMENTAL REVIEW

PROPONENT DECLARATION (To be completed by the proponent)

I, ..., *(full name)* declare that the information contained in this form is, to my knowledge, true and not misleading.

Signature Sean McGj	Name (print) **Sean McGunnigle**
Position: **Manager – Environmental Approvals**	Company **Fortescue Metals Group Limited**
Date 16/2/12	

PART A - PROPONENT AND PROPOSAL INFORMATION

(All fields of this Part must be completed for this document to be treated as a referral)

1.1 PROPONENT

Name	Fortescue Metals Group Limited (Fortescue)
Joint Venture parties (if applicable)	Not applicable
Postal Address	Fortescue Metals Group Limited PO Box 6915 East Perth WA 6892
Key proponent contact for the proposal • Name • Address • Phone • Email	Sean McGunnigle Manager – Environmental Approvals Level 2, 87 Adelaide Terrace East Perth WA 6004 (08) 6218 8888 smgunnigle@fmgl.com.au
Consultant for the proposal (if applicable) • Name • Address • Phone • Email	Merrilyn Barnes Principal Consultant Capricornia Environmental Outcomes Pty Ltd c/- Level 2, 87 Adelaide Terrace East Perth WA 6004 0488444572 mkbarnes@fmgl.com.au

1.2 PROPOSAL

Title	Io Direct Shipping Ore Project
Description	Fortescue intends to expand its current operations within the Pilbara region, Western Australia to include the development of a new iron ore project, known as the Io Project, which is located within the Nyidinghu Study Area. The Project is located on Marillana Station approximately 40 kilometres (km) south of Fortescue's Cloudbreak operations and approximately 100 km north-west of Newman (Figure 1). The iron ore deposits found within the Project Area are greenfields discoveries with Fortescue carrying out exploration drilling in the area since August 2010. The major components of the Project are detailed below: • An iron ore mine and resource comprising Brockman Iron Formation which is premised on a maximum of 11.4 Million tonnes (Mt) of

	Bedded Iron Ore (BID) that will be extracted. • Mine infrastructure including one mine pit, one temporary waste dump, crushing and screening hub, drainage and haul road. • All ore will be Direct Shipping Ore, with crushing and screening on site with an expected production rate of up to 6 million tonnes per annum (Mtpa). • Ore will be transported by road to the existing Cloudbreak Mine • The temporary waste dump will be located alongside the single pit and will be a maximum of 17.5 Mt. • Production of water supply for potable water and dust suppression will be required from three production bores. • Supporting infrastructure including an access road, accommodation camp, administration offices, waste water treatment plant and power generation. The life of mine is expected to be approximately 4 years.
Extent (area) of proposed ground disturbance	The area of disturbance for the Project is expected to be 370 hectares (ha).
Timeframe in which the activity or development is proposed to occur. (Include start and finish dates where applicable)	Subject to regulatory approvals, it is anticipated that construction of the Project will commence in July 2012. The life of mine of the Project is expected to be approximately 4 years including decommissioning and closure.
Details of any staging of the proposal	Not applicable
Is the proposal a strategic proposal?	No
Is the proponent requesting a declaration that the proposal is a derived proposal? If so, provide the following information on the strategic assessment within which the referred proposal was identified - • Title of the strategic assessment • Ministerial Statement number	No
Indicate whether, and in what way, the proposal is related to other proposals in the region.	The Project is related to the existing Cloudbreak operation. Ore will be trucked from the Project area to the Cloudbreak mine site.
Does the proponent own the land	Yes. The Project will be conducted on Mining Lease

on which the proposal is to be established? If not, what other arrangements have been established to access the land?	M47/1461. Fortescue is the holder of nearby Exploration Licence E47/1320, E47/1387 and E47/1388.
What is the current land use on the property, and the extent (area in hectares) of the property?	The current land use for the Project Area is pastoral and for minerals exploration. The site occurs within the Marillana Pastoral Station.

1.3 LOCATION

Name of the Shire in which the proposal is located	Shire of East Pilbara
For urban areas – • street address • lot number • suburb • nearest road intersection	Not applicable
For remote localities – • nearest town • distance and direction from that town to the proposal site	The Project is located approximately 100 km north-west of Newman (Figure 1 attached to the Supporting Information). The Project is located approximately 40 km south of Fortescue's Cloudbreak operation, and is located within close proximity to a number of operating iron ore mines in the Pilbara Region.
Electronic spatial data - GIS or CAD on CD, geo-referenced and conforming to the following parameters: • GIS: polygons representing all activities and named • CAD: simple closed polygons representing all activities and named • datum: GDA94 • projection: Geographic (latitude/longitude) or Map Grid of Australia (MGA) • format: Arcview shapefile, Arcinfo coverages, Microstation or AutoCAD	Enclosed: **Yes**

1.4 CONFIDENTIAL INFORMATION

Does the proponent wish to request the EPA to allow any part of the referral information to be treated as confidential?	No
If yes, is confidential information attached as a separate document in hard copy.	Not applicable

1.5 GOVERNMENT APPROVALS

Is rezoning of any land required before the proposal can be implemented? If Yes, provide details.		No	
Is approval required from any Commonwealth or State Government agency or Local Authority for any part of the proposal? If yes, complete the table below -		Yes	
Agency/Authority	Approval Required	Application lodged Yes / No	Agency/Local Authority contact/s for proposal
Environmental Protection Authority (EPA)	This Referral is being made to the EPA under Part IV of the EP Act.	No	Anthony Sutton
Department of Environment and Conservation (DEC)	A Works Approval and Licence will be required from the DEC under Part V the EP Act. A Works Approval Application will be submitted to the DEC in relation to waste discharges associated with construction of prescribed premises for a waste water treatment plant and crushing and screening licence.	No	Suzanne Roworth
Department of Water (DoW)	A Licence to Take Groundwater (5C licence) will be required from the DoW under *the Rights in Water and Irrigation Act* 1914.	No	Hamid Mohsenzadeh
Department of Mines and Petroleum (DMP)	The DMP will require Fortescue to submit a Mining Proposal, including a Mine Closure Plan, under the Mining Act 1978 (Mining Act) for the Project. A clearing permit will be required from the DMP under part v of the EP Act. A Project Management Plan will also be required to be submitted to the DMP.	No	Danielle Risbey
Shire of East Pilbara	Approvals such as a Building Licence, Planning Development Application and a permit for the wastewater treatment plant, will be required from the Shire of East Pilbara.	No	To be determined

National Native Title Tribunal	Fortescue has and existing Land Access Agreement with the Nyiyaparli Native Title Claimant Group. Fortescue is required to comply with the provisions of the Native Title Act 1993.		To be determined

PART B - ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT

2. ENVIRONMENTAL IMPACTS

Describe the impacts of the proposal on the following elements of the environment, through the questions below:

(i) flora and vegetation #;

(ii) fauna #;

(iii) rivers, creeks, wetlands and estuaries;

(iv) significant areas and/ or land features;

(v) coastal zone areas;

(vi) marine areas and biota #;

(vii) water supply and drainage catchments;

(viii) pollution;

(ix) greenhouse gas emissions;

(x) contamination; and

(xi) social surroundings.

These features should be shown on the site plan, where appropriate.

For all information, please indicate:

(a) the source of the information; and

(b) the currency of the information.

2.1 Flora and Vegetation

* Do you propose to clear any native flora and vegetation as a part of this proposal?

(A proposal to clear native vegetation may require a clearing permit under Part V of the EP Act *(Environmental Protection (Clearing of Native Vegetation) Regulations 2004)*. Please contact the Department of Environment and Conservation (DEC) for more information.

(please tick) ✓ Yes ***If yes, complete the rest of this section***

☐ No ***If no, go to the next section***

❑ How much vegetation are you proposing to clear (in hectares)?

Fortescue proposes to clear up to 370 ha of vegetation for the Project.

* Have you submitted an application to clear native vegetation to the DEC (unless you are exempt from such a requirement)?

☐ Yes ✓ No **If yes**, on what date and to which office was the application submitted of the DEC?

❑ Are you aware of any recent flora surveys carried out over the area to be disturbed by this proposal?

✓ Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey/s. (If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.)

A Level 2 flora and vegetation survey was undertaken by Cardno (2012) for the Project Area over two seasons from 28 March to 21 April 2011 and 4 July to 27 July 2011. This survey was conducted in accordance with Environmental Protection Authority Guidance Statement 51 – *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b).

Refer to Section 2.5 and 8.0 in the Supporting Information attached.

* Has a search of DEC records for known occurrences of rare or priority flora or threatened ecological communities been conducted for the site? #

✓ Yes ☐ No If you are proposing to clear native vegetation for any part of your proposal, a search of DEC records of known occurrences of rare or priority flora and threatened ecological communities will be required. Please contact DEC for more information.

A desktop assessment of the Project Area was conducted in April 2011 as part of the Level 2 flora and vegetation survey (Cardno 2012). The objectives of the desktop assessment were to identify flora and vegetation of conservation significance within the Project Area, and provide insight into potential environmental constraints prior to undertaking field work.

The desktop study included database searches from:

- DEC's Declared Rare Flora (DRF) and Priority Flora Database.
- Western Australian Herbarium Specimen Database for opportunistic priority flora.
- DEC's Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) database.
- NatureMap website.
- Commonwealth DSEWPaC's DRF and TEC online database.
- Commonwealth EPBC Act Protected Matters Database.

The desktop review identified one Threaten Flora species and 42 Priority listed species that could potentially occur with the Project Area. Refer to Section 2.5.2 in the Supporting documentation attached.

No TEC listed as matters of national significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) or under the *WA Wildlife Conservation Act 1950* were identified in the desktop assessment or recorded during the surveys (Cardno, 2012). Two Priority Ecological Communities (PECs) were identified in the desktop assessment in the search area. No PECs were recorded within the Project area (Cardno 2012). Refer to section 2.5.1 in the Supporting Documentation.

Section 2.5 of the Supporting information document describes the results of the above searches and details the vegetation within the project area.

Are there any known occurrences of rare or priority flora or threatened ecological communities on the site? #

☐ Yes	✓ No	**If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

The Level 2 flora and vegetation survey identified six Priority Flora species recorded within the wider Study area but none were found within the Project Area (Cardno 2012):

No DRF or species listed as threatened under the *Wildlife Conservation Act 1950* or the EPBC Act were recorded within the Project Area during the flora and vegetation survey (Cardno 2012). A targeted search for the DRF species *Lepidium catapycnon,* which was identified from the DEC database search as having been previously recorded from the vicinity of the Project Area, did not result in the identification of plants at the location where it had been previously recorded (Cardno 2012). Refer to Section 2.5.2 in the Supporting documentation attached.

No TECs were identified within the Project Area during the surveys. In addition, no PECs were recorded within the Project area (Cardno 2012). Refer to Section 2.5.1 in the Supporting documentation attached.

* If located within the Perth Metropolitan Region, is the proposed development within or adjacent to a listed Bush Forever Site? (You will need to contact the Bush Forever Office, at the Department for Planning and Infrastructure)

☐ Yes	✓ No (Not applicable)	**If yes**, please indicate which Bush Forever site is affected (site number and name of site where appropriate).

❑ What is the condition of the vegetation at the site?

The vegetation condition was assessed using the Vegetation Condition Scale (Trudgen, 1991), as ranging from Poor to Excellent within the Project Area. The majority of the proposed vegetation clearing will be in the Sand Plain Vegetation community recorded to be in Poor to Very Good condition (Cardno 2012). Refer to Section 2.5.1 and 8.5.1 in the Supporting documentation attached.

One introduced species, *Cenchrus ciliaris* (Buffel grass) was recorded in the Project Area. Buffel grass is not listed as a Declared Plants under the *Agriculture and Related Resources Protection Act 1976*.

The Project Area has been used for pastoral activities and mineral exploration and vegetation has been degraded through cattle grazing, particularly around Weeli Wolli Creek, where Buffel grass was found within the flats and around creeklines. Refer to Section 2.5.3 in the Supporting documentation attached.

2.2 Fauna

* Do you expect that any fauna or fauna habitat will be impacted by the proposal?

(please tick) ✓ Yes ***If yes, complete the rest of this section***

☐ No ***If no, go to the next section***

❑ Describe the nature and extent of the expected impact.

Construction and operation activities associated with the Project may result in potential impacts to fauna. Direct impacts may include the loss of fauna individuals and habitat during clearing. Fortescue proposes to clear up to 370 ha of vegetation as part of the Project. Indirect impacts may potentially include:

- Habitat fragmentation.
- Altered levels and changes in surface water hydrology.
- Altered fire regimes.
- An increased abundance of feral fauna.
- Alteration of vegetation composition and introduction of weed species resulting in altered feeding and breeding patterns.
- Impacts on habitat resulting from dust deposition.
- Disturbance due to noise, vibration and light.

Invertebrate fauna may be impacted by vibration as a result of construction and operation of the Project and from changes in surface water flows that may affect vegetation condition and fauna habitat. Short range endemic (SRE) invertebrates may be restricted at small spatial scales, and lack the mobility of many vertebrate fauna, therefore resulting in the potential loss of individuals.

The Project may impact stygofauna and troglofauna species through the loss of individuals or their habitat. The potential impact on subterranean fauna or subterranean fauna habitat, if present, relates to excavation of the pit and the drawdown zone.

❑ Are you aware of any recent fauna surveys carried out over the area to be disturbed by this proposal?

✓ Yes ☐ No **If yes**, please attach a copy of any related survey reports and provide the date and name of persons / companies involved in the survey/s. (If no, please do not arrange to have any biological surveys conducted prior to consulting with the DEC.)

Vertebrate fauna, invertebrate fauna and subterranean fauna surveys have been conducted for the Project Area.

Vertebrate Fauna Survey

A Level 2 vertebrate fauna survey for the Project area was conducted in two phases. Phase 1 comprised a vertebrate fauna survey conducted in accordance with EPA Guidance Statement No. 56 (EPA, 2004b) between 7 and 17 April 2011. The main sampling techniques for the survey included pitfall, Elliott and funnel traps, bird censussing, headtorching, bat call recordings

and spotlighting. Phase 2 was a targeted vertebrate fauna survey for conservation significant vertebrate fauna species potentially present in the area; the Northern quoll (*Dasyurus halluctus*), the greater bilby (*Macrotis lagotis*) and the mulgara (*Dasycercus cristicauda*). Phase 2 of the fauna survey was undertaken between 18 and 24 June 2011. During Phase 1, two (of five) trap sites fell within the Project area (sites 2 and 3) and during Phase 2 all three trap sites were located within or close to the Project area (Sections 2.6 and 9.3.1). Bat call recording devices were also deployed to target the presence of the Pilbara leaf nose bat (*Rhinonicteris aurantia*) and the ghost bat (*Macroderma gigas*). None of targeted species were recorded during either survey.

The methodology used for the surveys were undertaken in accordance with the following guidelines:

- *EPBC Act Policy Statement 3.25 (DSEWPaC 2011).*
- *EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004).*
- *EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002)*.*

Two species of conservation significance were recorded within the Project area; the rainbow bee eater (*Merops ornatus*) and the peregrine falcon (*Falco peregrinus*). Both birds are listed as Migratory under the EPBC Act. The bee eater is listed as Schedule 3 while the falcon is listed as Schedule 4 under the WC Act.

SRE Invertebrate Fauna Survey

A targeted SRE invertebrate fauna survey of the Project area was conducted between April and August 2011 (Section 2.7). Several sampling methodologies were employed for the surveys by Dalcon Environmental 2011 which were based on the principles outlined in the EPA Guidance Statement 20 (EPA 2009). The surveys utilised several foraging methodologies, including the use of wet pitfall traps, to target SRE taxa. Three species were recorded from within (or very close to) the Project area that were identified as potential SRE species. No confirmed SRE species were recorded within the Project area (Section 9.3.5).

Subterranean Fauna Survey

Subterranean fauna surveys of the Project area were undertaken between May and July 2011 by Bennelongia Environmental Consultants (Section 2.8). The sampling was undertaken in accordance with EPA Guidance Statements 54 and 54A (EPA 2003, 2007). 121 different bores/drill holes over the Study area were sampled for troglofauna, three of which were within proposed mine pit area. No troglofauna were recorded in the proposed mine pit area (Section 9.3.6). Samples were collected for stygofauna from 93 different bores/drill holes over the Study area and only one stygofauna species, *Pygolabis* sp. B6, was recorded from a bore within the predicted Project drawdown (Section 9.3.6). This species has been recorded outside the project area.

* Has a search of DEC records for known occurrences of Specially Protected (Threatened) fauna been conducted for the site?

✓ Yes ☐ No (please tick)

A DEC database search and EPBC Protected Matters Search of conservation significant fauna species was undertaken for the Project area prior to commencing fieldwork as part of the Level 2 vertebrate fauna survey (Section 2.6 and 9.3.4) by Bamford Consulting Ecologists (2011). Nine species were listed as Priority fauna by DEC.

* Are there any known occurrences of Specially Protected (Threatened) fauna on the site? #

✓ Yes ☐ No **If yes**, please indicate which species or communities are involved and provide copies of any correspondence with DEC regarding these matters.

Bamford Consulting Ecologists (2011) recorded two conservation significant fauna species during the vertebrate fauna surveys of the Project area, including:

- Rainbow Bee-eater (listed as Migratory under EPBC Act, expected regular migrant to Project area and Schedule 3 under the WC Act).
- Peregrine Falcon (Schedule 4 listed under the WC Act).

2.3 Rivers, Creeks, Wetlands and Estuaries

* Will the development occur within 200m of a river, creek, wetland or estuary?

(please tick) ✓ Yes ***If yes, complete the rest of this section***

☐ No ***If no, go to the next section***

* Will the development result in the clearing of vegetation within the 200 m zone?

Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Will the development result in the filling or excavation of a river, creek, wetland or estuary?

Yes ✓ No **If yes**, please describe the extent of the expected impact.

The Io mine is located on an alluvial fan of the Weeli Wolli Creek, on the southern flank of a rocky outcrop, which effectively isolates it from the main Weeli Wolli Creek channel. There will be no filling or excavation of the creek. Section 2.3 and Section 7 of the attached Supporting Information report describes the surface water nearby the project area and the potential impacts to flooding and runoff from the proposed development.

* Will the development result in the impoundment of a river, creek, wetland or estuary?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Will the development result in draining to a river, creek, wetland or estuary?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Are you aware if the proposal will impact on a river, creek, wetland or estuary (or its buffer) within one of the following categories? (please tick)

Conservation Category Wetland	☐ Yes	✓ No	Unsure
Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998	☐ Yes	✓ No	☐ Unsure
Perth's Bush Forever site	☐ Yes	✓ No	☐ Unsure
Environmental Protection (Swan & Canning Rivers) Policy 1998	☐ Yes	✓ No	☐ Unsure
The management area as defined in s4(1) of the Swan River Trust Act 1988/	☐ Yes	✓ No	☐ Unsure
Which is subject to an international agreement, because of the importance of the wetland for waterbirds and waterbird habitats (e.g. Ramsar, JAMBA, CAMBA) #	☐ Yes	✓ No	☐ Unsure

2.4 Significant Areas and/ or Land Features

* Is the proposed development located within or adjacent to an existing or proposed National Park or Nature Reserve?

☐ Yes ✓ No **If yes**, please provide details.

* Are you aware of any Environmentally Sensitive Areas (as declared by the Minister under section 51B of the EP Act) that will be impacted by the proposed development?

☐ Yes ✓ No **If yes**, please provide details.

* Are you aware of any significant natural land features (e.g. caves, ranges etc) that will be impacted by the proposed development?

☐ Yes ✓ No **If yes**, please provide details.

2.5 Coastal Zone Areas (Coastal Dunes and Beaches)

* Will the development occur within 300m of a coastal area?

(please tick) ☐ Yes ***If yes, complete the rest of this section***

✓ No ***If no, go to the next section***

* What is the expected setback of the development from the high tide level and from the primary dune?

* Will the development impact on coastal areas with significant landforms including beach ridge plain, cuspate headland, coastal dunes or karst?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Is the development likely to impact on mangroves?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

2.6 Marine Areas and Biota

* Is the development likely to impact on an area of sensitive benthic communities, such as seagrasses, coral reefs or mangroves?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Is the development likely to impact on marine conservation reserves or areas recommended for reservation (as described in *A Representative Marine Reserve System for Western Australia*, CALM, 1994)?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact.

* Is the development likely to impact on marine areas used extensively for recreation or for commercial fishing activities?

☐ Yes ✓ No **If yes**, please describe the extent of the expected impact, and provide any written advice from relevant agencies (e.g. Fisheries WA).

2.7 Water Supply and Drainage Catchments

* Are you in a proclaimed or proposed groundwater or surface water protection area?

(You may need to contact the Department of Water (DoW) for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

Yes ✓ No **If yes**, please describe what category of area.

* Are you in an existing or proposed Underground Water Supply and Pollution Control area?

(You may need to contact the DoW for more information on the requirements for your location, including the requirement for licences for water abstraction. Also, refer to the DoW website)

☐ Yes ✓ No **If yes**, please describe what category of area.

* Are you in a Public Drinking Water Supply Area (PDWSA)?

(You may need to contact the DoW for more information or refer to the DoW website. A proposal to clear vegetation within a PDWSA requires approval from DoW.)

☐ Yes ✓ No **If yes**, please describe what category of area.

* Is there sufficient water available for the proposal?

(Please consult with the DoW as to whether approvals are required to source water as you propose. Where necessary, please provide a letter of intent from the DoW)

✓ Yes ☐ No (please tick)

There are five aquifers located within the Project Area that groundwater is likely to be sourced from:

- an alluvial aquifer;
- a shallow detrital aquifer (limited);
- a CID aquifer associated with the palaeochannel(s) of Weeli Wolli Creek;
- a mineralised bedrock aquifer that exists within the Brockman Iron Formation and occurs in 'pods' (and which may be in contact with the CID aquifer); and
- a fractured rock aquifer in the unmineralised Brockman Iron Formation.

Fortescue is seeking licences to Construct Boreholes (26D licence) and to extract Groundwater (5C licence) from the DoW under the *Rights in Water and Irrigation Act* 1914. These licence applications will be submitted to DoW for construction of groundwater bores and for the abstraction of groundwater.

* Will the proposal require drainage of the land?

☐ Yes ✓ No **If yes**, how is the site to be drained and will the drainage be connected

to an existing Local Authority or Water Corporation drainage system? Please provide details.

* Is there a water requirement for the construction and/ or operation of this proposal?

(please tick) ✓ Yes ***If yes, complete the rest of this section***

☐ No ***If no, go to the next section***

❑ What is the water requirement for the construction and operation of this proposal, in kl/year?

The estimated water requirement for the construction of the Project is expected to be 298,800 kilolitres (kL) per annum. Water usage during the operation of the Project is expected to be up to approximately 1,314,000 kL per annum.

* What is the proposed source of water for the proposal? (eg dam, bore, surface water etc.)

Water supply for the construction phase and operation of the mine and for dust suppression will be abstracted from groundwater via a production borefield.

Fortescue has applied for a Licence to Construct Boreholes (26D licence) and will seeking a Licence to Take Groundwater (5C licence) from the DoW under the *Rights in Water and Irrigation Act* 1914.

2.8 Pollution

* Is there likely to be any discharge of pollutants from this development, such as noise, vibration, gaseous emissions, dust, liquid effluent, solid waste or other pollutants?

(please tick) ✓ Yes ***If yes, complete the rest of this section***

☐ No ***If no, go to the next section***

* Is the proposal a prescribed premise, under the Environmental Protection Regulations?
(Refer to the EPA *General Guide for Referral of Proposals to the EPA under section 38(1) of the EP Act 1986* for more information)

✓ Yes ☐ No **If yes**, please describe what category of prescribed premise.

A Works Approval to construct, and Licence to operate the Project under Part V of the EP Act will be required for:

- Site Sewage Facility (Category 54/85).
- Crushing and Screening (Category 12).

* Will the proposal result in gaseous emissions to air?

✓ Yes ☐ No **If yes**, please briefly describe.

Greenhouse gas emissions will be generated as a result of construction and operation of the Project. The majority of greenhouse gas emissions would be associated with power generation for the Project, including operation of the crushing and screening, vehicles and associated mining machinery and hauling.

Dust may also be generated from the construction and operation of the Project in areas that will be cleared of vegetation. Dust may also be associated with vehicle movements, stockpiles and crushing and screening operations.

* Have you done any modelling or analysis to demonstrate that air quality standards will be met, including consideration of cumulative impacts from other emission sources?

☐ Yes ✓ No **If yes**, please briefly describe.

No modelling or analysis has as yet been undertaken for the Project.

* Will the proposal result in liquid effluent discharge?

✓ Yes ☐ No **If yes**, please briefly describe the nature, concentrations and receiving environment.

The Project will result in the disposal of treated sewage effluent and hydrocarbon wastes from maintenance facilities.

All sewage and wastewater generated as a result of the Project will be treated in wastewater treatment plants in accordance with the Environmental Protection (Controlled Waste) Regulations 2004 (EPA 2004).

Hazardous materials and wastes (hydrocarbons) generated from servicing of machinery and equipment will be collected and stored on-site in a segregated bunded hazardous waste area. These will be removed off-site by licensed contractors for recycling or disposal to an approved waste disposal facility.

If there is likely to be discharges to a watercourse or marine environment, has any analysis been done to demonstrate that the State Water Quality Management Strategy or other appropriate standards will be able to be met?

☐ Yes ✓ No **If yes**, please describe.

* Will the proposal produce or result in solid wastes?

✓ Yes ☐ No **If yes**, please briefly describe the nature, concentrations and disposal location/ method.

The Project will result in the production of solid waste including:

- Construction wastes.
- Overburden.
- Putrescible waste associated with the accommodation village and administrative buildings.

Where practicable, Fortescue will employ the principles of reduce, reuse and recycle for the management of waste generated as a result of the Project.

The Project will have on-site waste collection and storage facilities, which will facilitate the segregation and storage of wastes prior to transport by a licenced contractor for offsite disposal at an appropriately licenced facility. A quantity of approximately 0.5Mt of overburden will be generated over the life of the Project.

* Will the proposal result in significant off-site noise emissions?

☐ Yes ✓ No **If yes**, please briefly describe.

* Will the development be subject to the Environmental Protection (Noise) Regulations?

✓ Yes ☐ No **If yes**, has any analysis been carried out to demonstrate that the proposal will comply with the Regulations?

Please attach the analysis.

The Project is located in a remote area, adjacent to existing and proposed iron ore mines. Noise will be generated from the operation of vehicles, plant and equipment. A noise assessment has been carried out and is summarised in Section 13 of the attached Supporting Information report. A full copy of the assessment is provide in the appendices of the report.

* Does the proposal have the potential to generate off-site, air quality impacts, dust, odour or another pollutant that may affect the amenity of residents and other "sensitive premises" such as schools and hospitals (proposals in this category may include intensive agriculture, aquaculture, marinas, mines and quarries etc.)?

☐ Yes ✓ No **If yes**, please describe and provide the distance to residences and other "sensitive premises".

* If the proposal has a residential component or involves “sensitive premises”, is it located near a land use that may discharge a pollutant?

☐ Yes ☐ No ✓ Not Applicable **If yes**, please describe and provide the distance to the potential pollution source

An accommodation village will accommodate personnel during the construction and operation of the Project. The location of the accommodation village will be located at an appropriate distance from the mine operations to minimise any potential noise impacts on personnel.

2.9 Greenhouse Gas Emissions

* Is this proposal likely to result in substantial greenhouse gas emissions (greater than 100 000 tonnes per annum of carbon dioxide equivalent emissions)?

Yes ✓ No **If yes**, please provide an estimate of the annual gross emissions in absolute and in carbon dioxide equivalent figures.

* Further, if yes, please describe proposed measures to minimise emissions, and any sink enhancement actions proposed to offset emissions.

2.10 Contamination

* Has the property on which the proposal is to be located been used in the past for activities which may have caused soil or groundwater contamination?

☐ Yes ✓ No ☐ Unsure **If yes**, please describe.

* Has any assessment been done for soil or groundwater contamination on the site?

☐ Yes ✓ No **If yes**, please describe.

* Has the site been registered as a contaminated site under the Contaminated Sites Act 2003? (on finalisation of the CS Regulations and proclamation of the CS Act)

☐ Yes ✓ No **If yes**, please describe.

2.11 Social Surroundings

* Is the proposal on a property which contains or is near a site of Aboriginal ethnographic or archaeological significance that may be disturbed?

✓ Yes No ☐ **If yes**, please describe.

Aboriginal heritage surveys are complete for the project site. Additional surveys are currently being undertaken for proposed haulage routes and Fortescue will comply with the requirements of the *Aboriginal Heritage Act* 1972.

* Is the proposal on a property which contains or is near a site of high public interest (for example, a major recreation area or natural scenic feature)?

☐ Yes ✓ No **If yes**, please describe.

* Will the proposal result in or require substantial transport of goods, which may affect the amenity of the local area?

☐ Yes ✓ No **If yes**, please describe.

3. PROPOSED MANAGEMENT

3.1 Principles of Environmental Protection

- Have you considered how your project gives attention to the following Principles, as set out in section 4A of the EP Act? (For information on the Principles of Environmental Protection, please see EPA Position Statement No. 7, available on the EPA web.)

1.	The precautionary principle. Technical and biological surveys and investigations have been used to assess preliminary potential impacts and management for this referral. An environmental risk assessment for the Project will be undertaken following the completion of all of the detailed baseline and technical studies. Key risks and specific mitigation/management measures have been identified during the risk assessment and are included in the supporting documentation.	✓ Yes	☐ No
2.	The principle of intergenerational equity. The Project will be managed so that the health, diversity and productivity of the environment is maintained and/or enhanced for the benefit of future generations. In addition, a rehabilitation programme utilising the knowledge gained from Fortescue's rehabilitation experience at its existing operations will be implemented. Fortescue will include mine closure planning over the life of the Project.	✓ Yes	☐ No
3.	The principle of the conservation of biological diversity and ecological integrity A range of biological studies have been undertaken or planned for the Project and a preliminary impact assessment has commenced. Studies that have commenced include a Level 2 flora and vegetation, a Level 2 vertebrate fauna survey, a subterranean fauna survey and a short-range endemic invertebrate fauna survey. The results of these studies will be used to develop mitigation and management measures to minimise impacts to the biological diversity of the area.	✓ Yes	☐ No
4.	Principles relating to improved valuation, pricing and incentive mechanisms. Objectives for each of the relevant environmental factors for the Project have been established and are addressed in the supporting documentation.	✓ Yes	☐ No
5.	The principle of waste minimisation. Fortescue will integrate a waste hierarchy (i.e. avoid, reuse, reduce, recycle, treat, dispose) for waste minimisation related to the Project.	✓ Yes	☐ No

Each of the Principles have been considered at this stage of the Project.

- Is the proposal consistent with the EPA's Environmental Protection Bulletins/Position Statements and Environmental Assessment Guidelines/Guidance Statements (available on the EPA web)?

✓ Yes ☐ No

The following EPA position and guidance statements are relevant to this Project and have been considered in this referral document and in the supporting documentation.

- EPA Position Statement No. 2 – Environmental Protection of Native Vegetation in Western Australia.
- EPA Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection.
- EPA Position Statement No. 4 – Environmental Protection of Wetlands.
- EPA Position Statement No. 5 – Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia.
- EPA Position Statement No. 7 – Principles of Environmental Protection.
- EPA Position Statement No. 8 – Environmental Protection in Natural Resource Management.
- EPA Position Statement No. 9 – Environmental Offsets.
- EPA Draft Guidance Statement No. 8 – Environmental Noise.
- EPA Guidance Statement No. 12 – Minimising Greenhouse Gas Emissions.
- EPA Guidance Statement No. 18 – Prevention of Air Quality Impacts from Land Development Sites.
- EPA Guidance Statement No. 19 – Environmental Offsets.
- EPA Guidance Statement No. 20 - Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.
- EPA Guidance Statement No. 33 – Environmental Guidance for Planning and Development.
- EPA Guidance Statement No. 41 - Assessment of Aboriginal Heritage.
- EPA Guidance Statement No. 51 - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.
- EPA Guidance Statement No. 54 - Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia.
- EPA Draft Guidance Statement No. 54a - Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (Technical Appendix to Guidance Statement 54.
- EPA Guidance Statement No. 55 – Implementing best practice in proposals submitted to the environment impact assessment process.
- EPA Guidance Statement No. 56 - Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.
- EPA and DEC Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment.

3.2 Consultation

- Has public consultation taken place (such as with other government agencies, community groups or neighbours), or is it intended that consultation shall take place?

✓ Yes ☐ No **If yes**, please list those consulted and attach comments or summarise response on a separate sheet.

The Fortescue stakeholder engagement program for the Proposal was undertaken from May 2011 and is ongoing. Key stakeholders were identified through Fortescue experience in the Pilbara on previous and other current projects, and project managers have collaborated to support each other's stakeholder engagement through joint identification of stakeholders and integrated engagement activities. Fortescue also adopted the recommendations of State government agencies on stakeholders that should be included in the program. Section 4 of the Supporting Information Report provides details of the stakeholders identified and liaison that occurred.

3.3 References

Bamford Consulting Ecologists (2011). *Fauna Assessment FMG's Nyidinighu Iron Ore Project. Prepared for Fortescue Metals Group Limited by Mike Bamford and Sean Tomlinson, and Ecoscape. Dated 16th August 2011.*

Bennelongia Environmental Consultants (2011). *Nyidinghu Project: Subterranean Fauna Assessment. Draft Report. Prepared for Fortescue Metals Group Ltd by Bennelongia Pty Ltd. Dated September 2011. Report 2011/122.*

Cardno (2012). Nyidinghu Project Flora and Vegetation Assessment. *Report prepared for Fortescue Metals Group Limited by Cardno.* January 2012 V11030.

Dalcon Environmental (2011). *Scorpion Identification Report. Report No. DA-1105. Prepared for Dalcon Environmental Services by Erich S. Volschenk.*

Department of Environment and Conservation (DEC) (1996). *Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009).* Western Australia.

Department of Environment and Conservation (DEC) (2006). *Controlled Waste Guideline Series Guideline 3 - Controlled Waste Treatment or Disposal Sites* (DEC 2006). Western Australia.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2011). *Environmental Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Endangered Northern Quoll, Dasyurus hallucatus.*

Environmental Protection Authority (EPA) (2000). *Environment Protection Authority Position Statement 2 – Environmental Protection of Native Vegetation in Western Australia.* Environmental Protection Authority, Western Australia.

Environmental Protection Authority (EPA) (2002). *Environmental Protection Authority Position Statement 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection.* Environmental Protection Authority, Western Australia.

Environmental Protection Authority (EPA) (2004a). *Environmental Protection (Controlled Waste) Regulations 2004.*

Environmental Protection Authority (EPA) (2004b). *Guidance Statement 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Australia.* Environmental Protection Authority, Western Australia.

Environmental Protection Authority (EPA) (2007). *Guidance Statement 54A Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia.* Environmental Protection Authority, Western Australia.

Environmental Protection Authority (EPA) (2009). *Guidance Statement No. 20 Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.* Environmental Protection Authority, Western Australia.

Trudgen, M.E. (1991). *Vegetation Condition Scale. In: National Trust (WA) 1993 Urban Bushland Policy. National Trust of Australia (WA). Wildflower Society of Western Australia (Inc.) and the Tree Society.*

ATTACHMENT 1

Location Map

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600,000
700,000
800,000
7,700,000
7,600,000
7,500,000
7,400,000
N
Port Hedland
Mount Goldsworthy
Marble Bar
Nullagine
WOODSTOCK/
ABYDOS
Cloudbreak
Christmas Creek
Auski Roadhouse
Project Area
Tom Price
KARIJINI
NATIONAL
PARK
Paraburdoo
Newman
LEGEND
FMG Mines
Proposed Solomon Railway
FMG Railway
BHP Railway
Rio Tinto Railway
Principal Road
Secondary Road
Project Area
Fortescue Marsh
0 10 20 30 40
Kilometres
Fortescue Metals Group Ltd
The New Force in Iron Ore
Locality Plan &
Regional Setting
Requested By: Merrilyn Barnes
Date: 23/01/2012
Drawn By: Sunny Hendricksen
550EO_00000_MP_GO_0008.001
Scale 1:1,200,000 Size: A3P
Revision: 2
Prj:GDA 1994 MGA Zone 50
Confidentiality: 1

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ATTACHMENT 2

Io Direct Shipping Ore Project – Supporting Information (February 2012)

Environmental Protection Authority

GOVERNMENT OF WESTERN AUSTRALIA

Environmental offsets reporting form

See *EPA Guidance Statement No. 19: environmental offsets - biodiversity*

Please note that the EPA may request additional information.

Section A: Administrative information

1. Proposal or scheme name: Io Direct Shipping Ore Project

2. Summary of proposal or scheme:

Fortescue intends to expand its current operations within the Pilbara region, Western Australia to include the development of a new iron ore project, known as the Io Project, which is located within the Nyidinghu Study Area.

The Project is located on Marillana Station approximately 35 kilometres (km) south of Fortescue's Cloudbreak operations and approximately 100 km north-west of Newman (Figure 1 in the Io DSO Project - Supporting Information). The iron ore deposits found within the Project Area are greenfields discoveries with Fortescue carrying out exploration drilling in the area since August 2010.

The major components of the Project are detailed below:

- An iron ore mine and resource comprising Brockman Iron Formation which is premised on a maximum of 11.4 Million tonnes (Mt) of Bedded Iron Ore (BID) that will be extracted.
- Mine infrastructure including one mine pit, one temporary waste dump, crushing and screening hub, drainage and haul road.
- All ore will be Direct Shipping Ore, with crushing and screening on site with an expected production rate of up to 6 million tonnes per annum (Mtpa).
- Ore will be transported by road to the existing Cloudbreak Mine
- The temporary waste dump will be located alongside the single pit and will be a maximum of 17.5 Mt.
- Production of water supply for potable water and dust suppression will be required from three production bores.
- Supporting infrastructure including an access road, accommodation camp, administration offices, waste water treatment plant and power generation.

The life of mine is expected to be approximately 4 years.

The area of disturbance for the Project is expected to be 370 hectares (ha).

Section B: Type of environmental asset (s) – State whether Critical or High Value, describe the environmental values and attributes

Type of Environmental Asset	Critical or High Value Asset	Description of Environmental values and attributes
Public Conservation Reserve System	N/A	No nature reserves, national parks, conservation parks, regional parks, marine parks, marine nature reserves or marine management areas will be cleared for this mine development.

Native Vegetation	High Value Asset	Up to 370 ha of native vegetation will be cleared for this mine proposal. • No Priority Ecological Communities (PEC) and no Threatened Ecological Communities (TEC) were recorded in the Project area (Appendix E). • Minimal (or no) clearing and disturbance will take place of vegetation surrounding creek lines. The vegetation along the major creek lines were categorised as Poor to Good due to cattle grazing pressure and the presence of the weed Buffel grass (*Cenchrus ciliaris*). • Clearing of the vegetation is unlikely to cause deterioration in the quality of surface or underground water (Appendix D). • Clearing of the vegetation is unlikely to cause, or exacerbate, the incidence or intensity of flooding (Appendix B and C).
Biodiversity	High Value Asset	No Declared Rare Flora (DRF) or Declared Threatened fauna (DTF) were recorded in the project area. • **Recorded** fauna species scheduled under the Wildlife Conservation (WC) Act include the Rainbow Bee-eater and the Peregrine Falcon. The Rainbow Bee-Eater is also listed as Migratory under the EPBC Act (Appendix G). • An additional 26 fauna species **not recorded**, but listed under the EPBC Act or Scheduled under the WC Act or listed as Priority fauna (by the WA Department of Environment and Conservation; DEC) potentially occur in the area. This includes two reptile, 16 bird, and 8 mammal species (Appendix G). • No confirmed short range endemic fauna (SRE) were recorded. Three potential SRE species were recorded (Appendix H). • One Stygofauna and no Troglofauna species were recorded (Appendix I).
Wetlands	N/A	The Fortescue Marsh is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an “Indicative Place” on the Register of the National Estate – Waterbirds The Fortescue Marsh lies 30 kms north from the Project and no springs or pools are known to exist in the Project area (Appendix D). It is expected that the integrity, function and environmental values of the Fortescue Marsh will be protected for the following reasons: • No impacts on marsh hydrology from groundwater draw down. • No threats to the ecology of the Fortescue Marsh from the Project are likely to occur due to changes in groundwater levels or secondary effects on vegetation and fauna.
Rivers	N/A	No wild or scenic rivers will be affected for the proposed development.
Landscape	N/A	No important landscape, natural feature or environmental icon will be impacted for this proposed development.
Environments sensitive	N/A	It is not anticipated that emissions, as a result of this mine development, will present a

to Emissions / Discharges		significant risk to human health or the environment and emissions will not exceed prescribed environmental or health standards.
Ecosystems vulnerable to threats	N/A	No TEC, PEC, DRF or DTF were recorded or identified within the proposed disturbance area. It is therefore not anticipated that this mine development will damage or threaten the survival, abundance or evolutionary development of an indigenous species or ecological community in the area. The nearest Priority Ecological Community is the Fortescue Marsh (P1) (20 km north or the Project area) and the Fortescue Valley Sand Dunes (P3) approximately 30 km north west of the Project are. No impact will occur from this Project on either PEC.
Heritage	N/A	Fortescue has conducted ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and Department of Indigenous Affairs. Fortescue maintains a site avoidance policy for this Project.

Section C: Significant impacts (describe the significant adverse environmental impacts related to the proposal or scheme before mitigation measures are applied)

1. Vegetation clearing for pit, stockpiling, infrastructure and road networks.
2. The primary impacts on fauna will be attributed to the loss of habitat associated with clearing of vegetation and the displacement of fauna through mining activities such as dust, noise, vibration, traffic.

Section D: Mitigation measures (describe all measures to Avoid, Minimise, Rectify and Reduce)

1. A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC.
2. To minimise the potential for adverse changes to the structure and floristic composition of the vegetation of the Project Area a fire management/prevention plan will be implemented. This plan will aim to:
   - Eliminate (or actively suppress) uncontrolled fires originating from mining activities; and
   - Dust suppression measures will be implemented to minimize the impact of dust from cleared areas and vehicle movement.
3. Clearing will not be undertaken outside authorised areas as defined under the GDP process.
4. Significant fauna habitat will be spatially identified and where appropriate demarcated on site.
5. All lined surface water storage areas will have fauna egress points.
6. Vehicles speeds will be restricted across the Project area.
7. Off road driving or driving on restricted access routes will be prohibited other than for emergency situations.
8. Rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented.
9. Appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes.
10. Low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards.

11. Lighting will be directed onto construction or operational areas.
Section E: Significant residual impacts (describe all the significant adverse residual impacts that remain after all mitigation attempts have been exhausted)
It is anticipated that there will be no significant residual impacts resulting from the implementation of this Project. All significant impacts have been either designed out at the engineering and design phase of the Project or have been mitigated during the impact assessment of the Project. The Project will be rehabilitated upon closure which is described in the Mine Closure and Rehabilitation Plan appended to the Supporting Information document.
Section F: Proposed offsets for each significant residual impact (identify direct and contributing offsets). Include a description of the land tenure and zoning / reservation status of the proposed offset site. Identify any encumbrances or other restrictions on the land that may impact the implementation of the proposed offset and provide evidence demonstrating how these issues have been resolved.
As there are no significant residual impacts expected from the development of this proposed mine. It is not anticipated that environmental offsets will be required.
Section G: Spatial data relating to offset site/s (see *EPA Guidance Statement No. 19: environmental offsets- biodiversity*, Appendix 4)
N/A
Section H: Relevant data sources and evidence of consultation (consultation with agencies, relevant stakeholders, community and references to sources of data / information). Include details of specific environmental, technical or other relevant advice and information obtained to assist in the formulation of the offset.
Refer to attached Io Direct Shipping Ore Project – Supporting information which presents information in section 4 Stakeholders. Technical Reports appended to the Supporting Information Document include: Appendix A Soils and Landform Report Appendix B Flood Study Appendix C Surface Water Report Appendix D Hydrogeology Report Appendix E Flora and Vegetation Assessment Appendix F Mulga Study Appendix G Terrestrial Fauna Study Appendix H Short Range Endemic Species Report Appendix I Subfauna Report Appendix J Mine Closure Report Appendix K Noise Report Appendix L Dust Report

Report

Supporting Information

Io Direct Shipping Ore Project

16 February 2012
100-RP-EN-9575

Fortescue
The New Force in Iron Ore

	Supporting Information – Io DSO Project		100-RP-EN-9575
Revision Number	0		16/02/2012
Status	IFU - ISSUED FOR USE		
Author	Merrilyn Barnes	Signature	16/02/2012
Checked	Sean McGunnigle	Signature	16/02/2012
Approved	Barry Knight	Signature	16/02/2012
Confidentiality	**FORTESCUE STAFF & CONTRACTORS**	**Publish on Extranet**	☐ Yes ☒ No
Review Date	**N/A**		

Revision History *(to be completed for each version retained by Document Control)*

Author	Checker	Approver	Rev No.	Status	Issued Date
M Barnes	S McGunnigle	B Knight	a	IFI	14/02/2012
M Barnes	S McGunnigle	B Knight		IFU	14/02/2012

This document was prepared on behalf of Fortescue Metals Group Limited by:		**Capricornia Environmental Outcomes Pty Ltd**	
Approved by Fortescue:	Barry Knight	Signature	16/02/2012

EXECUTIVE SUMMARY

Introduction

Fortescue Metals Group Ltd (Fortescue) proposes to develop the Io Direct Shipping Ore Project (the Project) to the south of its Cloudbreak iron ore mine (Cloudbreak) located in the Pilbara region of Western Australia. This new mine is located within the Nyidinghu reserves 30 km south of the Fortescue Marsh.

This document has been prepared as supporting information for the formal referral to the Environmental Protection Authority in accordance with the section 38 of the Environmental Protection Act 1986 (EP Act).

Assessment Process

This Project will be referred to the EPA under section 38 of the EP Act to enable the EPA to set the level of assessment for the Project. The Project does not warrant formal assessment and can be managed under the Mining Act 1978 (Mining Act) and Part V of the EP Act.

The Project

Fortescue proposes to build a new iron ore mine and truck the iron ore to its existing Cloudbreak mine for transport to Port Hedland. The Project in within Mining Tenement M47/1461 and will include a new mine with one mine pit, one waste dump, a crushing and screening hub, roads, drainage, and other associated mine infrastructure. The Project will mine a maximum of 11.4 million tonnes of Bedded Iron Ore (BID) and 17.5 million tonne waste that will be extracted at a rate of up to 6 Mtpa for approximately 4 years. The mined product will be Direct Shipping Ore with no processing will be conducted on site.

Table 1: Summary of key characteristics

Relevant Characteristic	
Main Activities	Production of iron ore using open cut mining methods, open pit, backfilling, ore crushing and screening, transport of ore by road to Cloudbreak.
Resource	Up to 11.4 Million Tonnes of Bedded Iron Ore (BID) hosted within the Brockman Iron Formation.
Ore production	Up to 6 Mtpa
Overburden	Approximately 0.5 Mt
Tailings	None
Life of Mine	Up to 4 years
Total Disturbance Footprint (mining and associated infrastructure)	Up to 370 ha
Pit Size	4,500,000 m^3 (total volume of void) or 120 ha
Pit depth	Maximum depth of 33 m.
Mining Method	Overburden and waste material will initially be stored outside of the open pit mining area in a temporary waste stockpile. When mine development is sufficiently advanced, overburden and waste will be backfilled to the mined out pit.
Waste Volume	Approximately 17.5 Mt to be stockpiled in a temporary waste stockpile
Topsoil Volume	Approximately 3 Mt
Export Tonnage	11.4 million tonne over the life of the project
Dewatering requirements	No requirement for dewatering.All mining will be conducted above the water table.
Mine Site Infrastructure and Ancillary Services	
Ore Processing	Processing of Bedded Iron Deposit (BID) will involve a primary, secondary and tertiary mobile crushing plant configuration to meet iron ore product specification of 12 mm size fraction for marketing and export.
Power	2 x diesel-fuelled power generators to supply up to 8MW in total.
Fuel storage requirements	Up to 32MLpa
Water and Wastewater Treatment	Water and wastewater treatment plant(s) supplied by 3 production bores.
Workshops and Administration Facilities	Administrative and maintenance buildings; product stockpiles and workshop, fuel storage and explosive storage magazine.
Camp	Accommodation camp up to 500 beds.
Workforce	Operational approximately 500 Operational hours are 24hrs per day, 7 days per week.
Transport	Ore to be transported by road to Fortescue's Cloudbreak Mine by fleet of up to 50 road trains (up to 6 road trains per hour).

Stakeholder Consultation

Stakeholder consultation for the Project has formed part of an ongoing and extensive stakeholder engagement program for Fortescue projects undergoing environmental approvals. The Fortescue stakeholder engagement program for the Project was undertaken from November 2011 and is ongoing.

Key issues raised during the stakeholder consultation process were:

- Potential impacts and management measures of water abstraction on ecological assets and nearby pastoral leases.
- Current health of vegetation within Project area.
- Transport route
- Heritage and nature title
- Impacts on current pastoral activities

Environmental Impact Assessment and Management

Environmental factors relevant to this Project were identified through internal scoping and are presented in this document. The key environmental factors that have been addressed in this document are:

- Groundwater
- Surface water
- Vegetation and flora
- Fauna
- Conservation areas (proposed) and natural heritage, including potential impacts on the Nationally Important Wetland, Fortescue Marsh
- Aboriginal heritage
- Landform, mine closure planning and rehabilitation
- Noise impact
- Air quality

The key environmental outcomes expected for each of these factors is outlined below.

Groundwater

The Project and the cumulative effects of the Project are expected to result in the following outcomes in relation to groundwater:

- The risk of potential impacts to groundwater within the Project mining area is considered to be low.
- The mineral deposit is located above the regional water table. Consequently, there is no need for dewatering during mining. Therefore groundwater levels and quality will not be impacted by the mining the deposit.

These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Project will not be significantly affected. The EPA objectives for this factor will be met.

Surface Water

The Project and the cumulative effects of the proposed project are expected to result in the following outcomes in relation to surface water:

- No significant impact on water quality and quantity of water entering the Weeli Wolli Creek or Fortescue Marsh.
- No significant impact on sheetflow due to infrastructure.
- Negligible change to flood levels due to infrastructure.

These impacts are considered to be acceptable as the key environmental values surrounding the Project will not be significantly affected. The key mitigation measure is that there will be no disturbance or discharges to the Weeli Wolli Creek. The EPA objective for this factor will be met.

Vegetation and Flora

The Project is expected to result in the following outcomes in relation to vegetation and flora:

- Approximately 370 ha of vegetation disturbed by the Project will almost totally occur on alluvial plains with soft spinifex grasslands (Urandy Land System).
- Clearing for the Project and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the “threshold level” of 30% of its pre-clearing extent.

- No Threatened Flora or Priority Ecological Communities will be affected by the Project and impacts to Priority flora are not expected.

The EPA objectives for this factor will be met.

Fauna

The Project is expected to result in the following outcomes in relation to terrestrial fauna:

- Approximately 370 ha of fauna habitat will be disturbed by the Project with the majority of this occurring in open low shrubland of mixed Acacia over spinifex on red sandy loam plain habitat.
- Significant regional impact to short range endemic (SRE) and subterranean fauna species is not expected to occur as a result of the Project as it is likely species occurring within the Project area occur in the wider region.
- It is unlikely that the Project will result in significant impacts to species listed as Endangered or Vulnerable under the Environment Protection and Biodiverstity Conservation Act 1999 (EPBC Act) or Scheduled species under the Wildlife Conservation Act 1950 (WC Act).

Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

Fortescue Marsh Wetland

The Fortescue Marsh is the largest ephemeral wetland in the Pilbara Bioregion. It is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an “Indicative Place” on the Register of the National Estate.

No threats to the ecology of the Fortescue Marsh from the Project are likely due to changes in groundwater levels and secondary effects on vegetation and fauna.

It is expected that the integrity, function and environmental values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.

Proposed Conservation Reserve

The Fortescue Marsh and surrounding Pastoral Leases are earmarked for reservation by DEC under pastoral lease renewal arrangements scheduled for 2015.

No vegetation within the Proposed Conservation Reserve will be disturbed under this Project.

It is expected that the potential impacts of the Project are consistent with Government planning for the Proposed Conservation Reserve which recognises mining interests in the area and that rehabilitation will be undertaken consistent with the long term management objectives for this area (CALM 2003).

Aboriginal Heritage

Fortescue has undertaken ethnographic and archaeological surveys for the Project area in consultation with the Traditional Owners, and native title claimant groups. The Project will be carried out in accordance with EPA Guidance Statement No. 41 through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group Land Access Agreements.

All Aboriginal Heritage Sites will be avoided for the Project.

Landform, Mine Closure Planning and Rehabilitation

The Project is not likely to result in significant environmental impact following closure when management measures are considered. As sections of the mine are closed, the mine closure plan will be implemented to achieve documented objectives and monitoring to check implementation and measure outcomes.

The key outcomes for closure are:

- Final landforms will be non-polluting and have stabilised slopes of appropriate gradient and covered by vegetation re-established from respread topsoil and/or seed of local provenance.
- The groundwater table will recover to a level and quality to that of pre-mining.
- Altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems.
- All areas disturbed for mining and infrastructure are rehabilitated following decommissioning and meet specified final land use criteria.
- The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure.

The outcomes for closure are considered to be acceptable according to the EPA's closure objective.

Noise

Noise modelling indicated that the operational plant noise, road product transport noise and blast overpressure and ground borne vibration effects will be in accordance with the requirements of the Environmental Protection (Noise) Regulations 1997. The major sources of noise and vibration from the Project will include vehicle movements and onsite equipment, crushing and screening activities, blasting operations and transportation of product. Studies conducted for the Propject have indicated that noise levels at the nearest sensitive receptors will meet the noise regulations.

Dust

Fortescue assessed the potential air quality impacts associated with the proposed mine and haul road options associated with the Project. This assessment recommended several management strategies to minise dust impact from haul roads. These include to the use of road surface materials and design to minimise mechanical erosion maximise surface drainage, provide regular road maintenance, watering of the haul road, and the application of appropriate surface dust suppression treatments and additives, impose speed limits to 40 km/h and 25 km/h close to the receptors, and reduced traffic along the route.

Environmental Management Framework

Fortescue will minimise environmental impacts through:

- Implementing the Environmental Management Plan (EMP) for the Project.
- Regularly reviewing the performance of the EMPs and developing environmental improvement plans for priorities identified in the reviews.
- Training staff and contractors in environmental requirements and considerations of their work.
- Ensuring that stakeholder views are sought, respected and considered.
- Reporting regularly to stakeholders on performance.
- Aligning with the Fortescue Environmental Policy.

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1. INTRODUCTION

Fortescue Metals Group Ltd (Fortescue) proposes to develop the Io Direct Shipping Ore Project (the Project) to the south of its Cloudbreak iron ore mine (Cloudbreak) located in the Pilbara region of Western Australia. This new mine is located within the Nyidinghu reserves 30 km south of the Fortescue Marsh, (Figure 1).

It is proposed that a small discrete mine within the Study area be developed to overcome exisiting short falls. This project will be known as the Io Direct Shipping Ore Project (herein referred to as the Project).

This document has been prepared as supporting information for the formal referral to the Environmental Protection Authority in accordance with the section 38 of the Environmental Protection Act 1986 (EP Act).

1.1 Project Overview

The following section provides a brief overview of the Project.

1.1.1 Background

The Cloudbreak mine commenced production in 2008 and currently produces approximately 45 Mtpa of iron ore which is transported to Port Hedland for shipment. The existing mine at Cloudbreak is implemented in accordance with Statement 721. The Io Mine will provide additional ore to meet current port capacities. The exisiting Nyidinghu reserve area was targeted to find additional ore to support the Chichester mines. Within the Nyidinghu reserves a small decrete mine with Direct Shipping Ore above the water table was discovered and developed.

1.1.2 Location

The Io DSO Project area is situated on the northern edge of the Hamersley Range, approximately 85 km north-west of Newman and 355 km south of Port Hedland (Figure 1). The Project area encompasses Mining Tenement M47/1461, with access roads through Exploration Lease tenements E 47/1387 and E 47/1320.

The proposed mine and associated infrastructure is located all within Mining Tenement M47/1461 on the broad plains of the Fortescue Valley. These valley plains slope gently down to the Fortescue Marsh which is located approximately 30 km to the north of the Project area. The Weeli Wolli Creek intersects the south-west extent of the Project area and meanders in a general north-west direction before

eventually discharging into the Fortescue Marsh. Occasional hills (up to 90 m relief) abut the southern extent of the site. The Study area (Figure 2) for the Project is wider reaching and includes the Weeli Wolli Creek and extends north towards the Fortescue Marsh. The Study area is large to ensure that all potential impacts to Weeli Wolli Creek and Fortescue Marsh have been considered as well as to incorporate the proposed haul road to Cloudbreak.

BHP Billiton Iron Ore's (BHPIO) Port Headland-Newman railway line and Munjina Roy Hill Road run roughly parallel in a north-west direction 15 km to the north of the Project area. Rio Tinto Iron Ore's Yandi and Hope Downs operations are located to the south of the Project area.

The nearest DEC estate is Karijini National Park (Reserve No 30082) which lies approximately 70 km to the west of the Project area.

1.1.3 Description

The Project includes a new mine with one mine pit, one waste dump, a crushing and screening hub, roads, drainage, accommodation camp, sewage treatment, and other associated mine infrastructure to enable iron ore production to be extracted at a rate of up to 6 Mtpa for approximately 4 years with a maximum of 11.4 MT resource (refer Figure 3). The Project will include a disturbance footprint of no more than 370 ha including mine, associated infrastructure and accommodation facilities and haul road to meet the Munjina-Roy Hill Road. The Project requires no processing to be conducted on site.

On site the depth of mining will be no more than 33 metre below ground level (mbgl) and will be conducted above the existing groundwater table. All activities will be set back from the Weeli Wolli Creek and no major surface water drainage will be diverted.

Ore will be trucked out to Fortescue's Cloudbreak Mine where it will be loaded onto the existing railway and shipped out of Port Hedland.

1.2 Proponent

The proponent for the Project is Fortescue Metals Group Limited. The contact person for the Project is:

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1.3 Purpose and Scope of this Document

The purpose of this document is to present supporting information to accompany the Referral of the Project to EPA, including a detailed description of the key components, environmental impacts and proposed environmental management measures for the relevant environmental aspects. This supporting documentation includes:

- A description of the existing environment (Section 2)
- A detailed description of the Project (Section 3)
- A description of the stakeholder engagement and consultation process undertaken for the Project (Section 4)
- A factor-by-factor assessment of the environmental impact of the Project (Section 6 to Section 14)
- A description of key environmental management measures and controls (Section 15).

1.4 Rationale for Project

Fortescue has identified an opportunity to develop a small discrete mine of direct shipping iron ore with a maximum resource of 11.4 Mt. The mine has been designed to ensure minimal impact to the environment including mining above the water table, set back from the Weeli Wolli creek and working within a footprint that avoids any species of conservation significance.

1.4.1 Demand for Product

The international demand for iron ore has experienced strong growth in the last five years, predominantly driven by increased steel production in China. In the last 10 years, steel production in China has increased from approximately 100 Mtpa to over 450 Mtpa. The increased demand resulted in the quantity of iron ore produced in Western Australia increasing from 195 million tonnes in 2003 to 303 million tonnes in 2008, valued at $31.2 billion (DMP 2009b).

The long-term demand for iron ore is not likely to change as China and India continue to urbanise even though the market has contracted in response to the global financial crisis. There will be continued long-term growth in the steel industry, notwithstanding fluctuations in steel demand.

1.4.2 Benefits of Project

The Project will result in community benefits for Australia and Western Australia through:

- Royalties and taxation payments from the sale of iron ore products
- Employment and training opportunities
- Encouragement in the growth of ancillary industries in WA

The Project will provide contractual and full-time employment opportunities to local communities and further employment opportunities will be created by the flow-on effects to service industries and other sectors of the economy.

Fortescue is committed to providing jobs and employment to local indigenous people through its' Vocational Training and Employment Centre developed as part of Land Access Agreement negotiations between Fortescue and traditional claimant groups. The Centre works by identifying employment opportunities within Fortescue, and with contractors who work with Fortescue, then developing courses using TAFE and other training organisations to provide indigenous people in the Pilbara with the necessary skills for those jobs.

1.5 Compliance with Legislation and Other Approvals

The following section provides a brief overview of all legislation and compliance associated with the Project.

1.5.1 Relevant Legislation

The following section provides a brief legislative context for mining projects within Western Australia and a summary of associated environmental approvals. Key environmental legislation and regulations relevant to this Project are described below.

The Environmental Protection Act 1986 (WA) is the primary legislation that governs environmental impact assessment and protection in Western Australia. Fortescue will refer this Project to the EPA under Section 38(1) of the Environmental Protection Act 1986.

The Mining Act 1978 (WA) regulates mineral exploration and mining in Western Australia. A mining Project will be submitted to the Department of Mines and Petroleum (DMP) in accordance with the *Mining Environmental Management Guidelines – Mining Projects in WA* (DoIR originally 2006 as updated).

The mobile crushing and screening plant and the accommodation camp wastewater treatment plant is classified as a prescribed premises Category No.12: crushing and screening of 50,000 t or more of ore per annum under Schedule 1 of the Environmental Protection Regulations 1987 and will require approval under Part V of the Environmental Protection Act. The wastewater treatment plant will be of a size that triggers Category 85 (sewage facility: premises on which sewage is treated (excluding septic tanks) or from which sewage is discharged to land or waters of capacity more than 20 but less than 100 m^3/day), which requires a works approval and subsequent registration.

Fortescue has prepared and will submit a works approval and licence/registration applications for assessment by the DEC. Following approval of the works and completion of construction activities, Fortescue will then submit an application for an operating licence, seeking approval to operate the prescribed premises.

The Rights in Water and Irrigation Act 1914 (RIWI Act) (WA) provides the legislation for the Department of Water (DoW) to manage and allocate terrestrial water resources in Western Australia. Fortescue has installed three water production bores to supply the Project's potable and process water requirements under its existing 26D Licence to construct and alter wells, and will require a Section 5C licence to extract water from these bores.

The Aboriginal Heritage Act 1972 (WA) makes provision for the preservation of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants. Sites located within the Project area will be avoided

and the mine infrastructure has been designed to avoid salvage or destruction of all heritage sites.

In the event that the Project is considered to be environmentally acceptable and sanctioned by the government, additional approvals may also be required under other planning and environmental legislation, including (but not limited to):

- *Agriculture and Related Resources Protection Act 1976* (WA).
- *Australian Heritage Council Act 2003* (Cwlth).
- *Contaminated Sites Act 2003* (WA).
- *Dangerous Goods Safety Act 2004* (WA).
- *Dangerous Goods Safety (Explosives) Regulations 2007* (WA).
- *Dangerous Goods Safety (General) Regulations 2007* (WA).
- *Dangerous Goods Safety (Road and Rail Transport of Non-explosives) Regulations 2007* (WA).
- *Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007* (WA).
- *Environmental Protection Regulations 1987* (WA).
- *Environmental Protection (Noise) Regulations 1997* (WA).
- *Health Act 1911* (WA).
- *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974* (WA).
- *Heritage of Western Australia Act 1990* (WA).
- *Land Administration Act 1997* (WA).
- *Local Government Act 1995* (WA).
- *Main Roads Act 1930* (WA).
- *Mine Safety and Inspection Act 1995* (WA).
- *Mining Amendment Act 2004* (WA).
- *Native Title Act 1993* (Cwlth).
- *Road Traffic Act 1974* (WA).
- *Soil and Land Conservation Act 1976* (WA).

- *Town Planning and Development Act 1928* (WA).
- *Wildlife Conservation Act 1950* (WA).

The Cloudbreak and Christmas Creek Mines are currently operated under the State Agreement *Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006.* Mining Tenement M47/1461 where the Project will be undertaken is not attached to any existing State Agreement. It is also not the intention of Fortecue to include this Project under any existing State Agreement. Fortescue will be submitting a Mining Proposal under the Mining Act for this Project.

1.6 Overview of Existing Environment

The following section provides a summary of the existing environment which is expanded in section 2.

1.6.1 Bio-Physical Setting

The Project area is located approximately 100 km north-west of Newman on the northern flanks of the Hamersley Range, adjacent to the Weeli Wolli Creek in the Pilbara region of Western Australia.

Climate

The climate of the Pilbara is arid tropical, characterised by low and variable rainfall, high daily temperatures, high diurnal temperature variability and high evaporation rates. Summer months extend from October to April, when maximum daily temperatures can exceed 35°C. The winter months extend from May to September, with temperatures ranging from approximately 7°C to 23°C (BoM 2010, 2012).

The Bureau of Meteorology Marillana weather station (Station Number 5009), located immediately north-west of the Project area, provides rainfall records since 1936 (BoM 2010). Long-term, mean annual rainfall is approximately 310 mm, but is highly variable between years and over longer timescales. Annual potential evaporation is estimated to be 320 mm to 360 mm, and annual average evaporation of 250 mm has been reported (Fellman et al. 2011). With the exception of infrequent cyclonic rains, evaporation exceeds rainfall in all months of the year (Equinox 2012).

Geology

The Study area is located in the Hamersley Basin, a late Archaean to early Proterozoic (2765-2470 Ma) depositional basin up to several kilometres thick overlying granite-greenstone basement rocks (Thorne and Tyler 1997). The original

sedimentary surface has been heavily eroded, dissected and laterised since the late Mesozoic era. A variety of partly consolidated Tertiary materials are associated with valley fill deposits including cemented colluvium and alluvium. Residual lateritic deposits are also recognised. More recent Quaternary deposits are typically comprised of unconsolidated silt, sand and gravel in various proportions depending on local formation processes (Equinox 2012).

The quaternary washplain associated with the Weeli Wolli Creek alluvial fan is extensive, and indicatively greater than 100 m thick near the Fortescue Marsh. Large areas of calcrete exposures occur along the southern fringe of the Marsh, putatively attributable to prolonged evaporitic conditions combined with fluctuating groundwater levels. Dunal sandplains formed from reworked deposits are prominent mostly to the east of the Study area, adjacent to the Weeli Wolli Creek alluvial fan (Equinox 2012).

Land Systems

An inventory of the Land Systems occurring in the Pilbara region was completed by van Vreeswyk et al. (2004). The Pilbara inventory recognized seven land systems within the Study area. These are listed below:

1. Divide Land System - sandplains and occasional dunes with shrubby Spinifex grasslands or pindan woodlands.
2. Boolgeeda Land System - stony lower slopes and plains below hill systems. Supporting hard and soft spinifex grasslands or mulga shrublands.
3. Newman Land System - rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
4. Urandy Land System - stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.
5. River Land System - active floodplains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.
6. Fan Land System - washplains and gilgai plains supporting groved mulga shrublands and minor tussock grasslands.
7. Fortescue Land Syatem - alluvial plains and flood plains supporting patchy grassy woodlands and shrublands and tussock grasslands.

The dominant land systems within the Project area are the River, Boolgeeda, Urandy and Newman land systems.

Soils

The Soil Atlas of Australia data (Northcote et al. 1960-1968) was used to identify the soils that occur within the Study area.

Table 2: Soils identified within the Study area (Northcote et al. 1960-1968)

Soil Type	Description
My55	Gently sloping outwash plains generally flanking the northern face of the Hamersley Range; coarse surface gravels are extensive. Chief soils are neutral red earths.
Mz25	Plains associated with the Fortescue valley, surface cover of stony gravels close to the ranges and hills. Chief soils are acid red earths with some neutral red earths; red-brown hardpan is absent. Creek lines are associated with calcareous earths and loams on kunkar and some hard red soils.
Fa13	Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. Soils are frequently stony and shallow and there are extensive areas without soil cover. Chief soils are shallow stony earthy loams.
Oc71	Outwash plains with a lot of coarse surface gravel. Chief soils are hard alkaline red soils however others do occur.
Ja1	Extensive valley plains largely associated with the Fortescue River. Chief soils are earthy clays. Small areas of calcrete also occur
Oc70	Dissected pediments and low stony hills associated with Cherts, laspilites, and iron ore formations. Course gravel evident on surface, chief soils are hard alkaline red soils
Lb12	Valley flats along major drainage lines associated with limestone and calcareous gravels. Chief soils are highly calcareous earths with minor areas of shallow calcareous loams

Source: GHD 2012 (Appendix E)

The soil types within the Project area are My55, Fa13 and Mz25.

Regional Catchment

The Project area lies within the Upper Fortescue Catchment. The Upper catchment incorporates the area upstream of Goodiadarrie Crossing and is relatively flat with the downstream portion of the main Fortescue River flowing through a marshy area (Fortescue Marsh) with poorly-defined channel geometry. The major tributaries contributing to the Fortescue Marsh are Weeli Wooli Creek, Yandicoogina Creek and Mindy Mindy Creek (MWH 2011).

Local Catchment

The Weeli Wolli Creek flows through the Study area and drains into the central-southern part of the Fortescue Plain area, forming a broad out-wash fan at the foot of the Hamersley Ranges draining north towards the Fortescue Marsh. Upstream of the Study area the Weeli Wolli System is a well-defined system and topographically

constrained by the Hamersley Ranges. The upstream catchment area is approximately 4,000 km^2. The Marillana and Yandicoogina Creek systems join immediately prior to merging with Weeli Wolli Creek system. The Marillana and Weeli Wolli Creeks converge approximately 10 km upstream from the Study area (MWH 2011).

The Fortescue Marsh is approximately 30 km north of the Project area with no springs or pools are known to exist in the Study area. The Fortescue Marsh is included in the Australian Heritage Commission Register of the National Estate as an "Indicative Place", and in the Directory of Important Wetlands in Australia (Environment Australia 2001).

Vegetation and Fauna

The Project area occurs within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typically open, and frequently dominated by Spinifex, Wattles and occasional Eucalypts.

Five broad floristic vegetation categories occur in the Project area (Appendix E). These are listed below:

1. Hummock grassland on sand plains.
2. Acacia woodlands in flowlines.
3. Major creeklines.
4. Hummock grassland on rocky hills.
5. Mulga on clay/clay loam Plain vegetation.

The condition of the vegetation in the Project area ranges from Poor to Excellent as per Trudgen (1991) condition scale (Appendix E).

Four major vegetation and soil associations were identified during the fauna assessment of the Project area (Appendix G). These are listed below:

1. Mulga over buffel grass on red clayey-loam.
2. Open low shrubland of mixed acacia over spinifex on red sandy loam plain.
3. Open low shrubland of mixed acacia over spinifex on rocky/gravelly lower slopes of hills.
4. Open woodland of eucalypts over buffel grass on brown rocky loam bordering the Weeli Wolli Creek.

1.6.2 Socio-economic Setting

The Project area is located within the Shire of East Pilbara. The surrounding land uses are mining and pastoral. The closest residence, Marillana Homestead (located approximately 10 km from the Project area), is not close enough to be affected by dust or noise from the mine. However, the proposed haul road route will pass approximately 1 km from the Marillana Homestead.

The site is located within the Marillana Station operational pastoral leases.

The Project area is subject to a native title claim by the Nyiyaparli claimant group. Fortescue has signed protocols with this claimant group to establish procedures under which Aboriginal heritage surveys and native title negotiations are carried out.

There are a number of other mines in proximity to the Project, being:

- Fortescue's Cloudbreak mine is located 42 km to the north of the Project area.
- Fortescue's Christmas Creek mine is located 58 km to the north-east of the Project area.
- Roy Hill (Hancock Prospecting) is located 67 km east of the Project Area.
- Marillana (Brockman Resources) is located 15 km to the north-west of the Project area.
- RTIO Tinto Yandicoogina mine, approximately 13 km south east from the Project area.

1.6.3 Key Conservation Values

The Fortescue Marsh has been identified as a 'Nationally Important Wetland' and is listed as an 'indicative place' on the Register of the National Estate due to its importance as a habitat for migratory birds. This is the key area of conservation significance in the vicinity of the Project and supports a number of significant flora and fauna species. Mulga communities on the Marillana plain (north on the BHP Railway) are also considered locally significant as they are at the northern extent of their range in this area.

Department of Environment and Conservation (DEC) is proposing that portions of the Mulga Downs, Hillside, Marillana and Roy Hill stations associated with the Fortescue Marsh be excluded from the renewal of pastoral leases in 2015 and be added to the conservation estate (or managed by conservation agreement).

The Fortescue Plains subregion is described by Kendrick (2001) as supporting three areas of value in relation to landscape, ecosystem, species, and genetic value. These are listed below:

- Millstream Wetlands - permanent spring-fed streams, pools and river flow.
- Millstream aquifer - extensive calcrete aquifer lying between Hamersley and Chichester Ranges.
- Fortescue Marsh - extensive episodically inundated samphire marsh.

Both the Fortescue Marsh and the Millstream Pools are recognised as Wetlands of National Significance (Environment Australia 2001). The Millstream Wetlands and aquifer are more than 250 km north-west of the Study area. The Fortescue Marsh is located 30 km north of the Project area.

Additional ecosystems that have been recognised as being at risk by Kendrick (2001) that are relevant to the Study area include:

- Fortescue Marsh saltbush community described as mixed Chenopod, Samphire and Forblands.
- Perennial grassland communities in the Fortescue Valley.
- Grove-intergrove mulga communities at the southern end of northern apron of Hamersley Ranges.

Kendrick (2001) provides a detailed description of special values and features of the Fortescue Plains subregion with respect to fauna and environments, including endemism, refugia, significant species and important wetlands. All rare features are associated with the Fortescue River, including Millstream Wetlands and Millstream Aquifer and the Fortescue Marsh. Little is known in the subregion concerning short-range endemism (Kendrick 2001), but these sites are almost certainly hotspots of the phenomenon. The region is also known to support primary populations of Greater Bilby (*Macrotis lagotis*), Night Parrot (*Pezoporus occidentalis*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*) (Appendix G).

2. EXISTING ENVIRONMENT

2.1 Geology

2.1.1 Regional Geology

The Pilbara Region has undergone a long geological evolution over a period of about 3,500 million years (Trendall 1990). The Pilbara Craton contains the oldest rocks (Precambrian basement rocks) in the Pilbara and is subdivided into the Archaean granite-greenstone terrane in the north and the Archaean and Proterozoic Hamersley Basin in the south (Van Vreeswyk et al. 2004).

The Hamersley Group is predominantly sedimentary, ranging from Banded Iron Formations (BIF) forming the basal Marra Mamba Formation, through a thick dolomitic sequence (locally Wittenoom Dolomite) into the overlying Brockman BIFs and Weeli Wolli BIFs (Appendix A). Ore grade mineralisation occurs in all three sub-units of the Brockman Iron Formation: Joffre Member, Whaleback Shale and Dales Gorge Member. Joffre outcrops to the west of the project area. Whaleback and Dales Gorge outcrop to the south-east where minor iron mineralisation has been mapped at the surface.

The Pilbara Craton structural geology is dominated by granitic domes and greenstone synclines. The northern edge of the Fortescue Marsh forms part of a monocline, as evident by the outcropping Marra Mamba Formation and (to the south) the Hamersley Group rocks underlying the centre of the Fortescue Valley (Appendix A) (Lascelles 2000).

The Hamersley Group sediments are unconformably overlain by Tertiary age sediments deposited in paleo-valleys. These Tertiary sediments host detrital iron deposits (DID) to the north and east of the Project area (Figure 4).

2.1.2 Local and Project Geology

In the Project area the main orebody is concealed under recent alluvial sediments and Tertiary detrital cover up of up to 50 m.

The Project area forms part of the larger Study area, which is located within the Fortescue Plains and Hamersley subregions of the Pilbara biogeographic region within the Pilbara Craton (Appendix A).

Investigations for the Study area (Figure 5) have identified that the Pilbara Craton is a Pre Cambrian tectonic unit comprising granitic sedimentary and volcanic rocks (Hickman 1983) and that the early Proterozoic stratigraphy of the Study area includes the Hamersley Group, which is comprised of a thick sedimentary sequence overlying the Fortescue Group and the early Archean Greenstone and Granite basement of the Pilbara Craton (Appendix A).

A detailed stratigraphy has been resolved for the Io mine deposit, which correlates well with the regional stratigraphic succession described in published scientific literature. Specific differences from the type sequence have, however, been documented.

Recent Alluvium

A layer of recent alluvial sediments forms an overburden across the Project area with colluvial and alluvial cover over the majority of the deposit to a maximum thickness of 28 m. Shallow sub-cropping Joffre Member BIF occurs along the western margin of the Project area forming a low hill and associated colluvial scree. The alluvial material is typically silty gravel to conglomeritic and composed of dominantly BIF and chert clasts of varying size within a fine silty to clayey matrix.

Detrital Iron Deposits

Along the north-eastern region of the Project area some DID mineralisation has been identified by geological logging. This colluvial iron-rich scree material is characterised by generally loose to partially cemented clasts, but can be heavily cemented by iron rich matrix. These detrital deposits vary in thickness up to 24m. Grades are yet to be fully assessed but vary from high grade ‘mature’ detritals to low grade ‘immature’ detritals.

Brockman Iron Formation

Joffre Member – The upper member of the Brockman Formation, the Joffre forms the majority of the Project resource. The lower 60 m of the unit has been intersected by drilling at the Project area and is characterised by thick mineralised BID. The dominant ore mineralogy is goethite hematite mineralisation with high grades common. The entire Joffre is mineralised in one drill hole.

Whaleback Shale Member

At the Project area, the central member of the Brockman Formation is 30 – 40 m thick and characterised by predominantly shaley units with lesser BIF. Hematitic or goethitic shales are mineralised to ore grades in places.

Dales Gorge Member

The lower member of the Brockman Formation occurs at depth beneath the Project area and drilling has found it to be at least partly mineralised. It is composed of alternating planar-bedded assemblages of BIF and shalely macrobands. The dominant ore mineralogy is goethite hematite mineralisation.

The Project only considers a small portion of the Dales mineralisation where it is closest to the surface. The full thickness of the unit has not been intersected here.

Regionally Dales may be subdivided into four units, easily correlated laterally with gamma survey; however, at the Project difficulty in correlating the gamma signatures indicates a modified stratigraphy was deposited in this easterly part of the basin. It is interpreted that the lower part of the member is significantly thinned from typical Dales stratigraphy.

Proterozoic Dolerite Dyke

A single cross-cutting dyke intrudes the BID of the Io deposit in the east. The dyke is 20 to 30 m thick and consists of barren dolerite.

2.2 Soils and Soil Profile

2.2.1 Land Systems

Findings from GHD's investigations (Appendix A) indicate that the Fortescue Plains sub-region (PIL 2) is considered to consist largely of alluvial plains and river frontages with extensive salt marsh, mulga-bunch grass and short grass communities. The Hamersley sub-region (PIL 3) is described as comprising a mountainous area of Proterozoic sedimentary ranges and plateaus, dissected by gorges (basalt, shale and dolerite) and supporting mulga low woodland over bunch grasses on fine textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges.

Ancient floodplains and riverways have caused erosion and deposition of thick Phanerozoic alluvial and colluvial material. Much of the proposed mine area and associated infrastructure is located at the apex of an expansive alluvial fan where Weeli Wooli Creek discharges onto the broad plains of the Fortescue Valley. These valley plains slope gently down to the Fortescue Marsh. Weeli Wolli Creek intersects the south-west extent of the Project area and meanders in a general north-west direction before eventually discharging into the Fortescue Marsh. Occasional hills (up to 90 m relief) abut the southern extent of the site.

Seven land systems were identified during the investigations within the landform assessment area and include the Boolgeeda, Divide, Fan, Fortescue, Newman, River and Urandy land systems (Appendix A). The biophysical characteristics of these land systems (as described by Van Vreeswyk et al. 2004; pp 181) are summarised below and are shown on Figure 7.

- Boolgeeda Land System – stony plains with spinifex grasslands;
- Divide Land System – sandplains with spinifex grasslands;
- Fan Land System – wash plains on hardpan with groved mulga shrublands, sometimes with spinifex understorey;
- Fortescue Land System – river plains with shrublands or spinifex grasslands;
- Newman Land System – hills and ranges with spinifex grasslands;
- River Land System – river palins with shrublands or spinifex grasslands; and
- Urandy Land System – alluvial plains with soft spinifex grasslands.

A summary of the land systems identified during the investigation, their associated geology units and soil descriptions is shown in Table 3.

Table 3: Land systems and associated geology units and soil descriptions

Land System	Geology	Soil descriptions
Boolgeeda	Quaternary colluvium	Low hills and rises – stony soils and shallow red loams. Stony slopes and upper plains – shallow red loams or loamy red earths. Stony lower plains – loamy red earths Groves – loamy red loamy earths. Narrow drainage floors and channels – loamy red earths and minor self-mulching cracking clays. Channels with river bed soils.
Divide	Quaternary Aeolian sand	Low hills – stony soils and shallow red sands. Sand dunes – deep red sands. Sandplains – deep red deep sands and sandy red earths. Plains with sand cover – shallow red sands and shallow gravel soils. Stony plains – shallow gravel soils.

Land System	Geology	Soil descriptions
Fan	Quaternary alluvium, minor colluvium and sand	Sand sheets and sandy banks – deep red sands with minor red sandy earths. Loamy plains – loamy red earths and sandy red earths. Washplains – loamy red earths. Groves – loamy red loamy earths. Gilgai plains – self-mulching cracking clays and red / brown non-cracking clays. Drainage tracts – loamy red earths. Drainage foci – deep red / brown clays with some self-mulching cracking clays.
Fortescue	Quaternary alluvium	Alluvial plains – deep red / brown non-cracking clays, deep red sandy surface texture contrast soils and infrequent shallow red sands. Floodplains, outwash river fans and depressions – deep red / brown non-cracking clays and self-mulching clays. Gilgai plains – self-mulching cracking clays with minor deep red / brown non-cracking clays. Hardpan plains – loamy red earths. Groves – red loamy earths. Sandy banks and sheets – deep red sands with some red sandy earths on sand sheets. Levees – deep red sands and sandy red earths. Channels – river bed soils.
Newman	Lower Proterozoic jaspilite, chert, siltstone, shale, dolomite and minor acid volcanics	Plateaux, ridges, mountains and hills – stony soils, shallow red loams and some shallow red sands. Lower slopes – stony soils on upper margins with loamy red earths on lower margins. Stony plains – stony soils, shallow red loams with some red loamy earths. Narrow drainage floors with channels – shallow red shallow loams, loamy red earths. Channels with river bed soils.

Land System	Geology	Soil descriptions
River	Quaternary alluvium	Sandy levees and sand sheets – deep red, sands, red sandy earths, loamy red earths and some river bed soils. Upper terraces – deep red sands. Floodplains and lower terraces – deep red / brown non-cracking clays and loamy red earths. Stony plains – shallow red loams and shallow red sands. Minor and major channels – river bed soils.
Urandy	Quaternary alluvium and colluvium	Stony plains – loamy red earths. Alluvial plains – loamy red earths with some shallow red sandy surface texture contrast soils. Drainage zones and channels – loamy red earths, levees of deep red sand and channels with river bed soils.

Dominant landforms observed during the investigations within the assessment area included:

- Weeli Wolli Creek
- alluvial/colluvial plains of the Urandy, Fan and Boolgeeda land systems
- aeolian sandplains of the Divide land system
- hills and plateaus of the Newman system

From a landform perspective, no land units were observed within the Project area that are considered to be unique to the region. The Weeli Wolli Creek system is a prominent feature within the Study area and is a major tributary of the Fortescue Marsh (Appendix A).

The investigation findings concluded that more than a third of the Pilbara consists of rugged, hills, ranges and plateaus occurring mostly in the central and southern parts. The oldest landscapes within the region occur in the central eastern area and consist of extensive gently undulating granitic plains, tor fields, drainage tracts and occasional low greenstone hills. Soils on this terrain are mostly red shallow sands. The hills give way to broad gently sloping plains with red sandy earths, deep red sands and loamy red earths (Appendix A).

2.2.2 Physical Properties

Most of the soil types observed during the investigation, within areas of higher relief, were recorded to have considerable quantities of stone throughout the soil profile and often possessed a stony surface mantle with rock outcrops. Less dominant soils included red shallow loams with some shallow red sands.

Calcareous shallow loams were mostly common on hills based on Basalt, and shallow red / brown non-cracking clays occurred as isolated pockets of soils within the hill systems and within hill valleys. Soils were observed to become deeper downslope from the ranges. In these areas, the dominant soils are stony surfaced red loamy earths with some areas of deep red / brown non-cracking clay. The lowest landscape units have been described as having self-mulching cracking clays with areas of deep red / brown non-cracking clays or red deep loamy surface texture contrast soils (Van Vreeswyk et al. 2004).

Soils within the Fortescue Basin, which is situated between the Hamersley Plateau and the Chichester Range, have been described as predominantly alluvial soils deposited in large fans. Salt accumulation has been observed within the Fortescue Marsh with soils within this system being saline or hyper-saline (FMG 2011a).

The investigation observations recorded that the soils of the Study area are highly oxidised, reddish to brown, and frequently contain horizons of coarse fragments. These soils were described as low in clay fines with textures of loamy sands to sandy clay loams gradually increasing in clay content with depth. Topsoils are characterised as usually very shallow quickly grading abruptly into rocky subsoils, which whilst not always present, were found to be up to and beyond 2 m in depth in places.

Landscapes within the Study area were recorded as being either erosional or depositional with gullying and sheet flow occurring in areas of higher relief with the soils on the plains and valleys have been influenced by this material, which has been deposited by alluvial and colluvial processes. Aeolian processes are also evident within the landscape, particularly the sandplains of the Divide land system. Rock is frequently observed on the soil surface and within the soil profile due to the resistant nature of this material. The Banded Iron Formation, indurated with both iron and silica rich minerals, is the final product in a weathering sequence that has left hard, residual material behind (Appendix A).

2.2.3 Chemical Properties

Soil investigation results presented in GHD's study (Appendix A) are summarised as follows:

- Soil pH provides a measure of soil acidity and is typically measured in water or 0.1 M $CaCl_2$ (Hazelton and Murphy 2007). Subsoils that have pH beyond 8.0 may lock up some nutrients, particularly some trace elements which are more available in an acidic to neutral pH range. It was concluded during the investigation that such results are not uncommon in the region.
- Alkaline pH values in the Urandy system were determined to be an indicator of hardpans within the soil, which can limit the amount of water in the soil profile that is available for plant growth and can result in a hostile soil environment for the establishment of deep rooted plant species. Investigation results indicated that the depth of hardpan varied from 0.6 m to deeper than 12 m across the investigation sampling sites.
- Electrical conductivity (EC) indicates the amount of soluble (salt) ions in soil or water. EC is typically categorised according to soil texture and is the most common measure of soil salinity. High salinity levels can adversely impact on plant growth and increase soil erodibility. The threshold EC value for plant growth is 1.2 dS/m. EC values for all investigation sites at all depths were considered to be extremely low, indicating that salt levels are low within the profile. EC values ranged from less than 0.010 ds/m to 0.067 dS/m.

Given that sodium chloride (NaCl) is a major salt compound contributing to conductivity, it is not surprising that NaCl levels were also extremely low in the profile. Chloride levels (Cl) did not exceed 5.2 mg/kg, whilst exchangeable sodium levels were also very low, not exceeding 0.07 meq/100g. Other salt types, such as carbonates, sulphates and potassium which also conduct electricity are also at very low levels. Low EC values in the Study area were considered to indicate that most nutrients have been leached out of the soils over time leaving a substrate poor in most plant available nutrients.

Organic matter is directly derived from plants and animals and is an important factor influencing many physical, chemical and biological soil characteristics. Its key functions include increasing plant available water, supporting organisms in the soil, buffering pH and improving the structural stability and nutrient levels of soils. (Hazelton and Murphy 2007). Organic carbon at all investigation sampling sites was recorded at very low levels. Topsoil OC levels ranged from 0.15-1.06% and subsoil OC ranged from 0.07- 0.26 %. The optimal OC range is reported to be between 2-3% and therefore, due to low OC levels, these soils have been determined to have

poor structure, be more prone to hardsetting and have reduced permeabilities due to the lack of stable soil aggregates and pore space for the movement of soil-water.

Cation exchange capacity (CEC) is a measure of a soil's capacity to hold and exchange cation nutrients. It affects the buffering capacity of a soil, nutrient availability, calcium levels and soil stability (Hazelton and Murphy 2007). A low CEC value indicates that the soil has a low resistance to soil chemistry changes resulting from land disturbance (Hazelton and Murphy 2007).

CEC is commonly approximated by calculating the Effective CEC. About 50% of the sites within the Project area had an effective CEC of less than 6 meq/100mg. A figure of less than 6 meq/100mg is considered to be very low. The remainder of the samples had CECs of between 6-12 meq/100mg which is still considered low.

ESP is a measure of the amount of sodium occupying the exchange sites within the soil. ESPs measured for the Project area are all extremely low with a maximum value recorded of 1.50%. These soils were considered to be unlikely to disperse due to the relatively low levels of sodium present. However, low sodium levels alone cannot be used to characterise the depressiveness of a soil. Calcium to magnesium ratios and physical characteristics are also important parameters in determining soil stability.

High levels of magnesium relative to calcium can affect a soil's stability.

Soil colloids (as well as sites on soil humus/carbon) are negatively charged, with calcium and magnesium making up the bulk of the cations attracted to the colloid surface. Calcium ions flocculate soil and magnesium ions disperse and disrupt soil aggregates. A balance between the two is needed to maintain ideal soil structure. A Ca/Mg ratio of greater than one is considered to be satisfactory for soil structure and plant growth. A higher ratio is desirable and can be achieved with the addition of lime. Soils within the study area all have Ca/Mg ratios greater than one and are considered stable.

The soils within the Study area are all deficient in copper with all values less than 3 mg/kg. Iron levels are moderate to high with some values greater than 200 mg/kg. This may represent toxic levels for non-tolerant plants at some sites but also underlines the fact that iron rich compounds are prevalent within the landscape. Zinc levels were generally observed to be extremely low, with most recorded values being less than 1 mg/kg. The highest value recorded was 2.35 mg/kg which is in the desired range for Zinc. Manganese levels are excessively high at a number of sites and may be at toxic levels for non-tolerant plants. Manganese levels may be high due to their likely association with iron rich minerals in the landscape. A manganese level of 140 mg/kg recorded was at Site 9, many times greater than the optimum

level. Boron levels in all soils were towards the lower end of the spectrum at all sites. Quite a few sites had topsoils and subsoils with values lower than 0.30 mg/kg.

The dispersibility index is calculated using a combination of other soil test parameters. The index is a score between 1-16 and is used to characterise the behaviour of the soil with a single parameter. The soil samples analysed within the assessment area have dispersibility indices of between 1 and 5 which once interpreted states that these soils fall within the stable range.

The investigation also conducted soil sampling at all sites that were measured for levels of the following heavy metals:

- arsenic
- cadmium
- chromium
- cobalt
- lead
- molybdenum
- selenium

During the investigation the assessment of heavy metal levels within the samples taken at the Project area were compared to the levels published within the *Contaminated Site Reference Series - Assessment Levels for Soil, Sediment and Water*, Department of Environment and Conservation, WA (2010). Most heavy metal concentrations are below critical values with the execption of the above.

2.3 Water

2.3.1 Surface Water

Regional Catchment

The Project area lies within the Fortescue River Basin which covers an area of approximately 49,700 km^2. The majority of the Fortescue River Basin is woodland and pasture, with a smaller percentage being covered by shrubby pasture and woody pasture (Appendix C).

The Fortescue River Basin is divided into three main sections. The downstream section which runs from Bullinnarwa to Gregory's Gorge has a well defined river

channel relative to the two upstream sections (Figure 8). The middle section which runs between Gregory's Gorge and Goodiadarrie Crossing is flat with a poorly defined river channel. The upper section, within which the Project area, is extremely flat and the catchment areas contributing to this portion of the Basin collect in a large flat area of the Fortescue Marsh. The major tributaries contributing to the Marsh are Weeli Wolli Creek, Yandicoogina Creek, Mind Mindy Creek and the Fortescue River (Ruprecht and Ivanescu 2000).

Local Catchment

The Weeli Wolli Creek is an important tributary to the Fortescue Marsh. It contributes up to 10% of the surface flows into the marsh. Localised rainfall could mean that the creek will contribute a far greater proportion of the surface flow during a rainfall event (Gardiner 2003). The Weeli Wolli Creek has three distinct zones – the upper catchment above the Weeli Wolli Spring has a number of tributaries that drain the east-west trending Hamersley Range. The creek then flows through the Packsaddle Range in a narrow gorge at Weeli Wolli Spring. The spring results from the Brockman Iron Formation damming groundwater, causing it to rise to the surface at this point. The Weeli Wolli Spring has permanent surface water flows, which disappears about 2 km downstream of the spring. Permanent water bodies are rare in the Pilbara region so the spring has high environmental significance (EPA 2001).

Below Weeli Wolli Spring the lower catchment features trunk drainage to the Hamersley Range Escarpment before emerging into a broad outwash on the Fortescue Plain.

The Marillana Creek is a tributary of the Weeli Wooli Creek with a catchment area of 2,050 km^2. It is ephemeral, flowing on average 213 days per year (ranging from 15 days in 1986 to 366 days in 2000) (Beckett and Cheng 2010b). The upper catchment drains the Hamersley Range before flowing into the internally draining Munjina Claypan. The internally draining catchment area is 274km^2 and retains flows up to 1 in 10 ARI (Beckett and Cheng 2010b). Flows above this internal drainage capacity will spill into the lower catchment. Below the claypan the lower catchment flows through a well-defined channel prior to merging with the Yandicoogina and then Weeli Wolli Creeks. It contributes approximately 50% of the surface flows into Weeli Wooli Creek (Gardiner 2003). Refer to Figure 8 for a description of the catchments in the area.

Topography

The topography of the Project area slopes in a general northerly direction with a slope of 0-2 degrees. The Project area is at an elevation of between 460 to 480 mRL, with localised incision due to the Weeli Wolli Creek. The Hamersley Range to

the south-west rises to approximately 700 mRL in the area surrounding the Project and to a height of 1,100 mRL in the headwaters of the upper catchment (refer to Figure 9).

Rainfall Stations

The Pilbara region receives low rainfall, characterised by low intensity, frequent events associated with thunderstorms and tropical upper air disturbance and infrequent high intensity rainfall in conjunction with tropical cyclones.

Six rainfall gauging stations are located in the the Weeli Wolli catchment (Figure 10). Table 4 shows rainfall data taken from the rainfall gauging stations and also also provides the mean monthly rainfall for each of the rainfall sites.

Table 4: Rainfall stations within the Weeli Wolli Creek Catchment

Gauge Number	Gauge Name	Station Opened	Station Closed	Years of Data	Annual Rainfall		
					Mean	Max	Min
505011	Flat Rock	01/03/1970	-	38	380.6	975.6	85.1
505004	Munjina	01/01/1969	-	39	416.4	1002	158.3
505014	Packsaddle	01/06/1970	05/09/1999	29	308.2	862.4	14
505035	Yandicoogina	14/12/1979	16/04/1986	6	241.6	486	6.4
505040	Tarina	10/05/1985	-	25	352.5	710.7	29.6
505041	Waterloo Bore	10/05/1985	-	25	389.1	950.3	25.8

Source: DoW, 2011

Flood Frequency

The closest station to the Project area is the DoW managed Waterloo Bore (station no. 505041) which has 25 years of flow data.

Flood frequency analysis was carried out on flow records from four stations within the catchment including the Weeli Wolli Creek at Waterloo Bore gauge (Appendix B).

Two frequency analysis methods were used as described in Australian Rainfall and Runoff (ARR):

- Annual Flood Series
- Partial Duration Flood Series

As a general rule, ARR and WA Main Roads guidelines recommend the use of annual flood series analysis when estimating flow for events less frequent than 10

year ARI, while the partial series is used for estimating more frequent events. Partial series analysis is also often used when the period of data record is short.

Results of partial and annual series analysis for Waterloo Bore are summarised in Table 5 and results for all gauges within the catchment including Rational and Region flood methods are presented in Table 6. The partial duration series analysis was carried out using the River Analysis Program (RAP) produced by the CRC Innovation Centre University of Canberra.

Annual series analysis was carried out using TIDEDA, a data hydrological archive and processing program developed by the National Institute of Water and Atmospheric Research.

Table 5: Waterloo bore flood analysis

	Partial Series analysis (m^3/s)	Annual Series Analysis (12mth) (m^3/s)		24 Month Series Analysis (m^3/s)	36 Month Series Analysis (m^3/s)
ARI (years)					
5	450	490	470	545	500
10	850	1300	1290	1400	1400
20	1500	2425	2420	2510	2520
50	3300	4180	4220	4230	4220
100	6500	5650	5730	5640	5600

The MWH *Io Surface Water Assessment, Data and Literature Review 2011* report, provides more details on the flood frequency analysis (Appendix B).

A summary of peak flows adopted for the flood modelling is listed in Tabl;e 6.

Table 6: Adopted peak flood flows

ARI (years)	Peak Flood Flow (m^3/s)
5	470
10	1290
20	2420
50	4220
100	5600
100 (upper estimate)	6500

Hydraulic Modelling of Weeli Wolli Creek System

The floodplain area around the proposed pit was modelled using the DHI (Danish Hydraulics Institute) MIKE21 2-dimensional floodplain modelling software. Output

from the model has been used to assess the extent of inundation and flow velocity around the minesite and to determine the scope of flood management infrastructure required. The flood hydrographs derived from the Weeli Wolli Creek Waterloo Bore gauge data have been used as inputs to the 2D model.

Model runs were completed for the 5, 10, 20, 50 and 100-year ARI design flood events with a nominal duration of 42 hours. The results of the modelling are shown in Figures 11, 12, 13, and 14.

The Project area is positioned downstream of an elevated topographic feature and all infrastructure is over 300 m away from the main Weeli Wolli Creek channel. The main creek channel curves to the north-west and away from the minesite as it passes the high ground. The mine site receives floodwater from two break-out overflow paths from the main Weeli Wolli Creek on both sides of the high ground during large events.

The proposed mine site will be protected with earth bunds around four sides that match into high ground.

The existing (pre-development) case and an operational case which included the flood protection bund around the minesite were modelled with the critical outputs (flood depth, velocity, flood discharge, flood duration) gathered at specific locations around the proposed mine site.

As shown by the hydraulic modelling, the proposed mine infrastructure is located outside the 1 in 20 flood extents for Weeli Wolli Creek (Figure 12), and in shallow flood extents in a 1 in 50 event (Figure 13).

Catchment Mine Water Discharge

Numerous mine sites located upstream from the Project in the Weeli Wolli Creek and Marillana Creek catchments are currently discharging excess water into the systems from their mine dewatering processes (refer to Section 2.3.2). These discharges have altered the natural hydrologic regime of the Weeli Wolli Creek and Marillana Creek systems. Some details on the discharge regime of mine sites in the local catchment are provided below:

- BHPB Yandi operation - Commenced discharging water into Marillana Creek in 1991.
- Rio Tinto Junction Central operation - Commenced discharging into Marillana Creek early in 1998.

- Rio Tinto Junction South East operation - Commended discharging into Weeli Wolli Creek in 2006.
- Rio Tinto Hope Downs One Operation - Commenced discharging into the Weeli Wolli Creek in 2007/2008.

Water Balance – Fortescue Marsh

A water balance study of the Fortescue Marsh was completed in 1995 (Woodward-Clyde 1995). This assessment concluded the following in regards to the regional contribution from the Marillana and Weeli Wolli Creek systems (period of 1974 to 1986):

- On an average annual volume basis, the Weeli Wolli Creek system contributed around 10% to the Marsh Inflows, second only to the upper Fortescue River.
- During periods of widespread regional rainfall, the Weeli Wolli Creek system contributed around 2% to 10% to the Marsh inflows, of which around half was generated by the Marillana Creek sub system.

Water Quality

Water quality data obtained from the DoW's database for Weeli Wolli Springs (1997-2008), Tarina (1993-2008) and Waterloo Bore (1985-2000) stations is limited, and few strong water quality trends are detectable. The water in Weeli Wolli Creek is fresh, with overall electrical conductivity (EC) values averaging 919 µS/cm at Weeli Wolli Springs, 940 µS/cm at Tarina and 275 µS/cm at Waterloo Bore, the latter likely reflecting a higher proportion of surface runoff and where to date there is no permanent flow. Wet season (January, February and March) average EC values are 905, 712 and 179 µS/cm, respectively. Prior to Hope Downs discharging to the creek (2007) EC values, at an average of 975 µS/cm, are higher than EC values associated with the Hope Downs Mine discharge (870 µS/cm). The highest EC values were recorded in December, associated with the first significant rains, which flush creekbed salts accumulated from the previous dry season.

Measured pH is dominantly neutral with slightly acidic pHs (from 6.2) registered at Waterloo Bore, and seasonally slightly alkaline, ranging up to 8.6 at Weeli Wolli springs, possibly registering the effects of carbonate rocks and calcrete in this area.

Turbidity values are much greater at Waterloo Bore, reflecting storm runoff conditions, and the infrequent flow conditions at Waterloo Bore, with an average of 177 Nephelometric Turbidity Units (NTU), while average values at Waterloo Bore and Tarina are both less than 1 NTU.

Total nitrogen values are relatively low. Increase of nitrogen downstream is potentially associated with runoff from stock activities.

2.3.2 Groundwater

The hydrogeology of the Study area is closely related to the geological units described in Section 2.1 and Figure 15. The hydrogeology of the study area is part of a regional groundwater system, including the aquifers within the Weeli Wolli palaeo-valley located to the south of the Study area and Upper Fortescue Valley located to the north of the study area.

Fortescue has undertaken an assessment of the regional and local hydrogeology, which included field investigations within the Study area (Appendix D).

Hydrostratigraphy

A summary of the main groundwater related hydrogeological units in the Study area, including hydrostratigraphy; flow regime; and water quality are presented in Table 7.

Table 7: Hydrostratigraphic Units of the Study area

Description	Hydraulic Characteristics
Upper Tertiary Alluvium: Consists of unconsolidated coarse sands and gravels in a silty sand matrix, associated with outwash from the Weeli Wolli Creek. The sequence increases in depth and thickness distally from the apex of the alluvial fan in a northward direction.	Generally low to moderate transmissivity, though discrete channel beds may present semi-continuous zones of higher permeability. Storage moderate to high. It may potentially accept significant recharge during major flood events, and facilitate subsequent leakage to the underlying sequences.
Lower Tertiary Alluvium: A ubiquitous silty clay horizon which is between 20 to 50 m thick. Extensive throughout the project area, only limited in areas of shallow bedrock subcrop and upstream from the apex of the alluvial fan in the Weeli Wolli palaeo-valley	Appears to act as a semi-confining layer to underlying aquifers. Characterised by low permeability although storage potential may be moderate, particularly given total volume of material present in area.
Tertiary Detritals: Consists of hillslope derived iron-rich clasts which may be pisolitic in nature. Limited to the slopes of the Hamersley Range and Hills adjacent to the Project.	Moderate to high permeability and storage where saturated. Presents a pathway for infiltration of runoff from hillslopes.
Channel Iron Deposits (CID): Consists of chemically altered and heterogeneous palaeochannel deposit material, with potential internal division into Upper and Lower CID. The palaeochannel incision follows inferred fault traces in the area with a depth of up to 230 m. Unit thickness is in the range of 50 – 150 m.	The Upper CID contains vugs which may be interconnected. The Lower CID contains enhanced permeability in the form of interconnected cavities and poorly consolidated silty clay bands. Permeability is high to very high, with considerable storage. The CID is the primary aquifer in the area, and received considerable recharge from upstream infiltration and throughflow.

Description	Hydraulic Characteristics
Mineralised/fractured Brockman Iron Formation (BID): Consists of hematite and goethite enriched BIF, with extensive fracturing from inferred fault activity. Depth and thickness vary across the project site.	Enhanced permeability and storage potential due to secondary fracturing and mineralisation. The aquifer is understood to be in direct connection with CID above.
Fresh Brockman Iron Formation: Consists of massive banded iron formation with localised fracturing	Low permeability and storage. Understood to have limited vertical or horizontal connectivity to the south.
Siliceous breccia/weathered dolomite: Related units consisting of silica rich clasts in a boxwork structure or carbonaceous dolomite with extensive dissolution features	Located to the north of the mine area, potentially abutting BID aquifer. Highly permeable site with considerable storage.

A summary of likely hydraulic parameters for these units based on a literature review for similar projects in the Pilbara (MWH 2011) is shown in Table 8.. Findings of specific project investigation for the Project area are reported in Section 6.

Table 8: Summary Hydraulic Parameters for the Hydrostratigraphic Units

Aquifer	Average K (m/d)	10th Percentile K (m/d)	90th Percentile K (m/d)	Standard Deviation K (% of Geomean)	Ss	Sy
Upper Alluvium	0.072	0.0059	2.9	2455%	$1x10^{-5}$	3-10%
Lower Alluvium	0.0016	0.00051	0.014	529%	$5x10^{-5}$	1-5%
Tertiary Detritals	0.68	0.43	2.1	136%	$1x10^{-5}$	2-5%
Channel Iron Deposits (CID)	6.3	0.48	75	1190%	$1x10^{-5}$	3%
Mineralised/Fractured Brockman Bedded Iron Deposit (BID)	14	5.2	48	152%	$5x10^{-7}$	1-2%
Unmineralised/unfractured Brockman Formation	n/a	n/a	n/a	n/a	$1x10^{-6}$	0.1–0.5%
Siliceous breccia/weathered dolomite	24	11	74	145%	$5x10^{-6}$	2-5%

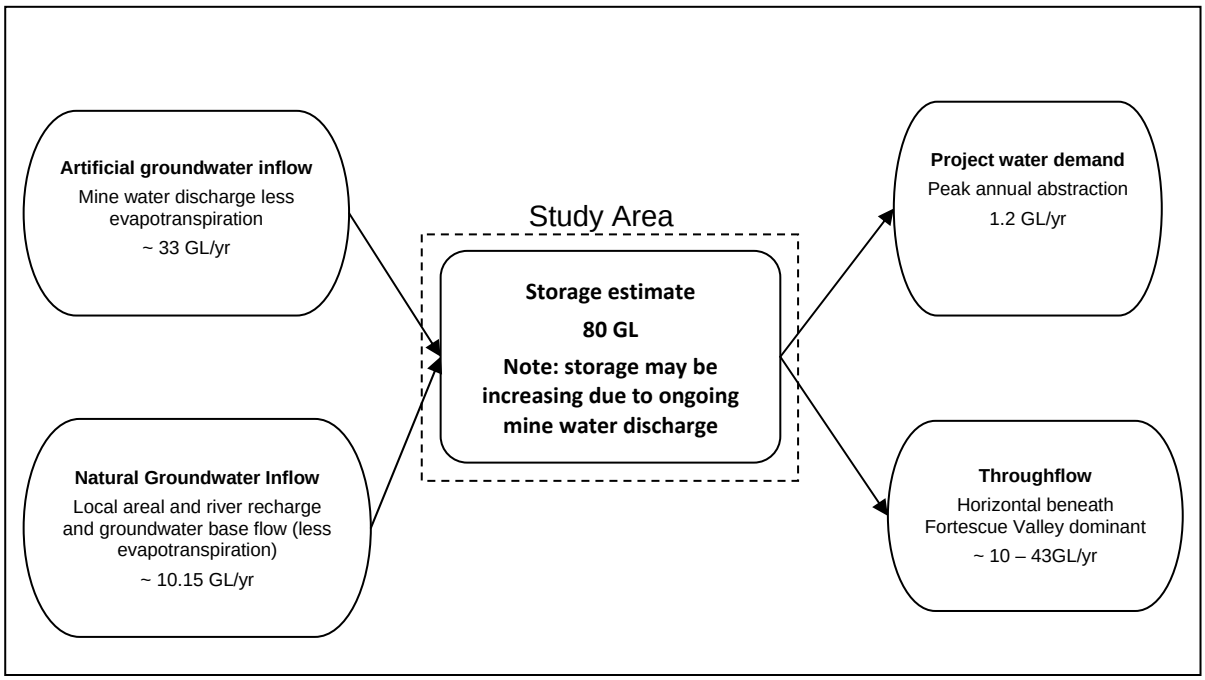
S_S = Specific Storage
S_Y = Specific Yield

Groundwater Flow Regime

Summary Water Balance

The drawing below (Drawing 1) summarises the components of the groundwater balance discussed within this section.

Drawing 1: Summary of the water balance for the Study area



Recharge

Semi quantitative estimates of recharge are presented in Table 9 below.

Table 9: Recharge sources to the Study area

Recharge Source	Occurrence	Annual Recharge[1] Volume (GL)
Areal Recharge	Intermittent throughout the year, but more likely in wet season	0.15
Surface water flow	Seasonal, following intense rainfall	10
Natural groundwater baseflow	Year round	
Mine water discharge supported groundwater flow	Year round, expected to last for life of Io Project	33

The combination of low precipitation, high potential evapotranspiration rates and fine sandy silt surface soils in most areas, is expected to result in relatively low, diffuse recharge. Most areal recharge is expected to occur following prolonged cyclonic rainfall events and focused largely in highland areas and areas of tertiary detritals where water may infiltrate through exposed fractured rock or coarser soils. Approximately 0.15 GL of recharge is estimated from rainfall recharge.

[1] Recharge after evapotranspiration losses

The principal source of freshwater to the study area is considered to be infiltration to the water table from Weeli Wolli Creek and its tributaries. This water is delivered from two sources:

- Natural inflow from wet season surface water flow and groundwater baseflow.
- Artificial mine discharge water infiltrating into the groundwater system.

Under natural conditions it is estimated the Study area receives an average net recharge of 10 GL/a, which is largely attributable to flow events in the Weeli Wolli system.

Mine water discharge occurring upstream in the Weeli Wolli catchment is estimated to be in the order of 43 GL/a. Given that evapotranspiration losses are expected to be up to 10 GL/a, it is estimated that 33 GL/a enters the aquifer system and flows through the Project area. The mine water discharge component of the water balance is the most dominant component of the water balance. Mine water discharge is forecasted to at least 2025.

Groundwater Flow Patterns

Groundwater flow is a reflection of topography, flowing in a northerly direction towards the Fortescue Marsh. Recharge from flood events and upstream mine discharges is expected to cause a groundwater mound extending radially from the Weeli Wolli Creek (Figure 16).

Groundwater gradients of 7 m/km occur upstream of the mining area. These flatten in the vicinity of the mining area to between 1 to 2 m/km, with some local influence from creek recharge. Beyond the creeks influence, groundwater flow exhibits a shallow (0.5 m/km) north to north-east gradient towards the Fortescue Marsh.

Groundwater Levels

The depth to groundwater contours for November 2011, obtained directly from the groundwater levels is shown in Figure 17. Depth to groundwater corresponds to local topography and recharge patterns. Upstream mine water discharge is expected to maintain permanent flow in the upper reaches of Weeli Wolli Creek. This results in shallow groundwater levels upstream of the study area. Groundwater depth near the creek and within the study area is in the order of 10 – 25 m bgl, varying seasonally. Groundwater depth in the deeper aquifers, CID and BID are in the order of 20 – 25 m bgl. Radially from the creek, depth to groundwater is in the order of 25 – 33 m, shallowing to the north.

Storage and Throughflow

Storage within the Study area is estimated to be in the range of 80 GL/yr. The CID and BID aquifers are expected to contain the greatest groundwater storage capacity, based on storativity and saturated thickness across the site. The alluvium is also expected to store groundwater.

Conceptually, the majority of throughflow is expected to occur within the upper alluvial and CID aquifers. These aquifers receive most of their recharge from the Weeli Wolli Creek and underlying palaeochannel; which itself is impacted mainly by discharge from Hope Downs mine and throughflow from the Marillana Creek palaeochannel.

Regional Connection

The aquifers described in the Study area are connected to the alluvial and CID filled palaeo-valley extending south beneath the present day Weeli Wolli drainage. This system directly overlies fractured and mineralised bedrock aquifers of the Brockman Formation. To the north, the aquifers in the study area are variably connected to the sedimentary, chemical and bedrock aquifers of the Fortescue Valley.

Vertically, the CID and BID aquifers appear to be in direct hydraulic connection, with only local separation from remnant unmineralised shale bands. Beneath the mineralised bedrock aquifers lie impermeable bedrock units. These units are not considered to be any notable throughflow or storage.

Discharge

Depth to groundwater in the Study area ranges from 10 – 40m bgl. No springs occur within the Study area.

Upstream of the Project, permanent water within the Weeli Wolli Creek is interpreted to be the surface expression of groundwater. Groundwater levels in this area have risen due to mine water discharge from other (external to Fortescue) mining operations.

Water Quality

Based on recent groundwater sampling in the Project area, shallow groundwater within Tertiary to recent deposits and the bedrock (BID) is fresh to marginal-fresh (< 1,500 mg/L) and pH-neutral (pH 7). Dominant cations and anions detected in groundwater comprise calcium, magnesium, sodium, bicarbonate, chloride and sulphate.

Saline to hypersaline groundwater is known to exist beneath and fringing the Fortescue Marsh. Investigations by Aquaterra (2010) for Brockman Resources, as well as monitoring by Fortescue and airborne geophysical investigations have defined the extent of saline to hypersaline groundwater (refer Figure 18). The occurrence of saline groundwater is considered to be outside the influence of the project.

2.4 Climate

The climate of the region is described as semi-arid to arid and is characterised by hot summers and warm winters. The region experiences a climate of extremes, where severe droughts and major floods can occur at close intervals.

Meteorological data are available from two Bureau of Meteorological Station (BOM) locations in proximity to the project area. Data is available from:

- Wittenoom (BOM No. 005026) data available 1949 to present. This meteorological station is located approximately 115 km north east of the Project area.
- Newman Aero (BOM No. 007176) data available 1971 to present. This station is located approximately 90 km southeast of the Project area.

A summary of long-term meteorological data from Wittenoom and Newman is listed in Table 10.

Table 10: Climate data summary (Wittenoom and Newman)

Month	Wittenoom			Newman Aero		
	Mean Daily Maximum Temp (°C)	Mean Daily Minimum Temp (°C)	Mean Monthly Rainfall (mm)	Mean Daily Maximum Temp (°C)	Mean Daily Minimum Temp (°C)	Mean Monthly Rainfall (mm)
January	39.6	26.1	103	39.5	25	57.3
February	37.8	25.3	109.1	37	23.9	77
March	36.7	24.3	70.7	35	21.5	40.7
April	33.1	21.2	28.7	31.7	17.3	19.6
May	27.7	16.1	27.4	27.3	11.6	18.1
June	24.5	12.8	28.3	23.1	6.8	14.2
July	24.2	11.5	14.3	23	6	14.9
August	26.7	13.2	8.8	25.7	7.5	8
September	31.1	16.8	2.3	30.2	11.8	4.6
October	35.3	20.6	3.7	34.9	17.3	4.9
November	38	23.6	8.8	37.4	20.8	10.3

Month	Wittenoom			Newman Aero		
December	39.6	25.4	49.5	39	23.7	37.6
December	39.6	25.4	49.5	39	23.7	37.6
Annual	**32**	**19.7**	**454.2**	**32**	**16.1**	**310.7**

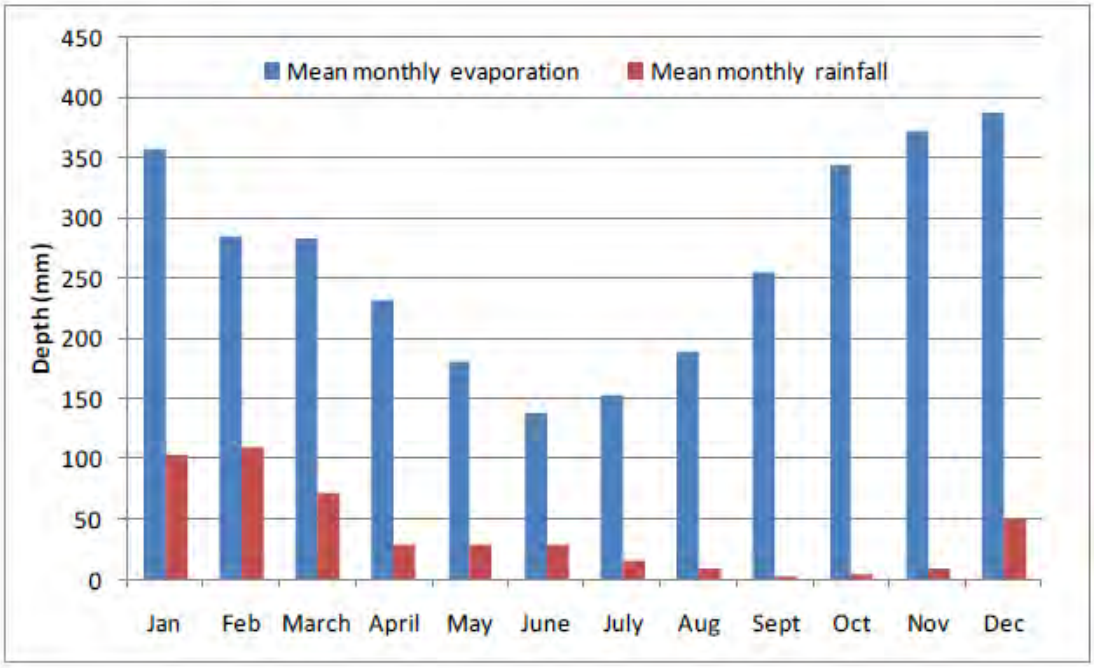
Notes:
*Periods for calculating statistical data vary between meteorological stations: Wittenoom (Temperature data 1951-2010 and Rainfall data 1950-2010), Newman (Temperature data 1996-2011 and Rainfall data 1971-2011).

Source: Bureau of Meteorology Climate Averages Station No. 005026 and 007176 respectively

Temperature variations in the region can be large, with the average daily maximum temperatures rising to 35 to 40°C in summer and dropping to a minimum of 6°C in winter.

Annual potential evaporation is 3,175 mm (mean daily average 8.7 mm). The excess of evaporation over rainfall, which is greater than a factor of ten, is typical for arid and semi arid areas in Australia (Graph 1).

Graph 1: Mean Monthly Evaporation and Rainfall at Wittenoom



Rain falls mainly in the summer months from January to March, and is unusual between July and October. Most of the summer rain comes from scattered thunderstorms, producing heavy localised falls in short periods. In addition, tropical lows that usually originate off the Pilbara coast can bring widespread rain to the region. A secondary peak in the monthly rainfall can occur in May as a result of rainfall caused by tropical cloud bands, which intermittently affect the area mostly in May and June. Rainfall in general is unreliable and highly variable, which

predominantly relates to the random nature of localised thunderstorms and cyclonic lows passing through the region. Details of open rain gauges in the region is shown in Table 11. Marillana rain (767265) gauge is approximately 10km north east of the Project area (Figure 10).

Table 11: Operating Rain Stations in vicinity of the Project

Station Number	Station Name	Opened	Observation Interval	Operating Agency
767725	Capricorn Roadhouse	27/02/1975	Daily	BOM (AUS)
767255	Ethel Creek	1/01/1907	Daily	BOM (AUS)
767265	Marillana	29/11/1936	Daily	BOM (AUS)
767264	Marillana	8/09/1998	Continuous	BOM (AUS)
748817	Munjina	1/01/1969	Continuous	DOW (WA)
748875	Newman	6/02/1980	Continuous	DOW (WA)
767672	Newman	31/05/2000	Daily	BOM (AUS)
767674	Newman	31/05/2000	Synop	BOM (AUS)
748850	Poonda	29/11/1984	Continuous	DOW (WA)
767700	Rhodes Ridge	30/01/1971	Daily	BOM (AUS)
767589	Sylvania	1/01/1950	Daily	BOM (AUS)
748881	Wonmunna	28/11/1984	Continuous	DOW (WA)

2.4.1 Cyclones

The northwest West Australian coastline between Broome and Exmouth is the most cyclone-prone region of the Australian coastline, having the highest frequency of coastal crossings (75% between 1970-71 to 2007-2008). The cyclone season usually starts in mid December, peaks in February and ends in April (BOM). Major rainfall events have resulted from tropical cyclones within the Fortescue Basin in 1975, 1999, 2006 and 2009 which generated significant surface runoff and streamflows in the region. Rainfall and discharge occurrence within 100 km of the catchment with associated rainfall and flow characteristics at Flat Rocks is summarised in Table 12.

Table 12: Tropical cyclone summary

Tropical Cyclone	Monthly rainfall (mm)	Peak flow rate (m^3/s)	Monthly volume (ML)
Shelia-Sophie in January 1971	N/A	25	317
Kerry in January 1973	39.7	796	42,338
Joan in December 1975	478.5	1,327	14,4287
Amy in January 1980	221.9	N/A	0

Tropical Cyclone	Monthly rainfall (mm)	Peak flow rate (m^3/s)	Monthly volume (ML)
Dean and Enid in January/February 1980	224.0	N/A	225
Emma in December 1984	83.5	23	206
Connie in January (February) 1987	90.3 (101.9)	27 (58)	686 (1096)
Kirsty in March 1996	15.2	0	0
Rachel in January (February) 1997	307 (208.4)	319 (76)	11,940 (8,043)
John in December 1999	240.0	503	19,623
Wylva in February 2001	106.2	39	1,196
Chris in February 2002	189.5	127	1,948
Unnamed in January 2003	233.5	726	29,536

Source: (Beckett and Cheng 2010a)

2.5 Flora and Vegetation

The Project area is located in the Fortescue Valley, one of eight localities that make up the Pilbara Region in the Eremaean Botanical Province. The Project area is 9,800 ha in size and is situated with the Pilbara Interim Biogeographic Regionalisation for Australia (IBRA) (Beard 1975).

Cardno (WA) Pty Ltd (Cardno) was commissioned by the Fortescue Metals Group Limited in March 2011 to conduct a Level 2 flora and vegetation survey of the larger Nyidinghu Study area, as defined by the *WA Environmental Protection Authority (EPA) Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys of Environmental Impact Assessment in Western Australia* (EPA 2004c).

Field surveys of the Project area were undertaken in two phases, each representing a different season, from 28 March to 21 April 2011 and 4 July to 27 July 2011. The full assessment report is provided in Appendix E.

The following details for the project area have been summarized from the larger Study area from the Nyidinghu Project Flora and Vegetation Assessment (refer to Appendix E).

2.5.1 Vegetation

Common vegetation communities that occur in the locality of the Study area are described by Beard (1975) as:

- Sandplains of *Triodia basedowii* and occasional *Triodia pungens* with *Hakea lorea* and *Eucalyptus gamophylla*.
- Valley plains of irregular low *Acacia aneura* woodlands associated with *Acacia tetragonophylla*, *Acacia pruinocarpa, Acacia xiphophylla, Eucalyptus microtheca* and *Corymbia dichromophloia*. The ground layer is seasonal and comprises of mainly *Ptilotus exaltatus*.

A total of 22 vegetation communities were observed and mapped within the Study area, 11 of which were located within the Project area (refer to Appendix E) (Figure 19). The dendrograms from the floristic community analysis separated the vegetation communities into seven floristic categories based on habitat and floristic structure. The five categories recorded within the Project area are described below:

- **Hummock grasslands on Sand Plains**
  - The communities were characterised by sparse to isolated low trees (usually *Corymbia opaca*) over open mixed Acacia shrublands over Triodia species.
- **Acacia woodlands in Flowlines**
  - Flowline vegetation refers to areas situated in topographical lows which experience inundation after heavy rainfall. Vegetation was dominated by several Acacia tree species over **Cenchrus ciliaris*.
- **Major Creeklines**
  - One community was identified as riparian vegetation found along major creek beds. This community was dominated by *Eucalyptus vixtrix* over **Cenchrus ciliaris.*
- **Hummock Grassland on Rocky Hills**
  - One community was identified on the skeletal soils of the low-lying hills. The community was characterised by isolated *Eucalyptus leucophloia* over sparse shrubs over *Triodia* sp. Shovelanna Hill IS. Van Leeuwen 3835.
- **Mulga on Clay / Clay Loam Plain Vegetation**
  - A Mulga dominated community was recorded in the north-east of the Project area.

A total of 11 vegetation communities were described and mapped within the project area (refer to Appendix E). Table 13 describes the key characteristics of the vegetation communities, vegetation condition and lists the mapped areas of each within the Study area.

Table 13: Vegetation Communities, condition and area within the Project area

Community Code	Description	Vegetation Condition	Total Area Mapped (ha)
Sand Plain Vegetation-Hummock Grassland Dominated			
CoAdTs - *Triodia* hummock grassland	*Corymbia opaca* and *Eucalyptus gamophylla* isolated trees over *Acacia dictyophleba, Hakea chordophylla* and *Acacia ancistrocarpa* sparse Shrubland over *Triodia schinzii, Triodia basedowii* and *Triodia pungens* hummock grassland	Excellent	567.3
CoAsTb – *Triodia* hummock grassland	*Corymbia opaca* and *Eucalyptus gamophylla* open woodland over *Acacia sclerosperma* subsp. *sclerosperma, Acacia dictyophleba* and *Acacia inaequilatera* over *Triodia basedowii* open hummock grassland.	Good to Very Good	1272.0
CoAaTp- *Corymbia opaca* open woodland	*Corymbia opaca, Acacia inequilatera* and *Eucalyptus gamophylla* open woodland over *Acacia ancistrocarpa, Petalostylis labicheoides* and *Grevillea wickhamii* subsp. *hispidula* open Shrubland over *Triodia pungens* open hummock grassland.	Excellent	347.9
CohAdTp- *Corymbia* open woodland	*Corymbia opaca and Acacia inaequilatera* open woodland over *Acacia sclerosperma* subsp. *sclerosperma, Acacia dictyophleba* and *Acacia pachyacra* sparse Shrubland over *Triodia epactia* sparse hummock grassland	Poor to Very Good	2974.1
Flowline Vegetation			
AcAhCc- *Acacia* open woodland	*Acacia citrinoviridis* and *Acacia pruinocarpa* open woodland over *Atalaya hemiglauca* and *Hakea lorea* subsp. *lorea* isolated Shrubland over **Cenchrus ciliaris*	Poor to Good	934.5

Community Code	Description	Vegetation Condition	Total Area Mapped (ha)
	tussock grassland.		
AtSaTp- *Acacia* mallee woodland	*Acacia tumida* var. *pilbarensis, Grevillea wickhamii* subsp. *hispidula* and *Gossypium robinsonii* open mallee Shrubland over *Senna artemisioides* subsp. *oligophylla* and *Acacia adoxa* var. *adoxa* sparse heath Shrubland over *Triodia pungens* hummock grassland	Very Good to Excellent	62.0
ApAdCc- *Acacia* open woodland	*Acacia pruinocarpa, Corymbia hamersleyana* and *Acacia citrinoviridis* open woodland over *Acacia dictyophleba, Hakea lorea* subsp. l*orea* and *Acacia synchronicia* sparse shrubland over **Cenchrus ciliaris, *Cenchrus setiger* and *Enneapogon polyphyllus* tussock grassland	Poor to Good	2490.3
Major Creekline			
EvAhCc- *Eucalyptus* open woodland	*Eucalyptus victrix*, Acacia citrinoviridis and *Acacia pruinocarpa* open woodland over *Atalaya hemiglauca* and *Hakea lorea* subsp *lorea* isolated Shrubland over **Cenchrus ciliaris* and **Cenchrus setiger* tussock grassland.	Poor to Good	617.8
Rocky Hill Vegetation			
EIGwTs –*Triodia* sp. Shovelanna Hill hummock grassland	*Eucalyptus leucophloia* open woodland over *Grevillea wickhamii* subsp. *hispidula* and *Acacia bivenosa* sparse Shrubland over *Triodia* sp. Shovelanna Hill (S. van Leeuwin 3835) and *Triodia pungens* open hummock grassland.	Excellent	617.8
Clay/Clay Loam Plains Vegetation- Acacia aneura (Mulga) Dominated			
AaEfTp- *Acacia* woodland	*Acacia aneura, Acacia pruinocarpa* and *Acacia*	Very Good to Excellent	735.9

Community Code	Description	Vegetation Condition	Total Area Mapped (ha)
	aptaneura woodland over *Eremophila forrestii*, *Acacia ancistrocarpa* and *Acacia tetragonophylla* open Shrubland over *Triodia pungens* open hummock grassland.		
AaAsTp (located on proposed haul road only)	*Acacia aneura, Acacia aptaneura and Acacia pruinocarpa woodland to open woodland over Acacia synchronicia and Psydrax latifolia open Shrubland over Triodia pungens hummock grassland*	Excellent	2443.6

The survey sampling plan was based on point based sampling, establishing at least one quadrat per forty hectares. The quadrat design was adapted to the vegetation communities present within the Project area to ensure each vegetation community was represented by a minimum of two quadrats as per Guidance Statement 51 (EPA 2004c).

The vegetation condition was assessed using Trudgen's (1991) vegetation condition scale. The condition of the vegetation within the Project area ranged from Poor to Excellent (refer to Appendix E) (Table 14).

Table 14: Vegetation condition scale (Trudgen 1991)

Condition Code	Definition
Excellent (E)	Pristine or nearly so. No obvious signs of damage caused by the activities of European man.
Very Good (VG)	Some relatively slight signs of damage caused by the activities of European man, e.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* species, or occasional vehicle tracks.
Good (G)	More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.
Poor (P)	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharta* species.

Condition Code	Definition
Very Poor (VG)	Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.
Completely Degraded (CD)	Areas that are completely or almost completely without native species in the structure of their vegetation, e.g. areas that are cleared or "parkland cleared" with their flora comprising weed or crop species with isolated, native trees or shrubs.

Threatened and Priority Ecological Communities

A desktop review of the Project area included a database search of the DEC's Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) database, NatureMap website, Commonwealth DSEWPaC's TEC online database and Commonwealth EPBC Act Protected Matters Database. The DEC TEC and PEC database search was undertaken within a 100 km buffer zone of the Project area.

No TEC listed as matters of national significance under the EPBC Act or under the WC Act were identified in the desktop assessment or recorded during the surveys of the Study area (Appendix E).

Two PECs were identified in the desktop assessment in the search area around the Study Area. The known locations of these communities in the vicinity of the Project area are illustrated on Figure 20.

Fortescue Marsh (Marsh Land System) - Priority 1

Fortescue Marsh occurs on the Fortescue River, east of Mulga Downs, on the Marillana and Roy Hill Stations. This community supports endemic *Eremophila* species and several near endemic and new to science samphires. It is a recorded locality for Night Parrot and Bilby and supports several restricted aquatic invertebrates. Specific vegetation types are found on Mulga Downs, only around the marsh, and an unusual system occurs downstream. Recognised threats to the Fortescue Marsh are fire, grazing, ferals, weed infestation,and altered hydrology. The Fortesue Marsh is located approximately 30 km north of the Project area.

Fortescue Valley Sand Dunes – Priority 3

This community is composed of red linear sand dunes that lie on the Divide Land system at the junction of the Hamersley Range and Fortescue Valley, between Weeli

Wolli Creek and the low hills to the west. A small number of dunes are vegetated with *Acacia dictyophleba* scattered tall shrubs over *Crotalaria cunninghamii, Trichodesma zeylanicum* var. *grandiflorum* open shrubland. These dunes are regionally rare, small and fragile and highly susceptible to threatening processes. Recognised threats to this community include weed invasion especially from buffel grass and erosion. This community is known to occur at the western edge of the Study area and was verified during the field survey (Appendix E). This community does not occur within the Project area and is located approximately 20 km to the north-west.

Other Communities of Conservation Interest

According to the Department of Minerals and Petroleum (DMP) Conservation Reserves and Other Environmentally Sensitive Lands in Western Australia map (1998) and the Department of Environment and Conservation (DEC) Native Vegetation Map Viewer (DEC 2011a), there are no Environmentally Sensitive Areas (ESA) in the locality of the Study area.

The Fortescue Plains subregion is described by Kendrick (2001) as supporting three areas of value in relation to landscape, ecosystem, species, and genetic value. These are listed below.

- Millstream Wetlands: permanent spring-fed streams, pools and river flow.
- Millstream aquifer: extensive calcrete aquifer lying between Hamersley and Chichester Ranges.
- Fortescue Marsh: extensive episodically inundated samphire marsh.

Both the Fortescue Marsh and the Millstream Pools are recognised as Wetlands of National Significance (Environment Australia 2001). The Millstream Wetlands and aquifer are more than 250 km north-west of the Study area. The Fortescue Marsh is located approximately 30 km north of the Project area.

Additional ecosystems that have been recognised as being at risk by Kendrick (2001) that are relevant to the Study area include:

- Fortescue Marsh saltbush community described as mixed Chenopod, Samphire and Forb lands.
- Perennial grassland communities in the Fortescue Valley.
- Grove-intergrove mulga communities at the southern end of northern apron of Hamersley Ranges.

The grove-intergrove mulga communities at the Southern end of the Northern apron of the Hamersley range is found in the Study area (Appendix E).

The north-east section of the Project area recorded an area of Mulga (*Acacia aneura*) dominated vegetation. The draft guideline for Environmental and Water Assessments Relating to Mining Operations in the Fortescue Marsh Area (DoW, DEC and OEPA 2011) highlights the environmental significance of Mulga communities on the Marillana Plain. The majority of the Project lies within the Poonda Plain management area of the Fortescue Marsh which does not list Mulga woodland as a key environmental value. A portion of the proposed road from the mine to the Munjina –Roy Hill Road to the north, is located in Mulga dominated vegetation on the Marillana Plain. Mulga communities that occur on the Marillana Plain are deemed as having a high environmental value for surface water management in the Fortescue Marsh (Appendix E).

2.5.2 Flora

A total of 361 vacsular flora taxa from 47 families and 144 genera were recorded from the Study area during the survey. The most well represented families were Fabaceae (68 taxa), Poacaea (54 taxa), Malvaceae (36 taxa) and Amaranthaceae (19 taxa).

The species accumulation curve is commonly used to evaluate the adequacy of sample size in a community data set (McCune and Grace 2002). The species area curve derived using the Study area field survey data increases rapidly and then starts to level out. The characteristics of the species area curve provide a robust level of confidence that the field survey design was adequate for the size and floristic diversity of the study area.

A desktop review of the Project area included a database search of DEC's Threatened Species and Priority Flora Database, NatureMap website, Western Australian Herbarium Specimen Database for opportunistic priority flora, Commonwealth DSEWPaC's DRF online database and Commonwealth EPBC Act Protected Matters Database. The DEC Threatend Species and Priority Flora database search area was between 20-50 km.

The desktop review identified one Threatened Species and 42 Priority Flora species that could potentially occur within the Study area. Of the 43 flora of significance identified, five had previously been recorded within the Study area including:

- *Lepidium catapycnon*- (T)
- *Stylidium weeliwolli*- (P2)

- *Acacia subtiliformis*-(P3)
- *Atriplex flabelliformis*- (P3)
- *Goodenia nuda*- (P4)

The Threatened Species and Priority Flora species identified in the desktop assessment are provided below in Table 15.

Table 15: Threatened flora species that may potentially occur within the Study area

Species	Conservation Code
Acacia aphanoclada	P1
Acacia bromilowiana	P4
Acacia cyperophylla var. *omearana*	P1
Acacia effusa	P3
Acacia fecunda	P3
Acacia sp. Nullagine (B.R. Maslin 4955)	P1
Acacia subtiliformis	P3
Adiantum capillus-veneris	P2
Amaranthus centralis	P3
Aristida jerichoensis var. *subspinulifera*	P1
Aristida lazaridis	P2
Atriplex flabelliformis	P3
Atriplex spinulosa	P1
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	P1
Brunonia sp. Long hairs (D.E. Symon 2440)	P1
Dampiera metallorum	P3
Eremophila magnifica subsp. *velutina*	P3
Eremophila spongiocarpa	P1
Eremophila youngii subsp. *lepidota*	P4
Fimbristylis sieberiana	P3
Glycine falcata	P3
Goodenia lyrata	P1
Goodenia nuda	P4
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P1

Species	Conservation Code
Indigofera gilesii subsp. *gilesii*	P3
Indigofera ixocarpa	P2
Iotasperma sessilifolium	P3
Lepidium catapycnon	T,Vulnerable (EPBC Act)
Myriocephalus scalpellus	P1
Nicotiana heterantha	P1
Nicotiana umbratica	P3
Peplidium sp. Fortescue Marsh (S. van Leeuwen 4865)	P1
Rhynchosia bungarensis	P4
Rostellularia adscendens var. *latifolia*	P3
Sida sp. Barlee Range (S. van Leeuwen 1642)	P3
Stylidium weeliwolli	P2
Tecticornia medusa, (recently updated from *Tecticornia sp.* Roy Hill (Pringle 62))	P3
Tecticornia sp. Christmas Creek (K.A.Shepherd et al. KS 1055)	
Tecticornia sp. Fortescue Marsh (K.A.Shepherd et al. KS 1055)	P1
Tephrosia bidwillii	P3
Themeda sp. Hamersley Station (M.E. Trudgen 11431*)*	P3
Tribulus minutus	P2
Triodia triticoides	P1

Source: Refer to Appendix E.

[1] Conservation Status

T- Declared Rare Flora – Extant Taxa: Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.

Priority One – Poorly Known Taxa: Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Two – Poorly Known Taxa: Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.

Priority Three – Poorly Known Taxa: Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of

known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
Priority Four – Rare Taxa: Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

No Threatened Species pursuant to subsection 2 of section 23F of the WC Act 1950 or Threatened flora species pursuant to Schedule 1 of the EPBC Act were recorded within the Study area. A targeted search was undertaken for *Lepidium catapycnon* which was the only Threatened Species identified in the desktop assessment as potentially occurring in the Study area. The targeted search for *Lepidium catapycnon* did not recover any plants at the location where it has previously been recorded.

No Priority flora species were recorded within the Project area. Six Priority listed flora species were recorded within the Study area (Figure 21 and Appendix E), included the following:

- *Calotis squamigera* (Priority1)
- *Eragrostis crateriformis* (Priority 3)
- *Eremophila spongiocarpa* (Priority 1)
- *Eremophila youngii* subsp. *lepidota* (Priority 4)
- *Goodenia nuda* (Prioirty 4)
- *Vigna* sp. Central (M.E. Trudgen 1626) (Priority 2).

2.5.3 Introduced Flora and Weed Species

One introduced (weed) taxa was recorded within the Project area, **Cenchrus ciliaris* (Buffel grass) (Appendix E).

Buffel grass is not listed as a Declared Plants under the *Agriculture and Related Resources Protection Act 1976* or as a Weed of National Significance (Thorp and Wilson 1998).

Buffel grass is a tufted perennial grass that grows up to 1.5 m high. It grows on white, red or brown sand, stony red loam and black cracking clay. Buffel grass is planted as a pasture grass (Hussey et al. 1997) that spreads rapidly as a result of vehicle and cattle movement. It is commonly associated with creek and flowlines and is scattered throughout the Project area.

2.6 Terrestrial Fauna

Bamford Consulting Ecologists (BCE) and Ecoscape Australia were appointed in 2011 to conduct a terrestrial vertebrate fauna assessment of the larger Study area (Appendix G). A desktop review analysis was initially undertaken to identify the potential vertebrate fauna assemblage in relation to fauna habitats present within the Study area. Two terrestrial vertebrate fauna surveys within the Study area (Figure 22) were undertaken following the desktop review. A Level 2 survey in accordance with the EPA Guidance Statement No. 56 was conducted from 7 to 17 April 2011 to document the fauna species present within the Study area (EPA 2002). The second survey involved targeted surveys of potential significant fauna identified to either be present or potentially present through the desktop review and during the first survey.

The Project area is a 370 ha area within the larger Study area (refer Figure 2). Data from these fauna surveys have been incorporated to form an understanding of the terrestrial fauna present in the Project area. Particular attention has been given to specific trapping sites that fell within or very close in location to the Project area (trap sites 2 and 3 from Phase 1 and trap sites 1, 2, and 3 from Phase 2) (Figure 23).

2.6.1 Fauna Habitat

Desktop surveys of the Study area (approximately 5,000 ha) identified five different vegetation and soil associations (VSA) These VSAs can be considered to provide varying habitat for resident and non-resident vertebrate fauna.

At each of the five VSAs identified, fauna trap sites were also positioned during the Phase 1 survey. The two trap sites that fell within the Project area were described as:

- flood plain and creek of eucalypts over grasses (site 2) and
- low ridge of hummock grassland (site 3).

Within the Project area, four of the five fauna habitat types were identified and are all present outside of the Project area in the Pilbara (Figure 23).

2.6.2 Fauna Diversity

The vertebrate fauna assemblage of the Study area was expected to comprise of 316 species based on the desktop review. The review of possible fauna diversity included three fish, five frog, 104 reptile, 158 bird, 38 native mammal and eight introduced species. The initial field survey recorded 103 species in the Project area,

consisting of two fish, two frog, 43 reptile, four mammal and 56 bird species. An additional five species (two reptiles and three mammals) were recorded during the second phase of sampling.

2.6.3 Conservation Significant Fauna

A search of relevant State and Commonwealth level literature and databases identified 28 vertebrate fauna species of conservation significance having the potential to occur in the Study area. Of these, 19 species are listed under Federal (EPBC Act) or State (WC Act) legislation. Nine of these species are listed as Priority fauna by the DEC. Two conservation significant species were recorded during the surveys within the Project area. These species were the Rainbow Bee-eater (*Merops ornatus*) and the Peregrine Falcon (*Falco peregrinus*).

2.6.4 Non-Indigenous Fauna

Nine introduced species could potentially occur within and surrounding the Study area, as indicated by desktop database and literature searches. Three introduced fauna species were recorded during the 2011 surveys: the Cat (*Felis catus*), Dingo or Dog (*Canis lupus dingo/familiaris*), and European Cattle (*Bos taurus*). Species that could potentially occur within the Study area, although were not recorded during the 2011 surveys, include the House Mouse (*Mus musculus*), Rabbit (*Oryctolagus cuniculus*), Red Fox (*Vulpes vulpes*), Camel (*Camelus dromedarius*), Horse (*Equus caballus*) and Donkey (*Equus asinus*).

2.7 Short-range Endemic Fauna

Short-range endemic (SRE) invertebrate species are defined as having a distributional range of less than 10,000 km^2 (100 km x 100 km). SRE species are generally characterised by poor dispersal, are confined to discontinuous habitats, have highly seasonal activity patterns and low fecundity and growth rates (Harvey 2002). A number of invertebrate groups have been identified as containing SRE species, such as mygalomorph spiders (Mygalomorphae), pseudoscorpions (Pseudoscorpionida), scorpions (Scorpionida), millipedes (Myriapods), slaters (Isopoda), schizomids (Schizomida) and terrestrial molluscs (Gastropoda) (Harvey 2002).

2.7.1 SRE Surveys and Specimens

A SRE terrestrial invertebrate desktop review followed by a field survey was undertaken by Dalcon Environmental (Appendix H). The field survey incorporated numerous sampling methods and was conducted between April and May 2011 in accordance with EPA Guidance Statement No. 20 (EPA 2009). Nine species were identified as potential SRE species, and of these, three were recorded from within (or very close to) the Project area. These potential species were from Chernetidae (spider), and Philoscidae (crustacean) and Planorbidae (gastropod) families (Figure 24).

SRE Habitat

Visual habitat assessment was conducted at each of the 13 trap sites. Habitats were assessed according to various factors including landscape position, vegetation complex, rocky outcrop substrate, burrowing substrate, leaf litter, disturbance, presence of SREs, connectivity and extent. Habitats were then defined as high, moderate and low potential for SREs to occur (Figure 24).

Subterranean Fauna

Subterranean fauna are species which spend all or most of their lifecycle underground. Most subterranean species are invertebrates. Bennelongia Environmental Consultants (Appendix I) sampled for subterranean fauna under the EPA Guidance Statements Nos 54 and 54a (EPA 2003, 2007). Samples were collected from proposed impact areas; the mine pit and borefield drawdown cone than the guidance statements recommend. Only three troglofauna samples and one stygofauna sample were collected within the proposed mine pit and borefield drawdown cones, respectively. However, an adequate number of samples were collected over the Project area and surrounds.

2.7.2 Troglofauna

Troglofauna are animals inhabiting air-filled caves or smaller cavities below the ground. Troglofauna were sampled across the Study area by setting traps from 9 to 13 May 2011 and retrieving traps on 4 and 5 July 2011. Sampling for troglofauna from 121 different bores over the Study area yielded 72 specimens representing 15 species from 12 Orders of invertebrates. The majority of samples were collected from within or close to the Project area boundary. No troglofauna species were collected from within the Project area (Figure 5.1 in Appendix I)

2.7.3 Stygofauna

Stygofauna are animals inhabiting groundwater, which are commonly spatially constrained by geology. Bennelongia Environmental Consultants surveyed for the presence of stygofauna within the Study area. Sampling for stygofauna from 93 different bores over the Study area yielded 392 specimens representing 22 species from nine Classes/Orders of invertebrates. The majority of the 93 samples were taken from within the Project area which yielded one stygofauna species (*Pygolabis* sp. B6) from within the 15 ha drawdown cone associated with the proposed mining (refer to Figure 5.2 and 5.3 in Appendix I).

2.8 Social Environment

The Project is located within the Pilbara region, which is situated in the north-west of Western Australia and covers a total area of 507,896 km², extending from the Indian Ocean to the Northern Territory border. The region comprises four local government authorities: the Shires of Ashburton, East Pilbara and Roebourne, and the Town of Port Hedland.

The Project sits within the Shire of East Pilbara, approximately 35 km south of Fortescue's Cloudbreak operations and 100 km north west of Newman (Figure 1).

2.8.1 Population and Demographics

The Pilbara region is Western Australia's second fastest growing statistical division outside the metropolitan area, with 3.1% growth in 2008-09. Official figures indicate that the Pilbara region has a population of approximately 47,528 people (ABS 2010b). In winter there is a large travelling population that moves through the region and a migration of people away from the region during the hot/wet summer months of December and January.

The population of the Shire of East Pilbara is between 8,000 and 10,500 people (ABS 2010a, c) and the town of Port Hedland has a population between 14,000 and 15,000 residents (ABS 2010a, c).

There is a discrepancy in population figures between various sources which may partly be linked to the high proportion of fly-in/fly-out employees who were not resident in the region on Census night or who reside in project accommodation camps. It has also been noted by the Australian Bureau of Statistics that there was considerable undercounting in relation to the Aboriginal and Torres Strait Islander

population in the 2006 Census, with a reported undercount of 11.5% compared to 2.7% for the rest of the population.

The Shire of East Pilbara's male population is concentrated with 79% in the 20 to 59 age bracket, compared to 57% across the rest of the state. There is a gender ratio of 151.9 males to 100 females, compared to 102.8 to 100 across the State. This is due to the male-dominated mining and construction industries that are the major attractions for working and living in the region (ABS 2010a, d).

The age of the majority of the population is below 60 years, with the largest population group being those aged between 30 and 44 (ABS 2010d).

The 2006 Census records an indigenous population of 1,429 in the Shire of East Pilbara Local Government Area (LGA), which represents 21.8% of the total recorded population at the time (ABS 2010b). This is significantly higher than the state average of 3.4%. Research indicates that indigenous people in the Pilbara are severely disadvantaged, with reduced life expectancy, high unemployment, low education levels, poor housing standards and disproportionate crime rates (Pilbara Iron 2006) some of the social issues that exist in the region.

2.8.2 Native Title and Indigenous Heritage

The Project area, including associated infrastructure, camps and roads, is located wholly within areas subject to the Nyiyaparli Native Title Claim (WC99/4). The Nyiyaparli People are recognised as the Traditional Owners with cultural heritage knowledge of the land. Fortescue signed a 'whole-of-claim' Land Access Agreement (LAA) with the Nyiyaparli People in 2005, which amongst other matters, establishes consultation processes with the groups as well as heritage survey and Section 18 of the Aboriginal Heritage Act, notice protocols.

Fortescue and the Nyiyaparli People have consulted in relation to the Cloudbreak and Christmas Creek mining areas for over six years. Throughout this time Fortescue and the Nyiyaparli People have developed a strong and enduring relationship. Importantly, the views of the Nyiyaparli People have come to play an important role in land use decisions in Fortescue's mining areas.

Fortescue's engagement of Nyiyaparli People to monitor ground disturbing works and the protection of Aboriginal heritage sites, and to deliver Aboriginal cross-cultural training to Fortescue employees, has also played an important role in developing the relationship and understanding between the parties.

Since 2005, heritage consultants Archae-Aus Pty Ltd have consistently worked alongside Nyiyaparli Traditional Owners in conducting heritage surveys; with surveys being conducted on an almost continuous basis. A number of these heritage surveys have taken place over the Project mining area, allowing drilling activities to commence and the resource to be defined.

2.8.3 Non-indigenous Heritage

Searches of places of non-indigenous cultural heritage in the vicinity of the Project area and surrounding areas have been conducted through review of databases held by:

- The Heritage Council of Western Australia.
- The Australian Heritage Council.
- The National Trust.
- The Town of Port Hedland.

No areas of non-indigenous heritage were found to exist in the Project area or vicinity. Further, no Heritage Agreements are in place and no Conservation Orders have been issued in the Project area or vicinity.

2.8.4 Current Land Use

The main use of the land surrounding the Project area is iron ore prospecting and exploration, pastoral grazing and, further afield, tourism.

The land is currently used as grazing for a Pastoral Lease held by Marillana Station.

3. PROJECT DESCRIPTION

3.1 Area of Disturbance

The area of disturbance associated with the Project under Mining Lease M47/1461 and Exploration Licence E47/1320 and E47/1387 is up to 370 ha. The disturbance area has been calculated to provide allowance for construction activities such as access and providing sufficient area for shaping and battering of designed slopes. A detailed breakdown of the disturbance by key areas is provided in Table 16.

Table 16: Disturbance of key areas

Description of Area	Area (ha)		
	M47/1461	E47/1320 & E47/1387	Total
Camp	52		52
Haul Mine Road (to Munjina-Roy Hill Rd)		45	45
Mine Area (includes Mine Pit, Waste Dump, Mine Infrastructure, Explosives Magazine, Topsoil Stockpile)	273	-	273
Total Area Disturbed	**325**	**45**	**370**
Total Tenement Area	**1175**	**21894**	**23069**
Undisturbed Land	**850**	**21849**	**22699**

3.2 Mining Operations

3.2.1 Overview

The key characteristics of the Project are summarised below in Table 17.

Table 17: Project Overview

Element	Cumulative
Total area of disturbance	Up to 370 ha
Life of mine (ore production)	Approximately 4 years
Number of open pits	One
Number of open pits below watertable	None
Total Ore Mined	Up to 11.4 MT
Number of ore stockpiles	Up to 4
Ore mining rate	Up to 6 Mtpa
Waste rock mass	Up to 17.5 Mt
Number of waste dumps (temporary)	One

Element	Cumulative
Water source and requirements	Three water bores producing up to 1,500 MLpa
Power source and requirements	Up to 8 MW supplied by diesel generators
Fuel storage and requirements	Up to 32 Mlpa
Product transport	Road trains
Operational hours	24 hours per day, 7 days per week
Expected workforce requirements	Up to 500 site based

3.2.2 Project Schedule

The Project Schedule includes:

- Commence early pioneering earthworks – Q2 CY 2012
- Commence pre-stripping and mining – Q2 CY 2012
- First production of DSO – Q2 CY 2012
- Completion of mining – Q1 CY 2016

It is anticipated that the Project's life will be up to 4 years, including rehabilitation and closure, but excluding post closure monitoring and maintenance.

3.2.3 Project Reserve

A reserve statement for the Project is provided in Table 18. The table also indicates the ore inventory that is expected to be recovered from the Project.

Table 18: Project reserve statement

	Ore	Waste
Tonnes	11,314,660	17,500,000
Fe (%)	56.73	
Silica (%)	8.17	
Aluminium (%)	2.92	
Phosporous (%)	0.12	
Manganese (%)	0.13	
Loss on Ignition (LOI) (%)	6.48	

3.2.4 Mining Method

The Project will produce approximately 11.4 Mt of ore and 17.5 Mt of waste rock at a mining rate of up to 6 Mtpa. The ore mining methodology employed for the Project

will follow the same methodologies employed at Fortescue's other Pilbara mining operations, namely the Cloudbreak and Christmas Creek Mines, involving conventional drill and blast, crush and screen, load and haul to railway for transport to Port.

Pre-stripping

Establishment of the Project area requires basic preparatory works including vegetation clearing and soil stripping.

Topsoil and vegetation will be removed, where possible, during pre-stripping and stockpiled in adjacent well-drained areas. Topsoil stockpiles will be managed appropriately and the materials will be reused during rehabilitation.

Open Pit Configuration

The Project involves the development of a single pit, to be named the Io Open Pit. It will be approximately 1.5 km in length and 0.8 km in width.

Benches at hilltop level will be free-dug where possible, exposing hard rock for drill and blast to the first bench level. The first blast bench will have a maximum height of 7.5 m, with the following benches being approximately 5 m in height. The 5 m benches will be mined in two 2.5 m flitches.

Grade control will be undertaken using reverse circulation (RC) drilling, or similar, in advance of mining, to establish ore blocks. The mining method and pit design parameters will be reviewed regularly and optimised during operations.

Drilling and Blasting

All areas that are not classified as "free dig" will be drilled and blasted utilising modern blasting techniques. The number of blasts will be minimised within the constraints of maintaining a continuous supply of broken rock for the mining operations.

The transport, storage and use of explosives will be subcontracted to a licensed service provider. Ammonium nitrate based explosives will be detonators, ripcords and any other site-stored explosives. All explosives material and equipment will be stored in a magazine compliant with the *Dangerous Goods Safety Act 2004* (WA).

Mining Equipment

The indicative mining fleet for the Project is provided in Table 19. Standby units, including those for the dump trucks and the bulldozer, may also be site-based.

Table 19: Indicative mining fleet

Fleet	Option 1	Option 2	Comment
	Cat 777 Fleet	Cat 785 Fleet	
Mining	Quantity	Quantity	Example of Possinle Fleet Specification
Primary Excavator	3	2	Komatsu PC1250 (120t)
Service Excavators	2	2	Cat 336 or similar
Trucks	15	10	Cat 777 or Cat 785
Drills	2	2	Gardner Denver GD5000
Dozer	2	2	Cat D10
Grader	1	1	Cat 16M
Water Cart	2	2	Cat 777
Service Truck	1	1	Cat 777
Roller	1	1	Cat CS 64
Wheeled Loader	2	2	Cat 844H
IT	1	1	Cat IT 14G
Blast MMU	1	1	Kenworth/Mack prime mover
Light Vehicles	15	15	Toyota LandCruiser
Fork Lift	1	1	Crown/Toyota - N/A
Tele Handler	1	1	Cat TH 414
Tire handler	1	1	N/a - attachment for IT
Frana Crane	1	1	25t non slew crane (285Hp)

There will be a number of smaller vehicles and equipment required onsite in addition to the mining fleet, such as forklifts, light vehicles, service vehicles and generator-driven lighting plants.

Dewatering

As mining will be conducted above the water table, Mine Pit dewatering will not be required. In-pit sumps may be required to collect any incidental rainfall or seepage during mining activities with sub-surface drainage from the sumps into the ore body. The surrounding topography and bund will direct any runoff away from the open pit, so the majority of water in the open pit will be from direct rainfall, rather than runoff.

Generally, any water collected in the open pit will be used for dust suppression where it can be recovered. Calculations of the direct rainfall volumes entering the Project pit in a 1 in 5 year Average Recurrence Interval (ARI) and 1 in 100 year ARI indicated that at the final pit limit, the pit would be inundated by approximately 0.12 m and 0.34 m of water, respectively. It is not considered that these volumes will cause significant disturbance to mining activities (Appendix C).

Waste Rock Management

A total of approximately 17.5 Mt of waste rock will be mined throughout the life of the Project.

Ore and waste rock will be loaded and hauled separately from the open pit. Waste rock will be used initially for bulk earthworks, then stored within the temporary waste rock stockpile (Figure 3).

Waste rock will consist of relatively competent material with a low soil size fraction. Geochemical characterisation of waste rock and ore has indicated that the materials are geochemically benign in terms of acid-forming potential and elemental composition.

Backfilling of the pit will commence prior to the end of Life of Mine. At closure all waste rock, inclusive of that stored in the temporary waste rock stockpile and used for bulk earthworks but excluding that material used in the upgrade of roads, will be returned to the pit. As a result, the pit will be entirely backfilled and will have a free draining final topography.

Management and design of the waste rock dumps is described in the Mine Closure Report (Appendix J).

3.3 Ore Stockpiling and Processing

3.3.1 Ore Stockpiling and Management

Ore will be transported via haul trucks to the run-of-mine (ROM) facility, where it will be stockpiled prior to processing according to iron grade and other physical and chemical characteristics. ROM stockpiles will be constructed radially around an arc centred on the crusher feed bin.

Surface-water runoff upstream of the ROM facility will be diverted into the adjacent natural drainage lines. Surface-water runoff from the ROM facility (and the waste rock dump) will be collected by cut channels or fill bunds and directed to sedimentation ponds, where it can be held until fines and contaminants settle out, before being released into the natural environment. Sedimentation ponds will be sized for a 5-year ARI rainfall event, with a rock-armoured overflow for larger events. The sedimentation ponds will be regularly maintained to retain capacity.

Product stockpiles will be kept moist via the mobile crushing and screening plant's sprinkler system, or via water carts. Trafficked areas around these stockpiles will be watered by the water carts on a regular basis.

No dust suppression is required for the ROM ore stockpiles, as they will consist of blasted ore with limited fines. However, should dust become evident at these stockpiles, the Project's dust management requirements will be revisited.

3.3.2 Crushing and Screening

In consideration of the Project's short mine life and projected total throughput, the Project proposes the use of contracted mobile crushing and screening plants capable of producing an all-fines product in up to four stockpile locations.

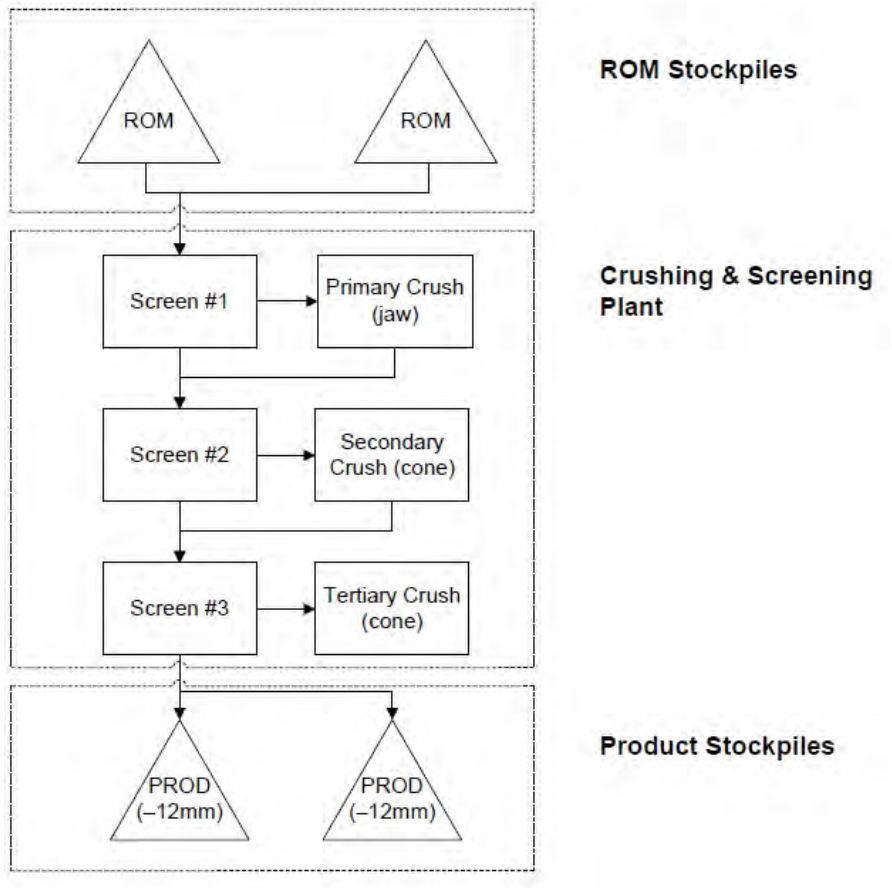
Ore hauled from the open pits to the ROM ore storage facility will undergo crushing through the three stage crushing and screening plant. It is required to produce an all-in product of minus 12 mm and also have the ability to produce and stack the iron ore product.

The proposed plant includes the three crushing stages and three screening stages. A flow diagram describing the crushing, screening and stockpiling process has been provided in Drawing 2 and includes the following elements:

- Loader Fed into Feeder Hopper with Vibrating Grizzly: A front-end loader will be used to load the feeder hopper, with a backup loader included to ensure continuity of supply and/or manage the product stockpiles and screening to produce DSO product.
- Primary Crusher: The primary crusher will be a jaw crusher powered by diesel engine. A rock breaker will be fitted to the primary station. The discharge conveyor is fitted with a belt magnet.
- Vibrating Screens: The screening plants will be track mounted units incorporating an inclined single deck or inclined double deck with discharge conveyors.
- Secondary Crusher: For secondary crushing, a cone crusher is proposed. The crusher is belt driven by a diesel engine.
- Tertiary Crusher: The proposed tertiary crusher is also a cone crusher.
- Radial Stackers: Stacking will be via radial stackers, capable of stacking trapezoidal heaps.

- Dust Suppression: Water mist dust suppression will be utilised throughout the plant on all transfer points as well as on the stockpile conveyor discharge points.

Drawing 2: Processing flowchart



Control Philosophy

The plant will be electrically interlocked via an integrated computerised operating system (PLC) mounted in an air-conditioned control room.

Finished Product Stockpile Management

For stockpile dust control, misting water sprays will be added at the top of the stacker conveyors to maintain moist ‘active’ stockpiles. Inactive stockpiles, loading stockpiles and surrounding areas will be sprayed by a water truck as required to maintain acceptable dust levels.

Primary waste streams generated from the crushing and screening of ore include dust (Appendix L).

Oversize reject from the crusher feed will be stockpiled and broken on a campaign basis for the crushing plant.

3.4 Tailings Storage

No tailings will be produced for the Project.

3.5 Support Facilities

The Project will require a number of facilities in order to provide power, water, fuel, parking, storage, offices, accommodation, and communications during construction and operation of the Project. These facilities are discussed in more detail below.

3.5.1 Construction Facilities and Utilities

Construction of the Project is anticipated to take four to six months and will require a number of temporary facilities. Fortescue will construct good quality road access and water to enable pioneering works. The construction workforce will initially be housed at the exploration camp. By constructing the Project accommodation camp early in the construction period, subsequent construction teams can then use the new site accommodation to complete their activities more efficiently.

Pioneering works will include earthworks and roadworks. Partial completion of the pioneering works will allow the following activities to commence:

- Construction of the accommodation camp.
- Construction of the mine operations centre and contractors' area.
- Establishment of the heavy mining equipment workshop.
- Mobilisation of heavy mining equipment.

3.5.2 Accommodation Camp

A Camp for up to 500 persons will be constructed for the Construction and Mine Operations workforces.

The Camp will be designed and constructed in accordance with Fortescue Specifications, relevant Australian Standards, Building Code of Australia, and Shire statutory requirements.

The Camp will include, but not limited to:

- Up to 500 rooms with ensuites.
- Dry mess and kitchen.
- Wet mess and outdoor area.
- Gymnasium.
- Recreation room.
- Primary first aid facility (including provision of an ambulance).
- Laundry facilities.
- Camp management office.
- Telephony and Internet room.
- Ice rooms.
- Power station (see Section 3.5.4).
- Potable water treatment infrastructure (see Section 3.8.1).
- Wastewater treatment infrastructure (see Section 3.5.5).
- Communications infrastructure.
- Fire pump set (package diesel, electric and jockey pump, fire water tank and associated fire water pump.
- Car parks and landscaped areas using native species. The landscaped areas will be irrigated with effluent from the wastewater treatment plant.

All buildings and structures will be designed for wind loads in accordance with AS1170.2.

3.5.3 Mine Operations Centre

The Mine Operations Centre will serve as the coordination centre for Mining Operations. The Mine Operations Centre will provide office facilities for site-based employees and will consist of transportable buildings.

The mine operations centre will consist of the following facilities:

- Administration Office - A number of transportable buildings for offices, communications equipment room, meeting room, reception area and a crib room.
- Stores - The stores will likely comprise several shipping containers.

- Secondary First Aid Facility.
- Ablution Block - One transportable building containing male and female ablutions. Sewage from the ablutions will be tank and pump-out by truck for off-site disposal, or piping connected to the Camp waste water treatment system.
- Parking Facility for Light Vehicles - Will be designed for reverse parking and will contain windrows to check the rear tyres.

Potable water will be reticulated to the Mine Operations Centre office buildings and amenities from the Camp treatment plant. Storage tanks will be used to ensure adequate back-up supply in case of service disruption.

3.5.4 Contractor Facilities

Contractors (crushing, mining and product transport) will be responsible for providing their own offices, amenities, ablutions, services and facilities as per the relevant Contract. Wastewater for ablutions will be tank and pump-out by truck for off-site disposal.

The contractor facilities will also contain fuel storage and refuelling area, workshop, washdown area and laydown area, all of which are discussed in more detail below.

Fuel Storage and Refuelling Area

Diesel fuel will be stored in double skinned (self-bunded) tanks. These tanks will be fitted with overfill alarms and visual indicators of an internal wall rupture (i.e. dip tube) and protected from vehicle strikes with windrows or bollards.

A lined refuelling pad will be provided adjacent to the fuel storage tanks, with at least one of the tanks consisting of an on-board bowser for dispensing fuel to light vehicles, and a fast fill for refuelling heavy earth-moving equipment. A contracted fuel supplier will transport diesel fuel to site on a regular basis by tanker road train deliveries.

Workshop and Washdown Area

A Workshop and Washdown area will be established for the maintenance of contractor plant and equipment.

The Washdown area will be designed to incorporate a collection sump to collect and store run-off that is potentially contaminated with hydrocarbons. The potentially contaminated water will either be removed from site using a licensed contractor for

disposal at a licensed facility, or be treated for re-use, with recovered hydrocarbons removed from site using a licensed contractor for disposal at a licensed facility.

Contractors' Parking and Laydown Area

The parking and laydown area will primarily be used for heavy vehicles and the storage of spares and waste materials to be transported offsite. Designated parking areas will provide a forward facing 'go-line' to avoid reversing manoeuvres and windrows to check vehicle movements. This area will be wetted and rolled to create a trafficable hardstand surface prior to use to minimise dust emissions.

Power Supply

No electrical grids exist within close proximity to the Project area that could be considered a feasible power supply. Power will be supplied by multiple diesel-driven generators, each housed within modular, weatherproof, sound-attenuated containers, complete with associated electrical works and diesel fuel storage.

3.5.5 Wastewater Management

All sewage and wastewater will be treated in a wastewater treatment plant. The wastewater treatment plant will consist of an aerobic treatment unit constructed and operated in accordance with Western Australian Department of Health and local government regulations. Treated effluent will be disposed of at a spray irrigated evaporation area and will meet quality standards described in the *Guidelines for Non-potable uses of Recycled Water in Western Australia* (DOH 2011) applicable for use as garden irrigation and any other statutory requirements.

3.5.6 Explosives Magazine

The explosives magazine has been located in a designated area 3 km away from the mine bund wall. The transport, storage and use of explosives will be subcontracted to a licensed service provider. Ammonium nitrate based explosives will be stored separately to detonators, ripcords and any other site-stored explosives. All explosives material and equipment will be stored in a magazine compliant with the *Dangerous Goods Safety Act 2004* (WA) and the *Mines Safety Inspections Act 1994* (WA).

3.5.7 Water Production Bores and Pipelines

The project water demand is described in Section 6. Water supply for the project has been designed to meet the project's peak water demand of approximately 140,000 kL/month occurring in the period third quarter 2012.

Water supply for the purpose of mine and road construction, mine operations and camp supply will be provided by up to three bores located in the Project area. Submersible pumps will be used to draw water from the cased bores for delivery in above ground pipes to storage tanks or storage ponds.

Water supply for camp use will be treated using a packaged reverse osmosis plant or ultraviolet treatment. Should a reverse osmosis plant be used, Fortescue will investigate disposal options for the small volumes of brine that would be produced, including dilution and reuse for operations or dust suppression water stream.

Table 20 below provides details of the three production bores planned to supply this water requirement. The following operating regime is proposed:

- NPB1004 is the primary production bore for non-potable supply during both construction and operations phases. It is anticipated this bore will operate at a rate of up to 80 L/s.
- NPB1003 will be utilised as a contingency bore for non-potable supply in the event that pumping from NPB1004 faults. It is anticipated this bore will operate for periods up to 2 weeks at a rate of up to 80 L/s in this event.
- NPB1005 is proposed to supply water for camp supply. This bore will be operated intermittently throughout the day at a rate of up to 5 L/s.

Table 20: Production bore details for Mine area supply

Bore Name	Easting	Northing	Cased Depth (m bgl)	Screened Interval (m bgl)	Casing ID (mm)	Casing Material	Screened Aquifer
NPB1003	739947	7487801	197.9	100.5 – 197.9	285	ABS and up to 3 stainless steel screens	BID
NPB1004	741716	7487159	248	90.2 – 248	285		CID/BID
NPB1005	743063	7485598	228	94.5 – 228	285		BID

3.5.8 Waste Management

Wastes produced will be those routinely produced at mining facilities and will include general refuse, medical waste, non-metal scrap (e.g., containers, pallets, wood,

plastic, concrete), office and administrative waste, putrescibles waste, sewage, tyres, batteries and wastewater.

Wastes will be segregated and stored appropriately offsite before being removed from site by a licensed contractor for disposal at an appropriately licensed facility as required. There will be no on-site waste disposal. Waste storage will be designed to minimise wildlife access, with closed lids on any putrescibles and crib waste collection and storage vessels.

As previously identified, should a reverse osmosis plant be used, Fortescue will investigate disposal options for the small volumes of brine that would be produced, including dilution through addition to the process water stream.

3.6 Workforce

The construction workforce will consist primarily of contractor employees, supplemented with a small number of Fortescue personnel and totalling up to 500 persons.

Due to the remote location of the Project, all personnel will be fly in / fly out via Newman.

During operations, contractors will be used for mining, crushing and screening, and product transport, the majority of whom will be accommodated onsite. Where possible, local contractors and employees will be used, depending on availability and the skills required. A number of Fortescue staff will also be onsite, primarily in management and technical roles.

Drill and blast will mostly be restricted to day shift operations as a safety precaution.

Other mining and transport activities including load and haul from the mine pit, crush and screen, loading for transport and haulage for shipping are expected to operate 24-hours a day, 7 days a week.

3.7 Haulage and Access Roads

The following section describes the proposed haul route from the Project area to Cloudbreak.

3.7.1 Product Transport and Export

Fortescue is proposing to haul iron ore by road from the Io mine to Cloudbreak. The haulage operation will be on a 24 hr basis with triple and/or quad-configuration road trains. The trucking frequency will be in the order of one truck every 10 minutes. The haul route distance is 175 km one-way and will comprise of the following:

1. New Io haul road to Munjina-Roy Hill Road (15 km) which requires upgrade of the existing level crossing of the BHPBIO Newman mainline.
2. Munjina-Roy Hill Road to Marble Bar Road (60 km) which is generally 10 m to 12 m wide, except at cattle grids where it reduces to about 8 m (Plate 1).
3. Marble Bar Road to Roy Hill Road (35 km) which is unsealed except for the sealed intersection at Munjina-Roy Hill Road.
4. Roy Hill Road to Cloudbreak Mine (65 km) which has approvals in place for construction and will be available for use by mid-2012.

Refer Figure 25 for map of the proposed haulage route.

The Mine Road will be constructed for access to the Munjina-Roy Hill Road and will be suitable for Class 1, 2 or 3 traffic. A 15 m wide constructed road pavement will be required to allow for access of heavy haulage trucks and light vehicles. The total disturbance width of the road will be 30 m to allow for road berms, shoulders and drains.

According to Regulation 13.7 of the Mines Safety and Inspection Regulations 1995, it is the responsibility of the Mine Manager to ensure that the design and construction of each road is such to enable the safe operation of all mobile equipment authorised to travel on the road. The road running surfaces have been designed to meet this requirement.

In consideration of the Project's short mine life, the access road basis of drainage design will account for a 1-in-5-year ARI rain event. The speed limit of the road is proposed to be limited to 70 km/hr.

As a result of recent site visit by Fortescue personel it was ascertained that the Munjina-Roy Hill Road is in relatively poor condition (Refer to Plate 1) and will require sheeting with a good road sub-base type material of approximately 300 mm thickness. There will be no requirement to clear vegetation for any sheeting of the Munjina-Roy Hill Road which will be limited only to the current cleared running surface. Sheeting material will be sourced from the Project mine. Construction water for re-sheeting works and road maintenance will also be sourced from the Project mine site.

The Marble Bar Road is unsealed except the Munjina-Roy Hill Road intersection. The Marble Bar Road has Main Roads Western Australia (MRWA) concessional load haulage requirements. Fortescue will comply with all MRWA notifications and permits for concessional load haulage.

Discussions to date with the Shire of East Pilbara and MRWA have been positive for upgrade options that will provide long-term improvements of the Munjina Roy Hill Road (see stakeholder register in Section 4).

The Roy Hill Access Road to Cloubreak mine will be located within Miscellaneous Licence L46/100, issued to Chichester Metals Pty Ltd, a wholly owned subsidiary of Fortescue. The Miscellaneous Licence traverses both Fortescue's Christmas Creek mine site area, and the adjacent Roy Hill iron ore mine site. The location of the road is shown in Figure 25.

The installation of the Roy Hill Access Road triggers an amendment to the original Project under Ministerial Statement 707 and is the subject of an application that is currently being assessed by the OEPA under Section 45C of the EP Act. On this basis, it is not considered that the Roy Hill Access Road be assessed as part of this Project.

Plate 1: Munjina-Roy Hill Road and Marble Bar Road (sealed) Intersection

Plate 2 shows the existing bridge over the Fortescue River on the Marble Bar Road, located approximately 3 km north of the Munjina-Roy Hill intersection. The bridge is single lane and heavy haulage is not permitted. Trucks currently use the temporary bypass track as shown on Plate 3 for access across the river. During flood events the crossing is unusable.

Plate 2: Fortescue River Bridge on the Marble Bar Road

Plate 3: Fortescue River Bridge Bypass Track used for heavy haulage

3.7.2 Access Ramp

An access ramp will be constructed between the Mine Pit and ROM facility to provide access for load and haul of material from the Mine Pit to the crush and screen plant.

Design of the Access Ramp will be in accordance with the relevant Fortescue Specifications and Australian Standards.

3.7.3 Access Roads and Tracks

A number of access roads and tracks will be required to provide access to the remote facilities including the camp, magazine and borefields. Existing exploration/pastoral tracks will be used where possible to minimise disturbance.

Due to the short mine life and relatively small footprint of the Project, all roads and access tracks are planned to be unsealed and constructed with local material.

Roads will be formed, by avoiding any larger vegetation where possible, followed by stripping groundcover vegetation and topsoil and stockpiling it in windrows adjacent to the roads or designated stockpile areas. A scraper-grader will then form the road and create an additional windrow to protect stockpiled soil from potential disturbance. Passive drainage will be created through construction of each minor access road. Drainage requirements (e.g. culverts) will be installed to maintain sheet flow to Mulga communities. Refer to the Mulga study conducted by Worley Parsons (Appendix F).

3.8 Resource Requirements and Regional Infrastructure

3.8.1 Water Usage

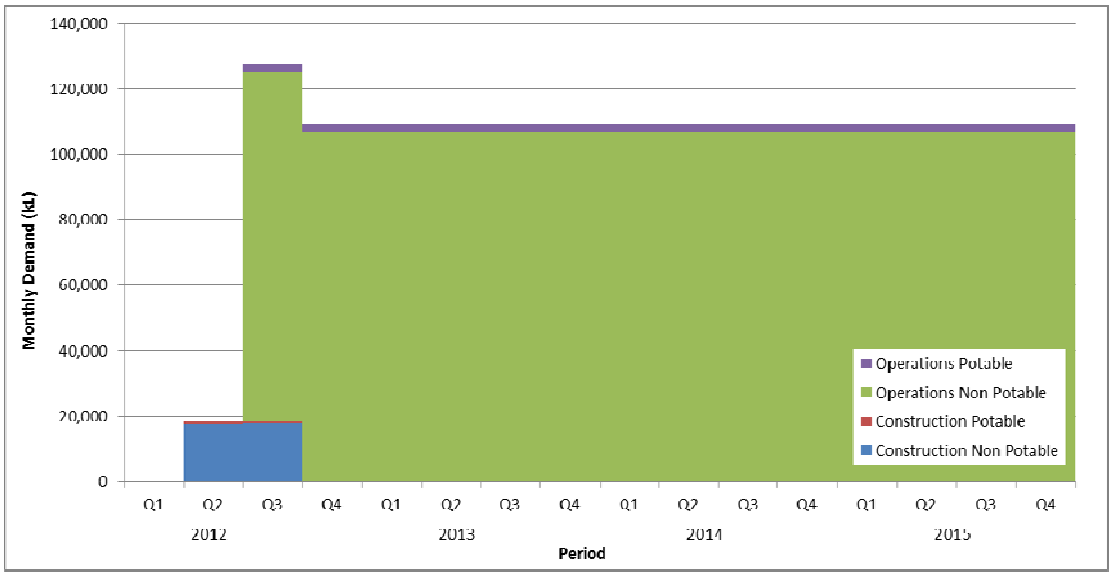
As no existing Water Corporation distribution assets are located within a reasonable distance of the Project area, Fortescue aims to source all of the Project's process and potable water requirements from local groundwater aquifers.

A summary of the Project's water demand for construction and operation is presented in Table 2. The average demand during construction is estimated to be approximately 25,000 kL/month. The average demand during operations is estimated to be approximately 110,000 kl/month. The life of mine water demand profile is illustrated in Graph 2. Overlap of construction and operation activities in the third quarter 2012 results in a peak water demand for non-potable water and potable water of approximately 140,000 kL/month and 3,100 kL/month respectively.

Table 21: Mine area construction and operations groundwater demand details

Demand Item	Average Monthly Demand (kL)	Annual Abstraction (kL)	Demand Duration
CONSTRUCTION			
Earthworks	11,000	132,000	
Road	10,800	129,600	
Camp	600	7,200	
Other	2,500	30,000	
Construction Total	**24,900**	**298,800**	**May – July 2012**
OPERATIONS			
Mining	55,000	660,000	
Processing plant	34,000	408,000	
Road dust suppression	18,000	216,000	
Camp	2,500	30,000	
Operations Total	**109,500**	**1,314,000**	**July 2012 – LOM**

Graph 2: Mine area construction and operations groundwater demand details



Water for dust suppression of the Munjina-Roy Hill Road will be sourced from the Mine groundwater aquifers. Water for dust suppression of the Roy Hill Road will be sourced from the Cloudbreak and Christmas Creek mines.

Commercial dust suppression products (e.g. Dustmag) will be used to minimise water that is required for haulage route dust suppression.

Bulk earthworks material that is required for sheeting of the Munjina-Roy Hill Road will be pre-conditioned at the Mine area prior to transport to sheeting locations.

Water extracted from the production bores will be stored in two turkey nest dams in the Mine area with capacity of 5 ML (50 x 50m) and 7 ML (60 x 60m) for a total of 12 ML which will provide up to 3 days storage for peak daily demand up to 4,400 kL/day.

These dams are expected to be constructed using mine waste material. Depending on the properties of the mine waste material, the turkey nest dams will be either unlined (i.e. if the dam is water holding) or lined with an imported clay blanket or synthetic liner. Dams will either be landscaped to allow animal egress or have specific animal egress points installed.

Water extracted for potable water will be piped to the camp where it will be treated to meet the minimum requirements of the Australian Drinking Water Guidelines. The treated water will be stored in tanks with five days storage capacity for camp demand.

Potable water demands for other facilities within the Project area will either be reticulated from the Camp or provided through separate treatment facilities and storage tanks at the source of demand.

3.8.2 Energy Usage

Power distribution assets are not located within a reasonable distance of the Project area, therefore Fortescue proposes power supply from two power stations with multiple diesel generators.

The Project power demand will be up to 8 MWpa which includes:

- Mining Infrastructure – up to 6 MWpa
- Camp – up to 2 MWpa

Note: MWpa = mega watts per annum

Multiple diesel generator power stations will be located at each of these main demand locations.

All electrical installations in the Project area will conform to Fortescue Specifications, Australian Standards, Western Australia Electrical Requirements, and the *Mines Safety and Inspection Act 1995 and associated Regulations*

3.8.3 Diesel Fuel Usage

Up to 32 MLpa of diesel will be required for the Project which includes:

- Camp Power Station – up to 3 MLpa
- Mining Infrastructure Power Station – up to 9 MLpa
- Mining Operations Plant and Equipment – up to 10 MLpa
- Haulage Road Trains – up to 10 MLpa
- Total – up to 32 MLpa

Note: MLpa = Million litres per annum

Site tank storage will be up to 1,300 kL based on two weeks site storage for 32 MLpa which will require up to 12 x 110 kL double skinned (self-bunded) tanks. It is expected that these tanks will be located at different geographical locations (e.g. 1 x 110 kL tank at the Camp power station, 3 x 110 kL tanks at the Mining Infrastructure power station, etc.)

The fuel tanks will be fitted with overfill alarms and visual indicators of an internal wall rupture (i.e. dip tube) and protected from vehicle strikes with windrows or bollards.

A lined refuelling pad will be provided adjacent to the fuel storage tanks, with at least one of the tanks consisting of an on-board bowser for dispensing fuel to light vehicles, and a fast fill for refuelling heavy earth-moving equipment.

A contracted fuel supplier will transport diesel fuel to site on a regular basis by tanker road train deliveries.

Bulk Earthworks

All bulk earthworks material will be sourced from mine waste and will be used for the following:

- New access roads – 100,000m^3 (250,000 tonnes)
- Sheeting upgrade to Munjina-Roy Hill Road – 200,000m^3 (500,000 tonnes)
- Main pad for the Mine Infrastructure area – 100,000m^3 (250,000 tonnes)
- Main pad for the Camp – 100,000m^3 (250,000 tonnes)
- Miscellaneous – 100,000m^3 (250,000 tonnes)
- Total – 600,000m^3 (1,500,000 tonnes)

4. STAKEHOLDER CONSULTATION

Stakeholder consultation on the Project has formed part of an ongoing extensive stakeholder engagement program for Fortescue projects undergoing environmental approvals. The overarching objectives of the program are:

- To disclose the Project to all interested parties with sufficient detail such that they are able to raise issues and concerns and obtain feedback at the project development stage.
- To establish relationships with key stakeholders that enable ongoing dialogue through implementation and regulation of the Project.

4.1 Stakeholder Engagement Process

The Fortescue stakeholder engagement program for the Project was undertaken from October 2011 and is ongoing. Key stakeholders were identified through Fortescue experience in the Pilbara on previous and other current projects, and project managers have collaborated to support each other's stakeholder engagement through joint identification of stakeholders and integrated engagement activities. Fortescue also adopted previous recommendations from State government agencies on stakeholders that should be included in the program. The following key stakeholders were identified:

4.1.1 Government Agencies

- Department of Sustainability Environment Water Population and Communities (SEWPaC)
- Office of Environmental Protection Authority (OEPA)
- Department of Environment and Conservation (DEC) (both Perth and Regional Karratha offices)
- Department of Mines and Petroleum (DMP)
- Department of State Development (DSD)
- Department of Water (DoW) (both Perth and Regional Karratha offices)
- Department of Indigenous Affairs (DIA)
- Department of Transport WA
- Main Roads WA

- Shire of East Pilbara
- Pastoral Lands Board

4.1.2 Community and Surrounding Land Users

- Nyiyaparli Working Group (Traditional Owners)
- Marillana Pastoral Station

4.1.3 Mining Companies

- BHPBIO
- RIO Tinto
- Brockman Resources
- Roy Hill (Hancock Resources)
- Mineral Resources
- Iron Ore Holdings

In addition to ongoing one-on-one telephone and email liaison, Fortescue employed the following modes of engagement in the development of the Project:

- Face-to-face meetings
- Site visits
- Direct mail
- Group emails
- Teleconferencing
- Telephone contact

Integrated engagement ensured efficient use of stakeholders' available time and resources by avoiding multiple briefings for multiple projects.

4.2 Stakeholder Comments and Proponent Responses

The consultation activities undertaken to date and the issues raised are summarised in Table 22. In addition, Fortescue also engaged in ongoing and *ad hoc* interactions with stakeholders on a one-to-one basis.

Table 22: Summary of stakeholder consultation

Date	Location	Stakeholder Group/s	Attendees	Consultation Method	Issues Raised
05-Jan-11	Port Hedland (following Nullagine route)	Main Roads Department	Ross Atkin, Ford Murray, Vicki James, Gary Player, Ammar Abdul	Meeting	Upgrade and contractual arrangements for Fortescue crossing near Roy Hill. Brief mention of the project.
10-Jan-11	Port Hedland	Main Roads Department	Ross Atkin, Jonathon Clements, Gary Player, Vicki James, David Pearson, Ammar Abdul	Meeting and brief presentation	Proposed trucking route.
12-Jan-11	West Perth	Port Hedland Port Authority	Sean David, Ross Atkin, Jonathon Clements, Katarina Busunovich, Roy	Meeting and brief presentation on North Star	Impact of trucking on Utah Road, possibility of trucking direct to Finucane Island.
19-Oct-11	Paraburdoo	Shire of Ashburton	Sean McGunnigle, Ford Murray, Scott Hansen	Presentation	
07-Nov-11		Nyiyaparli Working Group	Victor Parker, Bruce Bung, Sue Bung, Gordon Yuline, Brian Tucker, Keith Hall, Dorothy Tucker, Kate Holloman, Lisa Maher, Roberta Molson, Tom Weaver, Doug Brown, Michael Thompson, Heath Nelson	Meeting	Survey work and upcoming mining and infrastructure planning, land access matters including royalty payments.
15-Nov-11	Karratha	Department of Water		Meeting/ information session	
14-Dec-11	Port Hedland	Town of Port Hedland	Sean McGunnigle, Council	Council meeting - presentation	Dust and noise issues related to trucking of ore
14-Dec-11	Port Hedland (following Nyidi road inspection)	Main Roads Department	Ross Atkin, Clayton Brandwood, Brendan Purcell, Vicki James, Gary Player, Andrew Pyke	Meeting	Use of Great Northern Highway, Marble Bar Road, intersections, condition of the Fortescue River crossing on the Marble Bar Road. Traffic movement predictions.

Date	Location	Stakeholder Group/s	Attendees	Consultation Method	Issues Raised
16-Dec-11	Newman	Shire of East Pilbara	Sean McGunnigle, Council	Council meeting - presentation	
20-Dec-11	Tom Price	Shire of Ashburton	Ross Atkin, Brendan Purcell, Scott Hansen, Geoff Brayford	Meeting	If western route is chosen 8 km impact on Ashburton Shire road. Road standards to be consistent.
20-Dec-11	Newman	Shire of East Pilbara	Ross Atkin, Brendan Purcell, Allen Cooper (CEO)	Meeting	Discussed the trucking of ore from the Project and the possible impacts on Shire roads.
23-Jan-12	Port Headland	Nyiyaparli Heritage Sub-committee	Hank Rhee, Kate Holloman, Brian Tucker, Michael Stream, David Stock, Gordon Yuline, Jason Anthony, Jim Birckhead, Roberta Molson, Joanne Burke	Meeting	Survey work past and upcoming, in the Nyiyaparli area covering proposed rail, roads and infrastructure as part of Io and Nydidinghu projects.
27-Jan-12	FMG Office – Perth	Bunjima People native title claimants	Tom Weaver, Nerolie Nikolic, Paul Steiner	Meeting	Discussion on native title claimant's requirement to consent to grant of tenure per Fortescue land access agreement. Discussion of possible route.
07-Feb-12	FMG Office – Perth	Agencies	Mark Jefferies, Daniel Endacott, Nick Woolfrey, Merrilyn Barnes, Shaun Grein, Sean McGunnigle, Chris Heary.	Presentation	Significant environmental factors, impact assessment, mine closure and pathway for approvals.
07-Feb-12	BHBP's offices – Perth	BHPB	Damon Edwards, Neil Miller, Christian McArthur, Peter Hairsine, Stuart Robinson	Working Group Meeting	Mutal interactions of BHPB's Jinidi Railway and Io Project.

Date	Location	Stakeholder Group/s	Attendees	Consultation Method	Issues Raised
09-Feb-12	Karratha	Department of Water	Merrilyn Barnes, Sean McGunnigle, Dr Hamid Mohsenzadeh, Gary Humphries	Presentation	Presentation and discussion of the Io Project, mine water demand, ground water and surface water.
2011–ongoing	Io Project area	Nyiyaparli People and Heritage Consultants	Nyiyaparli Traditional Owners including: Brian Tucker, David stock, Gordon Yuline, Susie Yulline, Victor Parker, et al.	Archaeological and enthographic surveys	Recording and reporting of sites and areas of Aboriginal cultural heritage.

4.3 Ongoing Consultation

Fortescue will continue to maintain established communication channels and stakeholder relations throughout the life of the Project. The engagement program established with stakeholders regarding the Project prior to its referral to the EPA will be continued as a normal part of Fortescue business practices.

5. FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROJECT

5.1 Identification of Key Factors and Significance

Key environmental factors were identified by Fortescue and included:

- Agency consultation regarding the entire Study area.
- Comments on management plans for previous projects.
- Results of environmental investigations.

This process identified the key environmental factors dealt with in sections 6 to 14. A cumulative environmental assessment has been included within each individual factor section. Key issues were identified through an assessment of each of the factors likely to be affected by the Project.

5.2 Relevant Factors

The environmental factors considered likely to be impacted by the Project are:

- Vegetation and flora
- Fauna
- Surface water
- Conservation areas (proposed) and natural heritage, including the Fortescue Marsh
- Aboriginal heritage
- Groundwater
- Landform, mine closure planning and rehabilitation
- Noise
- Air quality

The potential impacts on the relevant factors and their proposed management are assessed within this document.

5.3 Consistency with Environmental Principals

The EP Act sets out five principles by which protection of the environment is to be achieved in Western Australia. These principles, and the manner in which Fortescue has sought to apply them in the design and planned implementation of the Project, are outlined in Table 23.

Table 23: Principles of environmental protection

Principle	Consideration Given in Project	Relevant Sections in Document
1. 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. In the application of the precautionary principle, decisions should be guided by: • - Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment • - An assessment of the risk-weighted consequences of various options.	The Proponent recognises the importance of minimising environmental impacts as it is vital in ensuring Fortescue's longevity, success, growth and positioning in the domestic and global markets. Fortescue aims to gain a level of achievement beyond legal obligations. This will be achieved by successful management of potential risks. The Proponent maintains an environmental management system (EMS) that addresses all of its activities with a potential to affect the environment. The key elements of the EMS include assessing environmental risk arising from environmental aspects with the intention of identifying issues early in the process to enable planning for avoidance and/or mitigation. Part of this process includes undertaking detailed site investigations of the biological and physical environs. Where these investigations identify significant conservation issues, management measures are incorporated into the project design to avoid, where practicable, and/or minimise any potential impacts. As a result, this Project has been designed to minimise potential impacts to the key environmental values of the local flora, vegetation, fauna and Fortescue Marsh. The Proponent is supporting University of Western Australia to develop a better understanding of Fortescue Marsh and associated Samphire plant communities and a study with the Department of Environment and Conservation and CSIRO to improve understanding of Mulga vegetation communities.	All factor sections

Principle	Consideration Given in Project	Relevant Sections in Document
2. Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The Proponent's decision-making processes incorporate sustainability principles and the implementation of new and better technologies where feasible. The proponent aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning. Fortescue encourages employees to engage in positive attitudes and behaviour concerning respect for the environment. We recognise sustainability cannot be achieved without the contribution and action of the entire team.	This is addressed in existing management plans and is not specifically addressed in this supporting information document. However, refer to Section 3.2
3. Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Conservation of biological diversity and ecological integrity is fundamental to the Proponent's approach to environmental management and is a major environmental consideration for the Project. Biological investigations have been undertaken by the Proponent early in the project planning process to identify values of environmental conservation significance required to be protected from disturbance. This Project has been designed to minimise potential impacts to the key environmental values of the surrounding flora and vegetation and the Fortescue Marsh. The Proponent has committed to restoring disturbed environments upon decommissioning, as well as ongoing rehabilitation of vegetation around the Project area. The aim of all rehabilitation is to establish sustainable endemic vegetation units consistent with reconstructed landforms and surrounding vegetation. The Proponent is also undertaking monitoring of groundwater and surface water in the area to determine impacts, as well as funding ongoing studies into the Fortescue Marsh.	8, 9, 10

Principle	Consideration Given in Project	Relevant Sections in Document
4. Improved valuation, pricing and incentives mechanisms Environmental factors should be included in the valuation of assets and services. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	The Proponent acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when and wherever possible. For example: • - Environmental factors have played a major role in determining infrastructure locations. • - The Proponent has put in place procedures that will ensure that pollution-type impacts are minimised as far as practicable. • - The cost of rehabilitation and closure requirements has been incorporated into the costs of the product from the commencement of operation.	8, 9, 10
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	The Proponent's approach to waste management is to, in order of priority: • - avoid and reduce at source • - reuse and recycle • - treat and/or dispose. The Proponent operates an appropriately licensed landfill for the disposal of general domestic solid wastes. The Proponent has a comprehensive recycling program on-site which includes the recycling of aluminium cans, scrap steel, plastic, batteries, light globes, fluorescent tubes, polyethylene pipe, office paper and cardboard.	3

6. GROUNDWATER IMPACT ASSESSMENT

The following section provides the results of the impact assessment of the Project on ground water in the Project area.

6.1 Relevant Environmental Objectives, Policies, Guidelines, Standards And Procedures

The following section outlines the relevant objectives, policies, standards and procedures that have been taken into account during impact assessment of the Project on groundwater.

6.1.1 EPA Objectives

The EPA applies the following objectives in assessing Projects that may affect groundwater:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

6.1.2 Legislation, Policy and Guidance

Legislation

The *Rights in Water and Irrigation Act 1914* (RIWI Act) makes provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes. Within this, the Act requires the construction of wells and groundwater abstractions (including dewatering) in proclaimed areas to be licensed. The Project lies within the proclaimed Pilbara Groundwater Area and is subject to such licensing, which is administered by the DoW under delegation from the Minister for Water. Groundwater abstraction licences typically specify annual limits on the groundwater volumes that may be abstracted and include a range of conditions, including requirements for monitoring and reporting on aquifer behaviour. The approval of an abstraction license will require the DoW to approve a Water Management Plan and Operating Strategy, in line with the *Pilbara Water in Mining Guideline* (DoW 2009) and *Pilbara Regional Water Plan* (DoW 2010).

The Country Areas Water Supply Act 1947 does not apply, as the area is not part of a proclaimed Water Reserve or Catchment Area for public water supply.

There is no Federal water legislation relevant to this Project.

National

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

Water quality guidelines for the protection of marine and freshwater ecosystems have been released under the auspices of the *National Water Quality Management Strategy* (NWQMS) (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and are applied to five geographical regions across Australia and New Zealand. The NWQMS is supported by the *Guidelines for Groundwater Protection in Australia* (ANZECC/ARMCANZ 1995), which outlines a framework for protecting groundwater in Australia. The Guidelines require the identification of beneficial uses for groundwater in aquifers, and policy to manage these issues.

A series of guidelines on national water quality management has also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State Policy and Guidance

The Government of Western Australia developed the *State Water Quality Management Strategy* in 2001 to supplement the *National Water Quality Management Strategy* with the objective “to achieve sustainable use of the Nation’s

water resources by protecting and enhancing their quality while maintaining economic and social development".

The S*tate Water Quality Management Strategy* proposes that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions can then require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed a series of *Water Quality Protection Notes and Guidelines for mining and mineral processing*. These guidelines address a range of mine site issues including dewatering, installation of groundwater monitoring wells, water quality monitoring, stormwater management and acid mine drainage.

6.2 Potential Sources Of Impact

The main value of groundwater in the area is for pastoral activities and in supporting the ecology of the Fortescue Marsh. Activities or aspects of the Project that may potentially affect groundwater include the following:

- Contamination of groundwater through hydrocarbons and chemicals
- Lowering of groundwater through abstraction for water supply

6.3 Findings of Surveys And Investigations

The Hydrogeological Investigation of the Study area comprised a total of 5 production bores and 61 piezometers with the objective of characterising the area's hydrostratigraphy (alluvium, CID and BID) (Appendix D). The distribution and targeted aquifer for these bores are shown in Figure 26.

6.3.1 Flow Regime

The findings of the hydrogeological investigations have confirmed the initial understanding of the existing groundwater environment described in Section 2.3.2 and presents revised hydrogeological parameters based on pump tests carried out on the CID and BID aquifers (italicised in Table 24). Storage potential within both the CID and BID aquifer is similar, although the CID demonstrates far greater transmissivity. Data from pump testing suggests the two aquifers are in direct connection.

Table 24: Updated hydraulic parameters from groundwater investigations

Hydrostratigraphic Unit	Transmissivity (m^2/d)	Conductivity (m/d)	Storativity	Specific Storage (S_S)	Specific Yield (S_Y)
Upper Alluvium	-	0.072		1x10-5	3-10%
Lower Alluvium	-	0.0016		5x10-5	1-5%
Tertiary Detritals	-	0.68		1x10-5	2-5%
Channel Iron Deposits (CID)	*4,100*	*33*	*2×10^{-4}*	*1×10^{-6}*	3%
Mineralised/Fractured Brockman Bedded Iron Deposit (BID)	*185*	*1.6*	*1×10^{-3}*	*$8x10^{-6}$*	1-2%
Unmineralised/unfractured Brockman Formation	n/a	n/a	n/a	1x10-6	0.1–0.5%

An estimate of likely groundwater storage based on the current understanding is provided in Table 25. The greatest storage potential lies within the CID and BID aquifers, with additional storage in the alluvial aquifers. A total of approximately 80 GL of storage is expected within the study area.

Table 25: Estimated aquifer storage in the Study area

Aquifer	Saturated Volume (m^3)	Average Specific Storage[1]	Estimated Storage Volume (m^3)	Estimated Storage Volume (GL)
Alluvium (Upper and Lower combined)	240×10^6	7 %	17×10^6	17
Tertiary Detritals	Negligible in Project Area	4 %	n/a	n/a
CID	$1{,}500 \times 10^6$	3 %	45×10^6	45
BID	$1{,}100 \times 10^6$	2 %	22×10^6	22
Total				**84**

[1] Obtained from Table 8 in section 2.3.2

6.3.2 Drawdown Response to Proposed Abstraction

Water level drawdown in response to the proposed abstraction has been investigated (Appendix D). The following pumping scenarios have been assessed:

- NPB1004 abstracting groundwater at a rate of 80 L/s for four years. This is an overestimate to demonstrate the bore and groundwater system's capacity for this volume of abstraction.
- NPB1005 abstracting groundwater for potable water at a rate of 5 L/s for four years. This is also an overestimate of the long-term supply rate for the purposes of demonstrating the limited response of groundwater levels from abstraction.
- NPB1003 abstracting groundwater at a rate of 80 L/s for two weeks. This duration is considered relevant as NPB1003 is a backup bore for circumstances where NPB1004 has to be removed from service. The rate is again an overestimate of likely operation, which may peak at 80 L/s but will operate at lesser rates for the majority of the time.

The results of the analysis are presented in Appendix D. Under the pumping regime described above the resulting depressurisation within the pumped aquifer is estimated to reach a maximum extent (greater than 0.1 m) of 1,000 m, 10,000 m, and 100 m for NPB1003, NPB1004 and NPB1005 respectively.

The calculated drawdown at the water table (alluvial aquifer) is significantly less due to the semi-confining nature of lower alluvial sediments. Maximum drawdown of the water table is less than 5 m nearby the pumping bore and decreases to negligible levels at a distance of approximately 1,000 m from bores NPB1003 and NPB1004 and 100 m for NPB1005 Table 26.

Table 26: Predicted drawdown effect from proposed abstraction

Bore	Abstraction rate (L/s)	Duration (days)	Predicted Drawdown (m)					
			10m from bore		100m from bore		1,000m from bore	
			Pumped Aquifer	Alluvial Aquifer	Pumped Aquifer	Alluvial Aquifer	Pumped Aquifer	Alluvial Aquifer
NPB1003	80	14	17	4.06	6	1.43	< 0.1	< 0.1
NPB1004	80	1,460	1.8	0.79	1.2	0.53	0.5	0.22
NPB1005	5	1,460	0.2	<0.1	< 0.1	< 0.1	< 0.1	< 0.1

6.4 Evaluation Of Options Or Alternatives To Avoid Or Minimise Impact

The primary option to avoid impacts would be to completely avoid any abstraction of, or interaction with groundwater. Given that the proposed mine void will be located above the water table, the only interaction with groundwater is through abstraction bores. The abstraction bores will cause a minor drawdown of the water table over

the life of the project. The water abstracted from these bore is necessary for the operation of the mine site (i.e. dust suppression, domestic use) Water could potentially be trucked in, which would eliminate the need for abstraction bores, however, this option is considered uneconomical. In addition, the proposed abstraction and predicted drawdown for the Project represents a negligible change to the groundwater regime in comparison to the significant mine water discharge occurring upstream (see section 6.7 – Cumulative Impacts).

6.5 Assessment of Likely Direct and Indirect Impacts

The following section describes the likely direct and indirect impacts of the Project on groundwater.

6.5.1 Impacts on Groundwater Quality

The proposed mine void will be excavated to a maximum depth which is above the water table. Therefore, there will be no direct interaction with groundwater in the pit void reducing the potential for contamination and eliminating the need for ongoing dewatering. In addition, the geology of the mine area is considered to be geochemically benign. Hence, there is not expected to be groundwater contamination from metalliferous drainage or PAF materials.

A chemical or hydrocarbon spill could potentially impact on groundwater quality if surface water flows were sufficient enough to carry it into the groundwater system. This risk is heightened within the confines of the mine void as there will be less buffering material between the water table and the pit floor. Notwithstanding this, the potential for chemicals and/or hydrocarbons to enter the groundwater system is considered low. This is based on the limited avenues in which these substances could enter the groundwater system and the mitigation due to the implementation of Fortescue's Hydrocarbon and Chemical Management Plan.

No changes to water quality are predicted from the proposed abstraction activities. The proposed abstraction represents less than 4% of total inflow into the Study area, and a regional reversal of groundwater gradients is not expected. Therefore saline groundwater located to the north will not be drawn into the Study area.

6.5.2 Impacts to Water Balance and Groundwater Levels

Groundwater is proposed to be drawn from three supply bores. The proposed abstraction represents less than 4% of total inflow that recharges the aquifer in the

Study area. Therefore no change to the natural groundwater flow regime or water balance is expected.

Predicted drawdown of the water table is within the flutuations currently experienced as a result of natural cyles and upstream mining discharge. Therefore, impacts to groundwater levels are considered to be minimal. A summary of the change in depth to groundwater resulting from the proposed abstraction is presented in Table 27.

Table 27: Change in ground water depth from proposed abstraction

Bore	Abstraction rate (l/s)	Duration (d)	Pre project depth to water table	Depth to water table 10m from bore	Depth to water table 100m from bore	Depth to water table 1,000m from bore
NPB1003	80	14	27.2	23.14	25.77	~ 27.2
NPB1004	80	1460	26.0	25.21	25.47	25.78
NPB1005	5	1460	27.0	~ 27.0	~ 27.0	~ 27.0

6.6 Management Measures And Performance Standards

6.6.1 Management Actions

A groundwater operating strategy for the Project will be submitted as part of a Department of Water abstraction permit (5C licence). These strategies will include a detailed description of the following items:

- Identifying and Managing Impacts
- Operating Rules for Abstraction
- Monitoring and Reporting
- Contingency and Trigger Levels

Fortescue will implement a Hydrocarbon and Chemical Management Plan to minimise the risk of spills and subsequent groundwater contamination.

Pumping from the three Project water bores will be managed to minimise drawdown, which may affect other beneficial uses in the area (i.e. livestock watering). Management will consist of continuous water level monitoring and ongoing adjustment of pump tensing rates that significant drawdown does not occur through over abstraction.

6.6.2 Proposed Future Investigations

The groundwater system within the Study area has been adequately investigated for the purpose of understanding the effects of the proposed abstraction on the water balance, groundwater quality and groundwater levels. Sufficient piezometers also exist to monitor and manage potential changes in the groundwater system.

6.7 Cumulative Impacts

The potential impacts as a result of this Project on groundwater quantity and quality are considered to be minor. In terms of groundwater quantity, the water abstracted from the system is more than offset by the water discharged into the groundwater system by the RTIO Hope Downs and BHP Billiton Yandi mine site up gradient. Total discharge from these operations is estimated to be approximately 49 GL/a with resulting groundwater recharge (after evapotranspiration losses) of 43 GL/a. Hence, there is no cumulative impact proposed.

The operation is unlikely to impact on groundwater quality as the only interaction with groundwater is through water abstraction. There is the potential for small chemical or hydrocarbon spills to enter the system in the event of an accident or incident, however, the likelihood of this entering the groundwater system is low. Therefore, there are no predicted cumulative impacts on groundwater quality.

6.8 Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures

The assessment has drawn the following conclusions:

- The risk of potential impacts to groundwater within the Project mining area is considered low.
- The mineral deposit is located above the regional water table. Consequently, there is no need for dewatering during mining. Therefore groundwater levels and quality should not be impacted by the direct mining of the deposit.
- A Hydrocarbon and Chemical Management Plan will be implemented to limit any impact on groundwater as a result of hydrocarbon and chemical use within the mine area.
- An assessment of the acid generating potential of the ore and waste was undertaken over the proposed mine pit area. Based on this assessment the potential for acid generation is considered low.

- Based on this assessment, it is predicted that Fortescue will maintain the quantity of groundwater so that existing and potential environmental values are protected. In addition, the quality of ground water is expected to be maintained so that Fortescue meets statutory requirements and acceptable standards.

7. SURFACE WATER IMPACT ASSESSMENT

The following section provides the results of the impact assessment of the Project on surface water in the project area and to the wider areas of the Weeli Wolli Creek and Fortescue Marsh.

7.1 Relevant Environmental Objectives, Policies, Guidelines, Standards and Procedures

The EPA applies the following objective in assessing Projects that may affect surface water:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

7.1.1 Water Resource Policies and Guidances

National

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

A set of water quality guidelines for the protection of marine and freshwater ecosystems has also been released under the auspices of *the National Water Quality Management Strategy* (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and applied to five geographical regions across Australia and New Zealand.

A series of guidelines on national water quality management have also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in

some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State

The Government of Western Australia developed the *State Water Quality Management Strategy* in 2001 to supplement the *National Water Quality Management Strategy with* the objective 'to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development'.

The State Water Quality Management Strategy requires that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed a series of *Water Quality Protection Notes and Guidelines for mining and mineral processing.* These guidelines address a range of issues including installation of mine site groundwater monitoring wells, mine site water quality monitoring, mine site stormwater management and acid mine drainage.

7.2 Potential Sources of Impact

The main environmental value of surface water in the Project area is supporting the ecology of the Fortescue Marsh.

- Construction of infrastructure on the floodplain can impede flood flows or increase/decrease flood levels adjacent to, upstream and downstream of the infrastructure.
- Mining pits filling up with flood waters reducing peak flows and volume of water moving downstream.
- Flood protection infrastructure can isolate areas of the catchment reducing the peaks flows downstream.

The following activities could potentially impact on the surface water quality of the Weeli Wolli Creek:

- hydrocarbon spills if not contained
- runoff from stockpiles and waste dumps if discharged untreated
- discharge of in-pit stormwater if untreated
- runoff from roads
- explosive spills
- spills from sewage treatment plant

7.3 Findings of Surveys and Investigations

This section is based on the following technical studies:

- *Io Surface Water Assessment – Data and Literature Review* (Dec 2011). Attached as Appendix C.
- *Marillana Scoping Surface Water Assessment* (Feb 2011)
- *Io Flood Study* (Jan 2012) (Appendix B).

7.3.1 Surface Water Flow Processes

The proposed Project pit and associated Project infrastructure is located on the eastern edge of the Weeli Wolli floodplain at the base of the Hamersley Ranges. Refer to Figure 27 which shows regional hydrology over the Project area.

Flood Protection Strategy

Given that the proposed mine is located within the floodplain of Weeli Wolli Creek, some level of flood protection of the mining infrastructure and mining pit is required.

Ideally infrastructure should be located outside the floodplain, however the location of the ore and available Fortescue tenements have restricted the ability to achieve this. Therefore structural measures and building controls are proposed as the methods to provide flood protection.

The life of mine is relatively short (4 years). For the purpose of this study, five years is used to allow for rehabilitation and maintenance. The probability of the occurrence for a range of flood event sizes is presented in Table 28. Fortescue has adopted 1 in 50 year level of flood protection for the pit and associated infrastructure. This means there is a less than 10% chance that during the five years, the site will experience flows greater than the level of flood protection.

Table 28: Range of flood event sizes

Average Return Interval (ARI)	Probability of an event of this magnitude occurring during LOM(%)
5	62%
10	41%
20	23%
50	10%
100	5%

The design of the flood levee was derived from the 2D hydraulic model. The flood maps for the 1 in 10, 1 in 20, 1 in 50 and 1 in 100 year events are shown in Figures 11, 12, 13 and 14 respectively.

Flood protection will be provided by constructing a flood levee around the active mine area (pit, ROM, stockpiles) as shown in Figure 27. The maximum height of the bund will be 2 m. The levee will be regularly inspected to ensure its integrity. A Flood Management Plan will also include details of management actions that will be implemented in the event of the levee overtopping and or failing if the site experiences a flood greater than a 1 in 50 year event.

Fuel and chemical storage will have a minimum of 1 in 20 year flood protection in accordance with the "Water Quality Protection Guidelines for Mining and Mineral Processing – Above ground fuel and chemical storage". If sited within the proposed flood levee, a minimum flood protection of 1 in 50 year ARI will be provided.

All flood infrastructure will be designed in accordance with Fortescue Engineering Specification for Drainage and ARI Design (Appendix C).

Minesite Stormwater Strategy

The Mine Stormwater Strategy describes the control of incident rainfall in and around the pits, ROM pads, stockpiles located within the proposed flood levee. Runoff will be contained and treated in sedimentation ponds prior to reuse or discharge to local drainage lines. Treatment will mainly focus on removing sediment and fines that have been picked up from the active mining areas.

The mining pit catchment is limited to the pit extent due to the flood bund and the pit safety bund. Incident rainfall on the pit will be collected in a sump, and then pumped to the minesite stormwater sedimentation basin using floating pontoon pumps.

In the event of the flood levee failing, a small portion of the flood waters will run into the pit. This water will be treated (either inpit through settling; sedimentation ponds;

or other) prior to discharge in accordance with licence conditions. A separate Pit Flooding Emergency Plan will be developed to deal with this event.

The Minesite Stormwater Management Plan will include containment of stormwater from these areas via earthen drains and bunds, and directed into a series of sedimentation basins. These basins will be design to treat the first flush of sediment from the runoff, as described in the Water Quality Guidelines. Water will then be re-used in the mine area or discharged to natural drainage lines subject to discharge licence conditions. The design of these controls will be consistent with the *Water Quality Protection Guidelines for Mining and Mineral Processing – Minesite (department of Water Stormwater, No.6, 2000 FMG Surface Water Management Plan, July 2011* (45-PL-EN-0024).

7.4 Evaluation of Options or Alternatives to Avoid or Minimise Impact

The scope to consider alternative locations for the Project to avoid or minimise impact is limited as the location of the mine is dictated by the extent of resource. Surface water drainage paths at the site generally run towards the Fortescue Marsh. As such, drainage has been a key consideration in mine planning.

The most significant means of avoiding surface water impact in the Project is no dewatering and injection system or surface water discharge is proposed for the Project.

Open cut mining changes landforms in order to extract the target ore and manage the waste rock or overburden. Pits, stockpiles and waste landforms will alter the local surface water regime by diverting or capturing water that would otherwise be transported downstream. Mining proposed for the project uses progressive backfilling to reduce the pit and stockpile areas that are active at any given time. This reduces the impact of mining upon the surface water regime of the area as the landforms can be stabilised and rehabilitated as the mining face progresses.

7.5 Assessment of Likely Direct and Indirect Impacts

The following section provides an assessment of the likely direct and indirect impacts on surface water from the implementation of the Project. It focuses on the potential impacts on the Weeli Wolli Creek and Fortecue Marsh.

7.5.1 Physical Presence of Infrastructure

Mine pits and waste landforms affect surface water flows by potentially diverting upstream flows and capturing rainfall within mining areas. This can result in areas of shadowing that receive less flow than previously because surface flow processes have been interrupted or diverted. Shadowing can affect both channel flow and sheet flow processes. Mine pits and waste landforms can also prevent water flowing downstream, causing previously dry areas to become inundated (ponding).

The impact of mine pits and waste landforms on the surface hydrology of the site has been modelled. The estimated modelled change to flood depth and velocities for the 1 in 20, 50 and 100 year events is shown in the flood maps. Figure 28, 29, 30 and 31 show the modelled flood extent after the proposed bund and mine infrastructure is built. There is no change to the 1 in 5, and 10 year flood events as the proposed infrastructure is located outside of the 10 year modelled flood extent for Weeli Wolli Creek

The proposed flood levee isolates just over 240 ha from the Weeli Wolli Creek catchment. This represents 0.14% of the total Weeli Wolli Creek catchment and 0.04% of the Fortescue Marsh catchment. Incident rainfall on this area will be captured, treated and reused where possible or discharges to the local drainage line subject to discharge licence conditions.

7.5.2 Water Quality Impacts from Mine Infrastructure

The project has considered water quality risks associated with:

- sedimentation
- nutrients
- heavy metals and metalloids
- waste water and discharge
- pesticides
- hydrocarbon contaminants.

Nutrients and pesticides are considered unlikely to be a risk in the context of the mine as fertilisers and pesticides will not be used and wastewater production will not be produced in significant quantities for the Project.

Hydrocarbon contamination is considered to be a minor issue, and will be managed through bunding of hydrocarbon storage and workshop areas, and treatment of stormwater from this area prior to release. .

Turbidity and Sedimentation

Waste landforms are formed from loose overburden and other waste material that is not suitable for ore processing. The waste material is unconsolidated and in low rainfall events creates little runoff due to high infiltration rates. In high rainfall events the unconsolidated material is susceptible to erosion which in turn affects the water quality of downstream flows and potentially leads to sedimentation.

The potential for erosion from waste landforms is mitigated through:

- Containing all waste landforms within windrows which will absorb and prevent runoff downstream.
- Use of perimeter drains designed to minimise erosion to divert upstream flows away from the waste landforms.
- Flattening the top of waste landforms to encourage infiltration and minimise runoff.
- Installing berms to minimise channel flow off waste landforms.
- Stabilising and rehabilitating waste landforms as soon as they are complete.

Water quality currently entering the Fortescue Marsh is generally highly turbid (SEWPAC 2010b). High turbidity and sediment loads are common in runoff in the Fortescue Valley due to the silty nature of the floodplain soils, paucity of vegetation and intensity of rainfall associated with tropical thunderstorms and cyclonic events. Consequently the Project will not impact on turbidity of water entering the Fortescue Marsh.

The Project will not significantly impact on the values of surface water in terms of water quality in the Fortescue Marsh or stock watering purposes.

Water Management within Mining Areas

During operation, the mine pits and waste landforms are designed to drain internally (except in major flood events) and act as closed catchments which do not pass runoff onto downstream areas. In-pit sumps may be required to collect any incidental rainfall or seepage during mining activities with sub-surface drainage from the sumps into the ore body.

Rainfall onto waste landforms infiltrates due to the waste landform design. The top of waste landforms are typically finished off as a level surface and surrounded by windrows to capture surface runoff. Some waste material is placed in unlevelled piles, creating an uneven surface. Little or no surface runoff occurs from the waste landforms, particularly during low flow events. In larger flow events, pits and waste landforms may absorb water and act as blockages to flow, causing upstream ponding and downstream water shadows to form (Worley Parsons 2011).

Water Diversion

Runoff from upstream will be diverted around the waste landforms and mine pits. However, all surface water diversions will flow into the nearby waterways and eventually Fortescue Marsh. Any diversion increases the risk of erosion and sedimentation through concentrating flows and increasing flow velocity. This risk has been taken into account when designing diversion structures. In areas where sheet flow occurs, there is a risk that the diversions will shadow some areas from the flow and increase flows to others changing the surface water hydrology and potentially the vegetation.

Impacts of the development due to the processes described above have been assessed based on the proposed engineering approach that incorporates the following steps to minimise impacts:

- Installation of perimeter drains around the outside of pits and waste landforms to divert flows around pits and waste landforms.
- Installation of engineering culverts or floodways where required on haul roads and access roads.
- Provision of rock aprons at the outlet of perimeter drains, culverts and floodways, to disperse flows and reduce erosion.

Infrastructure such as haul roads, pipelines, buildings, and waste dumps, will be placed in the drainage shadows created by the mine pits, where viable to do so, in order to minimise the overall impact of reduced sheet flow.

Impacts on Channel Flow and Erosion

Erosion generally occurs in larger flood events, when velocities are higher. Erosion occurs under natural flooding regimes, however, the disturbance to landform associated with mining increases this risk. To investigate this risk, the areas impacted by the 1 in 100 year flood event were modelled for the pre-mining and post-closure scenarios as well as during the mining period. The modelling was calculated

to determine where flows would be constrained by infrastructure as well as to show predicted changes in the areas inundated.

Mining alters the areas inundated in large flood events by:

- Shadow effects
- Through infrastructure constraining the areas subject to flooding,
- Causing expansion of flooding in another direction and,
- Increased depth and velocity of flows.

Modelling indicates that these potential impacts are minimal and will have minimal changes to flooding, flow or erosion. (Figure 31).

Areas Subject To Inundation

All buildings and processing infrastructure will be kept out of the 1 in 100 year flood zone or will be appropriately bunded to minimise flood risks. Chemicals and hydrocarbons will not be stored in the 1 in 100 year flood zone.

Impacts on Sheet Flow

As can be seen by the hydraulic modelling undertaken for the 50 year and 100 year pre and post infrastructure, there is a small shadowing effect from the mine pit and bund wall however the impact to sheet flow is considered minimal. There is no impact on the 5-20 year hydraulic models. (Appendix C).

7.5.3 Potential Impacts due to Chemical Storage

The storage of chemicals, including hydrocarbons, and their use has the inherent potential for leaks or spills to occur and affect surface water quality. The Chemicals and Hydrocarbon Management Plan will be implemented to minimise the risk of chemical spills and leaks to surface water.

7.5.4 Potential Impacts due to Clearing and Earthworks

Clearing and earthworks may lead to erosion of exposed soils, which may in turn lead to deterioration in water quality from increased turbidity. This risk is potentially greatest where clearing and earthworks occur on steep slopes with erosive soils. The Project area is gently undulating so the likelihood of significant impacts to surface water quality from this aspect is considered to be low. Management

measures will be undertaken to limit clearing in erosion prone areas and rehabilitation will occur progressively throughout the Project area.

7.6 Cumulative Impacts

The main cumulative effect of mining in the Fortescue Marsh catchment in terms of surface water is the potential reduction of runoff into the Fortescue Marsh.

The predicted extent of changes to surface water catchments from the Project has been examined in the context of predictions regarding mines in the vicinity of Fortescue Marsh where predicted changes in catchment areas or discharges are publicly available through environmental approvals documents:

- Fortescue Christmas Creek and Cloudbreak operations (located North of Fortescue Marsh)
- Roy Hill (proponent, Hancock Prospecting, located east of Christmas Creek)
- Marillana (proponent Brockman Resources, located near the proposed project)

In terms of total catchment area reduction, the maximum area of disturbance from the Project is estimated at 370 ha. The respective losses of catchment for mine voids and waste landforms for the other mines are:

- Christmas Creek: 10,100 ha (FMG 2010)
- Cloudbreak: 18,100 ha (FMG 2011b)
- Roy Hill: 12,000 ha (Environ 2009)
- Marillana: 3,100 ha (EPA 2005).

The total area of catchment lost is therefore estimated at 43,640 ha, or approximately 2% of the total Fortescue Marsh catchment area. This is not considered to be a significant proportion of the total catchment area and is not expected to have a significant impact on water inflows to the Fortescue Marsh.

The Project is located approximately 30 km from Fortescue Marsh and the project is expected to have minimal impact. Any impact on the tributaries that flow into Fortescue Marsh will have minimal cumulative effect on the water quality and quantity of inflows into the marsh. This potential for cumulative impacts will be mitigated in the mine through ensuring that surface water flows are not impacted and

that catchment boundaries and water quality are preserved during and following mining.

7.7 Management Measures and Performance Standards

The surface water management strategy for the Project will be designed to:

- Ensure the safety of personnel on site.
- Does not result in impact to the receiving environment downstream that is outside natural conditions.

The surface water management strategy will be focused on two main areas:

- Flood waters from Weeli Wolli Creek and other ancillary catchments.
- Mine site stormwater.

Management of potential impacts on surface water from the Project are also addressed in the Surface Water Management Plan and includes the following key management actions:

- Divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible.
- Separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release.
- Minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion bund to be constructed to prevent stormwater entering waste landform areas.
- Locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation.
- Ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding.
- Disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required.
- Ensure that chemical storage is undertaken in a manner that limits potential surface water contamination.
- Manage clearing and earthworks to minimise erosion.

7.8 Predicted environmental outcomes against environmental objectives policies, guidelines, standards and procedures

Through the mitigation measures, the Project and the approved project are expected to result in the following outcomes in relation to surface water:

- No significant impact on water quality and quantity of water entering the Fortescue Marsh.
- No increases in velocity of peak flows in major creek lines during the Project.
- No expected impact to protected species utilising the tributaries or the Fortescue Marsh systems.
- All surface flow from potentially contaminated areas contained.
- Minimal risk in increase in turbidity during high flow events, although flows in the area are already highly turbid.

These impacts are considered to be acceptable as the key environmental values surrounding the Project will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms. More information on closure management is provided in Section 12. The EPA objective for this factor will be met.

8. VEGETATION AND FLORA IMPACT ASSESSMENT

8.1 Relevant Environmental Objectives, Policies, Guidelines, Standards and Procedures

The following section provides the relevant objectives, policies, guidelines, standards and procedures which were taken into consideration during the impact assessment of vegetation and flora upon implementation of the Project.

8.1.1 EPA Objectives for Vegetation and Flora

The EPA applies the following objective to the assessment of Projects that may affect vegetation and flora:

- To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

8.1.2 Policies and Guidances

Fortescue Marsh Area

Recently the DoW, DEC and OEPA released the *Draft Guideline for Environmental and Water Assessments Relating to Mining Operations in the Fortescue Marsh Area* (DoW,DEC and OEPA 2011). The document divides the Fortescue Marsh area into seven management zones. All zones are further categorised into three levels of conservation significance, high, medium or low.

National Strategy for Conservation of Australian Biodiversity

The State and Australian Governments have endorsed the *National Strategy for Conservation of Australian Biodiversity* and the *National Strategy for Ecologically Sustainable Development* that protects biodiversity. The strategies address the conservation of Australia's biological diversity by defining guiding principles.

National Strategy for the Conservation of Australia's Biological Diversity

The principles of this Strategy are:

- Biological diversity is best conserved in situ.

- Although all levels of government have clear responsibility, the cooperation of conservation groups, resource users, indigenous peoples, and the community in general is critical to the conservation of biological diversity.
- It is vital to anticipate, prevent and attack at source the causes of significant reduction or loss of biological diversity.
- Processes for, and decisions about, the allocation and use of Australia's resources should be efficient, equitable and transparent.
- Lack of full knowledge should not be an excuse for postponing action to conserve biological diversity.
- The conservation of Australia's biological diversity is affected by international activities and requires actions extending beyond Australia's national jurisdiction.
- Australians operating beyond our national jurisdiction should respect the principles of conservation and ecologically sustainable use of biological diversity and act in accordance with any relevant national or international laws.
- Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.
- The close, traditional association of Australia's indigenous peoples with components of biological diversity should be recognised, as should the desirability of sharing equitably benefits arising from the innovative use of traditional knowledge of biological diversity.

National Strategy for Ecologically Sustainable Development

The principles of this Strategy are:

- Decision-making processes should effectively integrate both short-term and long-term economic, environmental, social and equity considerations.
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The global dimension of environmental impacts of actions and policies should be recognised and considered.

- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised.
- The need to maintain and enhance international competitiveness in an environmentally-sound manner should be recognised.
- Cost-effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms.
- Decisions and actions should provide for broad community involvement on issues which affect them.

EPA Position Statement No. 2

EPA Position Statement No. 2, Environmental Protection of Native Vegetation in Western Australia (EPA 2000), provides an overview of the EPA position on the clearing of native vegetation in Western Australia. Principles and related objectives and actions have been adopted from the above mentioned national strategies in the formation of this Position Statement. In assessing a Project, the EPA consideration of biological diversity will include the following basic elements:

- Comparison of development scenarios or options of biodiversity at the species and ecosystems level.
- No known species of plant or animal is caused to become extinct as a consequence of the development and the risks to threatened species are considered to be acceptable.
- No association or community of indigenous plants or animals ceases to exist as a result of the Project.
- There is a comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or in areas which are biologically comparable to the project area, protected in secure reserves.
- If the project is large (in the order of 10 ha – 100 ha or more, depending on where in the State) the project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected.
- The on-site and off-site impacts of the project are identified and the proponent demonstrates that these impacts can be managed.

EPA Position Statement No. 3

EPA Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002), discusses the principles which the EPA would

apply when assessing Projects which may affect biodiversity values in Western Australia. The outcomes sought by this Position Statement are intended to:

- Promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and therefore the need to develop and implement best-practice in terrestrial biological surveys.
- Enable greater certainty for proponents in the EIA process by defining the principles the EPA will use when assessing Projects which may impact on biodiversity values.

EPA Guidance Statement No. 51

EPA Guidance Statement No. 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c), provides guidance on standards and protocols for terrestrial flora and vegetation surveys, particularly those undertaken for the environmental impact assessment of Projects.

Significance of Vegetation

Vegetation is considered significant by the EPA (2004c) for a range of reasons including:

- scarcity
- unusual species
- novel combination of species
- a role as a refuge
- a role as a key habitat for threatened species, or large populations representing a significant proportion of the local or regional total population of a species
- being representative of the range of a unit
- a restricted distribution.

Threatened Ecological Communities (TECs), as listed by DEC and under the EPBC Act are of high significance.

In addition, DEC maintains a list of Priority Ecological Communities (PECs) which identifies those communities that need further investigation before possible nomination for TEC status.

Native vegetation is protected under the EP Act, Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

Significant Flora

The preservation and conservation of flora is covered primarily by the following statutes:

- *Wildlife Conservation Act 1950* (WC Act)
- *Conservation and Land Management Act 1984*
- *Environmental Protection Act 1986* (EP Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act).

The WC Act protects all native flora in Western Australia. Flora considered to be rare are gazetted as Threatened Species under Section 23F of the WC Act. Under the WC Act it is illegal to remove or damage Threatened Species without approval. Threatend Species are specifically scheduled for protection under the WC Act and are species that have been adequately searched for, and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection.

Priority species are those listed by DEC as potentially threatened but for which there is insufficient evidence to properly evaluate their conservation significance. They range from Priority 1 to Priority 4 species (refer to Section 2.5.2 for definitions). Note that of the above classifications, only Threatened Species has statutory standing. The Priority flora classifications are employed by the DEC to manage and classify their database of species considered potentially to be at risk, but these categories have no legislative status for protection in addition to the native vegetation clearing legislation.

Species may also be protected as Matters of NES under the EPBC Act.

8.2 Potential Sources of Impact

Based on available information from the impact analysis undertaken by Cardno in 2012 and attached in Appendix E, the likely impacts of the Project will include:

- Vegetation clearance activities
- Alterations to surface hydrology
- Alterations to groundwater hydrology

- Introduced species
- Alterations to natural fire regimes
- Dust

8.3 Findings of surveys and investigations

The following section outlines the desktop and field studies that were conducted by Fortescue for flora and vegetation for the Project.

8.3.1 Studies Undertaken

Cardno (WA) Pty Ltd (Cardno) was commissioned by the Fortescue in March 2011 to conduct a Level 2 flora and vegetation survey of the larger Nyidinghu Study area, as defined by the *WA Environmental Protection Authority (EPA) Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys of Environmental Impact Assessment in Western Australia* (EPA 2004c).

Field surveys of the Project area were undertaken in two phases, each representing a different season, from 28 March to 21 April 2011 and 4 July to 27 July 2011. The full assessment report is provided in Appendix E.

Previous vegetation surveys conducted by Biota Environmental Services (2004) for the proposed Fortescue Stage A Rail Corridor overlap a large proportion of the Study area.

Differences between the surveys were the sample intensity, the time difference between surveys, and the quality of aerials available for Cardno to undertake the vegetation mapping. In addition, Ecologia Environment completed a Level 1 flora and vegetation survey on behalf of Brockman Resources Limited (tenements M47/1414, M47/1419 and E47-1408) north west of the Project area.

Standards of flora and vegetation surveys have changed in the past decade, with the incorporation of EPA Guidance Statement 51 (EPA 2004c) and the National Vegetation Information System guidelines (Executive Steering Committee for Australian Vegetation Information 2003). For these reasons, the Biota Environmental Services (2004) vegetation mapping was taken into consideration but naming of vegetation units follows NVIS standards (refer to Appendix E).

The following reports were used as technical references:

- Biota (Aug 2004) *Baseline Botanical Surveys for the Fortescue Stage A Rail Corridor.*
- van Vreeswyk et al. (2004) *Inventory and Condition Survey of the Pilbara Region.*
- EPA (2010) *Report and Recommendations for the Marillana Iron Ore Project.*
- Ecologia (2009/2010/2011) Flora and Vegetation Survey for Brockman Resources Limited.
- C Muller Consulting (2005) Water Flow in Mulga Areas Adjoining the Fortescue Marsh (refer to Appendix E).

8.3.2 Vegetation

According to Shepherd et al (2002) and based on Beard (1975), three broad vegetation association as present in the Project area. Refer to Table 29 and Figure 32.

Table 29: Broad vegetation associations identified within the Project area taken from Shepherd et al. (2002)

Vegetation Unit (Shepherd et al. 2002)	Beard Equivelent Mapping Code	Vegetation Description
Fortescue Valley_29	A1Lp	Sparse low woodland; mulga, discontinuous in scattered groups.
Fortescue Valley_82	E16Lrt3Hi	Hummock grassland, low tree steppe, snappy gum over *Triodia wiseana*.
Fortescue Valley_111	E25Srt2Hi	Hummock grasslands, shrub steppe, *Eucalyptus gamophylla* over hard spinifex.

Vegetation Communities

A total of 11 vegetation communities were described and mapped by Cardono within the Project area. Refer to Table 30, Figure 19 and Appendix E.

Table 30: Vegetation associations in the Project area

Community Code	Description
Sand Plain Vegetation-Hummock Grassland Dominated	
CoAdTs- *Triodia* hummock grassland	*Corymbia opaca* and *Eucalyptus gamophylla* isolated trees over *Acacia dictyophleba, Hakea chordophylla* and *Acacia ancistrocarpa* sparse Shrubland over *Triodia schinzii, Triodia basedowii* and *Triodia pungens* hummock grassland.
CoAsTb – *Triodia* hummock grassland	*Corymbia opaca* and *Eucalyptus gamophylla* open woodland over *Acacia sclerosperma* subsp. *sclerosperma, Acacia dictyophleba* and *Acacia inaequilatera* over *Triodia*

Community Code	Description
	basedowii open hummock grassland.
CoAaTp- *Corymbia opaca* open woodland	*Corymbia opaca, Acacia inequilatera* and *Eucalyptus gamophylla* open woodland over *Acacia ancistrocarpa, Petalostylis labicheoides* and *Grevillea wickhamii* subsp. *hispidula* open Shrubland over *Triodia pungens* open hummock grassland.
CoAdTp- *Corymbia* open woodland	*Corymbia opaca and Acacia inaequilatera* open woodland over *Acacia sclerosperma* subsp. *sclerosperma, Acacia dictyophleba* and *Acacia pachyacra* sparse Shrubland over *Triodia epactia* sparse hummock grassland.
Flowline Vegetation	
AcAhCc- *Acacia* open woodland	*Acacia citrinoviridis* and *Acacia pruinocarpa* open woodland over *Atalaya hemiglauca* and *Hakea lorea* subsp. *lorea* isolated Shrubland over **Cenchrus ciliaris* tussock grassland.
AtSaTp- *Acacia* mallee woodland	*Acacia tumida* var. *pilbarensis, Grevillea wickhamii* subsp. *hispidula* and *Gossypium robinsonii* open mallee Shrubland over *Senna artemisioides* subsp. *oligophylla* and *Acacia adoxa* var. *adoxa* sparse heath Shrubland over *Triodia pungens* hummock grassland.
ApAdCc- *Acacia* open woodland	*Acacia pruinocarpa, Corymbia hamersleyana* and *Acacia citrinoviridis* open woodland over *Acacia dictyophleba, Hakea lorea* subsp. l*orea* and *Acacia synchronicia* sparse shrubland over **Cenchrus ciliaris, *Cenchrus setiger* and *Enneapogon polyphyllus* tussock grassland.
Major Creekline	
EvAhCc- *Eucalyptus* open woodland	Acacia citrinoviridis and *Acacia pruinocarpa* open woodland over *Atalaya hemiglauca* and *Hakea lorea* subsp *lorea* isolated Shrubland over **Cenchrus ciliaris* and **Cenchrus setiger* tussock grassland.
Rocky Hill Vegetation	
EIGwTs –*Triodia* sp. Shovelanna Hill hummock grassland	*Eucalyptus leucophloia* open woodland over *Grevillea wickhamii* subsp. *hispidula* and *Acacia bivenosa* sparse Shrubland over *Triodia* sp. Shovelanna Hill (S. van Leeuwin 3835) and *Triodia pungens* open hummock grassland.
Clay/Clay Loam Plains Vegetation- *Acacia aneura* (Mulga) Dominated	
AaEfTp- *Acacia* woodland	*Acacia aneura, Acacia pruinocarpa* and *Acacia aptaneura* woodland over *Eremophila forrestii*, *Acacia ancistrocarpa* and *Acacia tetragonophylla* open Shrubland over *Triodia pungens* open hummock grassland.
AaAsTp	*Acacia aneura, Acacia aptaneura and Acacia pruinocarpa woodland to open woodland over Acacia synchronicia and Psydrax latifolia open Shrubland over Triodia pungens hummock grassland*

Vegetation Condition

The condition of the vegetation in the Project area ranged from Poor to Excellent, under the Trudgen (1991) vegetation condition scale (refer to Appendix E). The sand plain vegetation dominated by hummock grassland was categorized as Good to

Excellent, whilst the flowline vegetation was categorised as Poor to Excellent. The major creeklines were categorised as Poor to Good due to cattle grazing pressure and the presence of the weed Buffel Grass (*Cenchrus ciliaris*). The rocky hill vegetation was categorised as Excellent and the Mulga (*Acacia aneura*) dominated clay/clay loam plains were categorised as Very Good and Excellent.

Threatened Ecological Communities and Priority Ecological Communities

No Threatened Ecological Communities listed under the EPBC Act or by the DEC were identified in the desktop assessment or recorded during the surveys of the Project area (refer to Appendix E).

Two Priority Ecological Communities (PECs) were identified in the desktop assessment in the search area around the Study area (refer to Appendix E). The Fortescue Marsh (Priority 3) occurs on the Fortescue River, east of Mulga Downs, on the Mariliana and Roy Hill Stations approximately 30 km to the north of the Project area.

The Fortescue Valley Sand Dunes (Priority 3) was identified in the north-west of the Study area (refer to Appendix E) and is located approximately 20 km northwest of the Project area. The *Stylobasium* sparse shrubland vegetation community associated with the Fortescue Valley Sand Dunes was not recorded within the Project area.

There will be no direct impact to the Priority 1 Fortescue Marshes Ecological Community or the Priority 3 Fortescue Valley Sand Dune Ecological Community from the proposed project.

Refer to Figure 20 for the location of the PEC communities.

Other Significant Vegetation Communities

Mulga

Mulga is considered to be generally shallow-rooted (likely less than 2 m depth) and to utilise water from shallow surface soils (Ecoscape 2009). Currently it is generally accepted that groved Mulga communities have a strong reliance on sheet flow to replenish soil water in the groves (ENV 2011).

The *Draft Guideline for Environmental and Water Assessments Relating to Mining Operations in the Fortescue Marsh Area* (DoW,DEC and OEPA 2011) highlights the environmental significance of Mulga communities on the Marillana Plain. The

majority of the Project area lies within the Poonda Plain. A proposed road to the north to link with the Munjina-Roy Hill Road is located on the Marillana Plain.

Mulga (*Acacia aneura*) dominated communities (AaEfTp and AaAsTp) are located on clay loam plains to the north-east section of the Project area.

8.3.3 Flora

Flora of Conservation Significance

No Threaten Flora species under the *Wildlife Conservation Act 1950* or the EPBC Act were recorded within the Study area during the flora and vegetation survey (Appendix E). Five Priority Flora species were recorded within the Study area, however no Priority flora species were recorded within the Project area.

Proposed vegetation clearance associated with the Project area should therefore not impact Threaten Flora or Priority species.

Priority Flora recorded in the Vicinity of the Project Area

Refer to Figure 21 for locations of priority flora.

8.4 Evaluation of Options or Alternatives to Avoid or Minimise Impact

The Project has been designed to minimise impact to flora and vegetation by implementing a number of measures including mining above the existing groundwater table, no dewatering requirements, mining activities to be set back from the Weeli Wolli Creek and no major surface drainage will be diverted.

No significant flora or vegetation communities were recorded within the Project area (Appendix E).

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process, areas of vegetation which may comprise high value flora and vegetation may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required.

8.5 Assessment of Likely Direct and Indirect Impacts

The following section outlines the assessment of the likely direct and indirect impacts to flora and vegetation as a result of the implementation of the Project.

8.5.1 Vegetation Clearing

Vegetation clearing is an immediate direct impact that will result from the implementation of the Project. Vegetation clearance will be required for the purposes of establishing mining infrastructure and the camp facilities.

The majority of the proposed vegetation clearing will be in the Sand Plain Vegetation community with minor clearing in the Rocky Hill Vegetation community and in the Clay Loam Plains Mulga community (Table 31 below). There is no clearing proposed in the Weeli Wolli creekline.

Vegetation will be progressively removed from sections of the Project area during the construction of mining infrastructure and during mining. The total disturbance area of the proposed Project is up to 370 ha. The vegetation community, condition and area to be cleared for the mine as well as all associated infrastructure and the haul road are shown in Table 31.

Table 31: Vegetation communities, condition and area proposed to be cleared

Vegetation Communities	Vegetation Condition	Proposed Area to be Cleared (ha)
Clearing for Mining and Infrastructure (M47/1461)		
Sand Plain Vegetation-Hummock Grassland Dominated		
CoAdTs- *Triodia* hummock grassland	Excellent	21
CoAsTb – *Triodia* hummock grassland	Good to Very Good	15
CoAaTp- *Corymbia opaca* open woodland	Excellent	7
CoAdTp- *Corymbia* open woodland	Poor to Very Poor	254
Flowline Vegetation		
AcAhCc- *Acacia* open woodland	Poor to Good	3
AtSaTp- *Acacia* mallee woodland	Very Good to Excellent	1
ApAdCc- *Acacia* open woodland	Poor to Good	1
Major Creekline		
EvAhCc- *Eucalyptus* open woodland	Poor to Good	15

Vegetation Communities	Vegetation Condition	Proposed Area to be Cleared (ha)
Rocky Hill Vegetation		
EIGwTs –*Triodia* sp. Shovelanna Hill hummock grassland	Excellent	7
Clay/Clay Loam Plains Vegetation- *Acacia aneura* (Mulga) Dominated		
AaEfTp- *Acacia* woodland	Very Good to Excellent	1
Total Area cleared for Mine		**325**
Clearing for the Mine Haul Road E47/1320 & E47/1388		
AaEfTp – *Acacia* Woodland	Very good to Excellent	24
ChAdTp – *Corymbia* Open Woodland	Poor to Very Poor	3
AaAsTp – *Acacia* Woodland	Excellent	13
Not Mapped in detail		5
Total Area Cleared for Haul Road		**45**
Total Area Cleared for entire Project		**370**

Threaten Flora and Priority Listed Flora

No Threaten Flora or Priority Listed Flora were recorded in the Project area (Appendix E) and as such the proposed vegetation clearance associated with the Project area should not impact Threaten Flora or Priority species.

Threatened Ecological Communities and Priority Ecological Communities

No Threatened Ecological Communities listed under the EPBC Act or by the DEC were identified in the desktop assessment or recorded during the surveys of the Study area (Appendix E).

The Priority 3 Fortescue Marshes Ecological Community and the Priority 3 Fortescue Valley Sand Dune Ecological Community, are located approximately 30 km and 20 km respectively, outside of the Project area to the north and north-west (Figure 20).

There will be no impact to the Priority 3 Fortescue Marshes Ecological Community or the Priority 3 Fortescue Valley Sand Dune Ecological Community (Appendix E).

The groundwater drawdown from the three proposed production bores will not have any affect on PEC (Section 6.3.2).

Mulga Communities

Approximately 38 ha of Mulga dominated vegetation is proposed to be cleared for the widening of the haul road to the north-east of the Project area. The Mulga communities are located on the Poonda Plain and the Marillana Plain.

Mulga communities delineated in the Project area on clay/clay loam soils are likely to be sheet flow dependent. Alterations in surface water flow as a result of development may potentially impact these Mulga woodlands. Refer to Section 8.5.2 for details.

Regional Impacts on Vegetation

The regional impacts to the Beard (1975) vegetation associations have been assessed using the extent of vegetation associations determined by Shepherd et al. (2002) and Comprehensive Adequate Representation (CAR) remaining extent calculations maintained by the Department of Agriculture. It should be noted that there is likely to be some inaccuracy in the calculation of extent remaining as these have only been determined a scale of 1:250 000 and likely do not include all areas cleared for mining throughout the Pilbara. However, this data is the only available to determine regional impacts.

The EPA, in Position Statement 2 (EPA 2002), outlined several key criteria that should be applied to clearing of remnant vegetation, particularly in agricultural areas:

- The “threshold level” below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30% of the pre-clearing extent of the vegetation type.
- A level of 10% of the original extent is regarded as being a level representing “endangered”.
- Clearing which would put the threat level into the class below should be avoided.

As the data indicates, in Table 32 below, the three vegetation associations have 100% of their pre-European extent remaining. The Project will therefore not comprise the vegetation associations by taking it below the “threshold level” of 30% of its pre-clearing extent (EPA 2000).

Table 32: Impacts on vegetation associations Shepherd et al. (2002) based on Beard (1975).

Beard Code	Association	Vegetation Description	Pre-European Extent (ha)	% Remaining	Extent within Disturbance area (ha)	%Extent of Association within Disturbance area
A1Lp	Fortescue Valley_29	Sparse low woodland: mulga, discontinuous in scattered groups.	7,903,991	100	330	0.004
E16Lrt3Hi	Fortescue Valley_82	Hummock grassland; low tree steppe; snappy gum over *Troidia wiseana.*	2,565,901	100	16	0.0005
E25Srt2Hi	Fortescue Valley_111	Hummock grassland, shrub steppe; *Eucalyptus gamophylla* over hard spinifex.	762,963	100	20	0.0002

8.5.2 Alteration to Surface Water Regime

No major alteration to the drainage of the Weeli Wolli Creek is proposed. There will be minor changes to localised surface drainage through the clearing of vegetation and the installation of infrastructure including a diversion bund.

Adverse impacts to native vegetation and flora associated with altered surface hydrology can be attributed to a number of factors:

- The diversion of stormwater runoff away from flora and vegetation associated with wetlands, drainage channels, and topographical depressions that rely on periodic surface water flows and/or ponding.
- The concentration of surface flows resulting in erosion of drainage lines and loss of flora and damage to vegetation communities and/or deposition of sediment.
- The ponding of water within drainage channels associated with the establishment of infrastructure crossings.
- Localised inception of surface sheet flows associated with the construction of roads, rail and drainage infrastructure can result in die-off of vegetation downslope areas (Appendix E).

Mulga Communities

Surface water dependent vegetation relies on lateral water inputs in addition to rainfall to meet water use requirements. Some species from the Mulga complex (*Acacia aneura* and allied taxa) are regarded as being sheetflow dependent, particularly when growing in banded formations (Equinox 2012).

Surface water flow disruption from road construction and building infrastructure has the potential to alter run-on dynamics for Mulga vegetation (Equinox 2012).

A section of the proposed haul road corridor is located within the Mulga dominated communities AaEfTp and AaAsTp to the north-east of the Project area.

The draft guideline for Environmental and Water Assessments Relating to Mining Operations in the Fortescue Marsh Area (DoW,DEC and OEPA 2011) highlights the environmental significance in relation to surface water of Mulga communities on the Marillana Plain. The majority of the Project area lies within the Poonda Plain management area of the Fortescue Marsh, which does not list Mulga woodland as a key environmental value for surface water management. A section of the proposed haul road from the mine, to link with the Munjina-Roy Hill Road to the north, is

located in Mulga dominated vegetation on the Marillana Plain. Mulga communities that occur on the Marillana Plain are deemed as having a high environmental value for surface water management in the Fortescue Marsh (Appendix E).

A Sheetflow Impact Assessment has been undertaken by Worley Parsons (Appendix F) for those areas potentially impacted to the north of the Mine. Conclusions from the report state that:

- Sheetflow occurs at the Mulga communities for a 1 in 2 year event.
- Only a small portion (less than 10 ha) of the sheet flow dependent Mulga area is affected by the proposed Io mine.

8.5.3 Alterations to groundwater hydrology

The key potential impacts from the alteration to groundwater hydrology are from groundwater drawdown and mounding on vegetation that may be intolerant of waterlogging (Mulga).

Mulga has a shallow root distribution with root zones generally within 2 m of the surface (Ecoscape 2009) and predominantly utilise water from surface runoff. Mulga are therefore not considered groundwater-dependent.

However, Mulga are sensitive to waterlogging and salinity and may potentially be affected by groundwater mounding if groundwater levels resulting from groundwater reinjection, rise to within 2 m of ground surface resulting in prolonged saturation of their root zone.

No dewatering will occur for the mine and therefore no reinjection of ground water into the aquifer below the Mulga vegetation. Mulga therefore will be not affected by groundwater mounding beneath vegetation. Refer to Section 6 describing groundwater.

8.5.4 Introduced species

The Project will involve a range of activities that have the potential to result in the introduction of weed species to the Project area and/or spread existing weed species throughout the Project area. The introduction and spread of weed species will occur due to non-related activities and processes, including dispersal via livestock, native fauna, wind and water (refer to Appendix E).

Activities that have the potential to introduce weed species include the operation of machinery, movement of surface soil, including alteration of drainage patterns.

One introduced species was recorded within the Project area, **Cenchrus ciliaris* (Buffel Grass). This weed is not listed as a Declared Plant under the *Agriculture and Related Resources Protection Act 1976.*

Buffel Grass was the most common introduced species recorded in the Study area. Historically, farmers have purposely seeded **Cenchrus ciliaris* to provide fodder food for their cattle (Hussey et al. 1997). As a result this species is well established within the Project area in communities susceptible to weed invasion, particularly those associated with creeklines.

The potential for environmental degradation due to occur as a result of the introduction or spread of invasive species can be mitigated via the implementation of an appropriately designed and resourced weed management plan as part of the Project.

8.5.5 Alterations to natural fire regimes

The Project will involve a range of activities that have the potential to alter the existing fire regime in terms of both the frequency and intensity of fire experienced. The operation and maintenance of machinery and the presence of a workforce are all factors that have the potential to result in an increase in potential fire ignition sources, with a resultant increase in fire frequency. The same factors also mean that any fire event is more likely to be suppressed due to the potential risk that the fire presents to property or human health and arrangement are likely to be in place to exclude fire from certain sensitive areas (Appendix E).

In general terms any change in the frequency/intensity of fire has the potential to have adverse impacts on the flora species and vegetation occurring in that area. This includes the exclusion of fire from an area, which can result in long-term changes in the vegetation structure, species composition and fuel loads and the eventual occurrence of a high intensity fire with a subsequent series of changes associated with the post-fire regeneration of the vegetation.

Prediction of the likely impact on the Project area's flora and vegetation communities associated with changes to the existing fire regime is complex and requires consideration of a number of factors including:

- The nature of the existing fire regime that characterises the Project area and the extent to which that regime represents an "optimal" regime for a particular species or community type.
- The nature of the fire management regime that will be implemented as part of the Project.

- The duration of the Project.

In respect of the above it is initially recognised that the Project is anticipated to be a relatively short-term land use (4 years) and as such any fire management regime that is implemented as part of the project will be in place for a relatively short period of time (Appendix E).

8.5.6 Dust

There were no recorded flora species or vegetation associations of conservation significance within the Project area. Dust related impacts are likely to be minor provided that appropriate dust suppression measures are implemented.

8.5.7 Summary of predicted direct and indirect impacts

A summary of the predicted direct and indirect impacts to each of the vegetation types within the Project area are shown in Table 33.

Table 33: Maximum direct and indirect disturbance to vegetation communities

Vegetation Communities	Total Area Mapped (ha)	Maximum Direct Disturbance (ha)	Percentage of Mapped Vegetation Communities
Sand Plain Vegetation-Hummock Grassland Dominated			
CoAdTs- *Triodia* hummock grassland	567.3	21	3.73
CoAsTb – *Triodia* hummock grassland	1272.0	15	1.19
CoAaTp- *Corymbia opaca* open woodland	347.9	10	1.93
CoAdTp- *Corymbia* open woodland	2974.1	254	8.57
Flowline Vegetation			
AcAhCc- *Acacia* open woodland	934.5	3	0.36
AtSaTp- *Acacia* mallee woodland	62.0	1	2.26
ApAdCc- *Acacia* open woodland	2490.3	1	<0.001
Major Creekline			
EvAhCc- *Eucalyptus* open woodland	617.8	15	2.56
Rocky Hill Vegetation			
EIGwTs –*Triodia* sp. Shovelanna Hill	420.0	7	2.15

Vegetation Communities	Total Area Mapped (ha)	Maximum Direct Disturbance (ha)	Percentage of Mapped Vegetation Communities
hummock grassland			
Clay/Clay Loam Plains Vegetation- Acacia aneura (Mulga) Dominated			
AaEfTp- *Acacia* woodland #	735.9	25	2.66
AaAsTp Acacia Woodland	2443.6	13	0.56
Unmapped	0	5	-

8.6 Cumulative Impacts

The main potential cumulative impact on vegetation and flora is the combined effect of clearing of conservation significant vegetation communities from nearby mining operations.

Cumulative impacts from the clearing of Mulga communities from the following projects has been calculated (FMG 2011b):

- Roy Hill Mine– Stages 1 and 2.
- Christmas Creek Mine – approved project and Water Management Scheme Project.
- Cloudbreak Mine – approved project and Project.
- Fortescue Port Hedland to Christmas Creek Rail Duplication Project.

The potential cumulative loss of Mulga communities from the above projects is 22,430 ha (with 85,303 ha of Mulga remaining) (FMG 2011b).

This Project proposes to clear approximately 38 ha of Mulga community.

8.7 Management Measures and Performance Standards

8.7.1 Ground Disturbance

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that

where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage line and Mulga).

If required, further surveys are conducted prior to clearing.

Management measures and performance standards for each potential impact are outlined in Table 34:

Table 34: Management measures and performance standards for each potential impact

Potential Sources of Impact	Management Measures	Performance Standards
Vegetation clearing	All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing. Clearing and disturbance of vegetation will be kept to a minimum. Impacts to vegetation and flora will be managed under the Biodiversity Management Plan.	Ground Disturbance Permit Biodiversity Management Plan
Alterations to surface hydrology will be used to identify areas for culverts in the haul road.	A Sheetflow Impact Assessment (Appendix F).	Surface Water Management Plan Recommendations from Sheet Flow Impact Assessment
Alterations to groundwater hydrology	Mulga vegetation will not be subject to injection of surplus water into aquifers and will therefore not be affected by groundwater mounding beneath vegetation.	Groundwater Management Plan in the EMP
Introduced species	The potential for environmental degradation due to occur as a result of the introduction or spread of invasive species will be mitigated through the implementation of a weed management plan (refer to Appendix E).	Implement the Weed Hygiene and Management Plan prior to construction
Alterations to natural fire regimes	To minimize the potential for adverse changes to the structure and floristic composition of the vegetation of the Project area a fire management/prevention plan will be implemented. This plan will aim to: • Eliminate (or actively suppress) uncontrolled fires originating from mining activities. • Allow fire not triggered by mining activities to occur within those parts of the Project area that do not require protection due to the presence or infrastructure or consideration of human health and safety (Appendix E).	Implement the Fire Management Plan.
Dust	Dust suppression measures will be implemented to minimise the impact of dust from cleared areas and vehicle movement.	Implement the Dust Management Plan.

8.7.2 Environmental Management Plan

Relevant areas of Fortescue's Cloudbreak EMP will be implemented for this Project. The EMP is comprised of management sub-plans that describe specific environmental objectives and targets for each environmental factor, the management measures to be applied to avoid and minimise the environmental impact of the Project, monitoring to measure the performance of management against the targets, and contingency measures to mitigate unavoidable or accidental impact.

8.8 Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures

The Project is expected to result in the following outcome in relation to flora and vegetation:

- Approximately up to 370 ha of vegetation will be disturbed by the Project, with the majority of this occurring in *Triodia* hummock grassland Sand Plain vegetation.
- 38 ha of Mulga vegetation will be directly cleared by the Project.
- No TEC's, Priority Ecological Communities, Threatened Species or Priority listed flora will be affected by the proposed project.
- Proposed vegetation clearing and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the "threshold level" of 30% of its pre-clearing extent.

9. FAUNA

9.1.1 EPA Objectives

The EPA applies the following objectives in assessing Projects that may affect fauna:

- To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge
- To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.

9.1.2 EPA Statements and Guidelines

EPA Position Statement No. 3

EPA Position Statement No. 3 (EPA 2002) discusses the principles the EPA would apply when assessing Projects that may have an effect on biodiversity values in Western Australia. The outcomes sought by this Position Statement are intended to:

- Promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and, therefore, the need to develop and implement best practice in terrestrial biological surveys.
- Enable greater certainty for proponents in the environmental impact assessment process by defining the principles the EPA will use when assessing Projects that may have an effect on biodiversity values.

EPA Guidance Statement No. 56

EPA Guidance Statement No. 56 (EPA 2004b) provides guidance on standards and protocols for terrestrial fauna surveys, particularly those undertaken for the Environmental Impact Assessment of Projects.

EPA Guidance Statement No. 20

EPA Guidance Statement No. 20 (EPA 2009) provides guidance on standards and protocols for surveys for Short Range Endemics (SRE) fauna, particularly those undertaken for the Environmental Impact Assessment of Projects.

9.1.3 State Regulatory Framework

State Protection

The preservation and conservation of fauna is covered by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WA) (WC Act)
- *Conservation and Land Management Act 1984*

In WA, rare or endangered species are protected by the *Wildlife Conservation (Specially Protected Fauna) Notice 2008*, under the WC Act. Schedules 1 and 4 in this Notice are relevant to this assessment, providing a listing of the species protected by this Notice. The conservation status definitions are as follows:

- **Schedule 1 (S1)** Fauna that is rare or likely to become extinct.
- **Schedule 2 (S2)** Fauna that is presumed to be extinct.
- **Schedule 3 (S3)** Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds.
- **Schedule 4 (S4)** Fauna that is in need of special protection, otherwise than for the reasons mentioned above.

Fauna are also listed by DEC as Priority species if they are potentially threatened but for which there is insufficient evidence to properly evaluate their conservation significance. They range from Priority 1 to Priority 4 species, and are described in section 2.5.2.

Note that the Priority status does not have statutory standing. The Priority fauna classifications are employed by the DEC to manage and classify their database of species considered potentially to be at risk, but these categories have no legislative status for protection in addition to the native vegetation clearing legislation.

9.1.4 International Agreements

Australia is party to the Japan-Australia (JAMBA), Republic of Korea- Australia (ROKAMBA) and China-Australia (CAMBA) Migratory Bird Agreements.

9.2 Potential Sources of Impact

Each stage of the Project (construction, operation and closure/rehabilitation) has the potential to affect the abundance, distribution and condition of conservation significant fauna within the Project area and surrounds. Potential impacts of the Project on terrestrial fauna of conservation significance include:

- Loss and/or degradation of regional representation of fauna habitat resulting in a direct loss of species, fragmentation effects and reduced breeding and foraging habitat.
- Injuries to and mortalities of fauna caused by interactions with vehicles, infrastructure, machinery and the workforce.
- Reduced diversity or abundance of foraging resources due to an altered hydrological regime.
- Presence of artificial water bodies (turkey dams) may result in the impact to native fauna through increases in introduced fauna, entrapment, or alteration of fauna behaviour.
- Alteration in behaviour of fauna due to dust, noise, vibration and light emissions.
- Increased presence of non-indigenous species due to introduction of workforce and vehicles, inappropriate waste collection and disposal practices, and inadequate rehabilitation of disturbed land, resulting in fauna mortality and/or competition for resources.
- Increased fire potential from the presence of human activity in the area, resulting in the modification or loss of fauna habitat and conservation significant fauna.
- Increased levels of dust may affect the quality of available habitat for shelter and foraging.

9.3 Findings of Surveys and Investigations

9.3.1 Studies Undertaken

Vertebrate Fauna

Desktop survey

A desktop review of terrestrial fauna was undertaken by Bamford Consulting Ecologists (BCE) (Appendix G). The purpose of this study was to consolidate previous survey information in order to provide sufficient information to the EPA to assess the impact of the Project on vertebrate fauna of the Study area. This study utilised several databases including:

- NatureMap (which incorporates the Western Australian Museum's FaunaBase and the DEC Threatened and Priority Fauna Database).
- Birds Australia Atlas Database.
- EPBC protected matters database and BCE internal databases.
- Results of previous surveys undertaken by Ecologia during 2009 from areas close to the Project area (Ecologia 2009).

- Published information relating to the distribution of fauna species expected to be present within the Study area was also included.

Field Survey - Phase 1

Phase 1 of a Level 2 vertebrate fauna survey (reconnaissance and detailed field investigations) (EPA 2004b) of the Study area by BCE from 7 to 17 April 2011 comprised of five sites which were targeted for systematic trapping within representative fauna habitat types identified by BCE across the Study area. At five sites, replicated trapping grids were positioned and trapped fauna were recorded over seven consecutive nights using a combination of pitfall traps with drift fences, Elliot box traps and funnel traps (Appendix G). Trap sites 2 and 3 were located within the Project area (Figure 23).

Bird numbers and species were recorded each morning at the five trap sites. Bats were surveyed using two methods. A two-tiered harp-trap was set from 8 to 11 April 2011 at Weeli Wolli Creek crossing near Site 3. Ultrasonic recording units were set at two locations at two creek crossings of Weeli Wolli Creek to record bat echolocation calls for later identification. Spotlighting from vehicles took place whenever night travel occurred, including when returning from sites after sunset and during one night of the survey period. When spotlighting, vehicle speeds were kept low (<20 km/h) and personnel used car headlights and hand-held spotlights to search for fauna species. Head-torching (two or three personnel on each occasion) took place at Weeli Wolli Creek (8th and 14th April), in gorges near Site 3 (11 April 2011), in Priority area 2b (13 April 2011) and at the Yandi Road crossing of Weeli Wolli Creek (15 April 2011). Approximately 20 person-hours were spent head-torching.

Field survey - Phase 2

The second phase of the field survey involved targeted searches for conservation significant species identified during the Phase 1 Survey as potentially occurring in the the Study area by BCE from 16 to 24 June 2011. The survey aimed to determine the status of the Northern Quoll and Pilbara Leaf-nosed Bat. The Northern Quoll (*Dasyurus hallucatus*) was targeted using cage and Elliot traps.

The Northern Quoll survey was designed in accordance with the National Northern Quoll Survey Guidelines (SEWPAC 2011). Three trap sites were established across the Study area, one which falls within the Project area, two which are located within 2 km of the Project area boundary, in locations previously identified as potential Northern Quoll habitat (Figure 23). Twenty-five cage traps and 55 Elliot traps were installed across the three sites and checked daily, over seven consecutive trap-nights. The three trap sites were positioned in different locations from those used during the Phase 1 survey.

Equipment to record bat calls (ANABAT SD series, Titley Electronics, Ballina, NSW) were deployed for two nights at two different locations during Phase 2 (at sites 1 and 3). Analysis of recordings was conducted by Mr Bob Bullen of Bat Calls Australia. During Phase 1, eight nights of recordings were also made at other locations over the Study area. Specifically the recording

devices were set to target the calls of the Pilbara Leaf nose Bat (*Rhinonicteris aurantia*) and the Ghost Bat (*Macroderma gigas*).

Transect searches were conducted specifically to identify (including records of indirect evidence such as burrows and tracks) conservation significant species. Three people were spaced approximately 50 m apart for a total transect-length of approximately 5 km. In particular the Greater Bilby and Mulgara were targeted (Figure 4 in Appendix G).

Short Range Endemic (SRE) Invertebrates

Desktop Review

A desktop review was undertaken by Dalcon Environmental to identify the occurrence of potential and confirmed SRE fauna within the Study area, to aid in the identification of potential SRE habitat within the Project area, and to assist in the analysis and conservation significance of the field survey results.

The desktop review included the following sources of information limited to a 150 km area surrounding the Study area:

- previous Dalcon Environmental surveys within the surrounding region
- other consultancy surveys
- journal articles
- books
- Department of Environment and Conservation database searches

Field survey

A baseline SRE invertebrate fauna survey of the Study area was undertaken between 7 April and 24 May 2011 (Appendix H). The EPA recommends SRE fauna surveys are conducted within the cyclone season (November – April) and therefore the results of Phase 2 of the SRE field surveys fell marginally outside of the optimal timeframe for surveying species presence (EPA 2009).Due to an unusually high rainfall and wet ground conditions for sampling, the timeframe for Phase 2 of the field surveys are considered adequate.

Thirteen sampling sites were used across the Study area following inspection of aerial photographs for vegetation complexes and topographic features suitable for SRE fauna. Three of the 13 sampling sites were within the Project area (site 6, 7, and 9), and one was within 1 km of the Project area (site 8) (Appendix H, Figure 24).

A combination of trap types, hand foraging, leaf litter collection, burrow excavation, light trapping and UV night searches were incorporated in the survey. Site 6 included wet, dray and light traps, site 7 included wet and light traps, and sites 8 and 9 included wet, light and hanging

traps. Specimens belonging to known SRE taxa were forwarded to expert taxonomists for identification.

Subterranean Fauna

Field Surveys

Bennelongia Environmental Consultants (Appendix I) undertook Field surveys for subterranean fauna, including surveys for both stygofauna and troglofauna were conducted in accordance with the guidelines outlined within the EPA Guidance Statements 54 and 54a (EPA 2003, 2007) (Appendix I) Samples for troglofauna and stygofauna were collected from exploration drill holes and pastoral bores within the Study area. Reference samples that have been collected by Bennelongia from areas within the Pilbara were used to compare recorded specimens during this survey.

Troglofauna

Two sampling techniques were used to collect troglofauna:

- Scraping – troglofauna were collected by lowering a net (150 µm) to the bottom of the bore or to the level of the water table and scraping along the surface of the bore walls.
- Trapping – custom made PVC cylindrical traps were baited with sterilized leaf litter and lowered to within a few meters of the water table or to the depth of the bore. Every fourth bore was baited with a second trap, positioned mid-way down the bore. Traps were set from 9 to 13 March 2011 and were retrieved on 4 and 5 July 2011. Bores were sealed while traps were set to minimise the ingress of surface invertebrates.

Stygofauna

The majority of stygofauna were collected during the 9 to 13 March 2011 survey period, however, collections from earlier years (July 2005 and July 2006) from within the Study area were also included in the analysis. Impact and reference bores were sampled to collect stygofauna species. Six hauls using weighted plankton nets were collected from each bore; three of the hauls were taken using a 50 µm size mesh net and three were taken using a 150 µm size mesh net. The contents were transferred to a 125 ml polycarbonate vial and preserved in 100% ethanol for subsequent identification of species present.

9.3.2 Terrestrial Fauna Habitats

Five habitat types were identified from the Study area (Figure 22). Four of these are found within the Project area (Figure 23). The four habitat types include (refer to Appendix G for photographs of each habitat type):

- Mulga over buffel grass on red clayey loam.

- Open low shrubland of mixed acacia over spinifex on red sandy loam plain.
- Open low shrubland of mixed acacia over spinifex on rocky/gravelly lower slopes of hills.
- Open woodland of eucalypts over buffel grass on brown rocky loam bordering Weeli Wolli Creek.

9.3.3 Occurrence of Vertebrate Fauna

Desktop studies of potential fauna abundances for the larger Study area identified 317 vertebrate fauna species that may either potentially occur or have previously been recorded in the surveyed area. This total included 158 species of birds, 38 species of native mammals, 9 species of introduced mammals, 104 species of reptiles, five species of amphibians, and 3 species of fish. Surveys within the Study area recorded 67% of the fish species, 40% of the amphibians, 50% of the reptiles, 45% of the native mammals, 55% of the birds and 33% of the introduced mammals potentially occurring in the area. Within the Project area two conservation significant species were observed and one species was observed within the Study area (Figure 22).

9.3.4 Vertebrate Species of Conservation Significance

Based on previous surveys, database and literature searches from surrounding areas of the Study area (Appendix G), there is the potential for 28 species of conservation significance to occur in the area (Table 35 and 36). Of these, 19 species are listed under Commonwealth (EPBC Act) or state (WC Act) legislation. Nine of these species are listed as Priority fauna by the DEC.

The Fork-tailed Swift, Eastern Egret and Australian Bustard were all recorded in the Study area most of which were recorded over 10 km north of the Project area towards the Fortescue Marsh. Anecdotal evidence indicates the Pilbara Olive Python (*Liasis olivaceus barroni*) may occur within the Study area.

Species of Conservation Significance in the Project Area

Two species of conservation significance were directly observed within the Project area; the Rainbow Bee-eater (*Merops ornatus*) and the Peregrine Falcon (*Falco peregrinus*). Inactive mounds of the Pebble Mound Mouse (*Pseudomys chapmani*) were also recorded within the Project area.

A summary of species across the vertebrate fauna assemblage expected and recorded within the Study area during 2011 (Phase 1 and 2 surveys*) is shown in Table 35. Recorded conservation significant fauna are also indicated for the Project area.

Table 35: Summary of species across the vertebrate fauna assemblage expected and recorded within the Study area.

	Study area (includes Project area)				Project area
	No. of species		No. of conservation significant fauna		No. of conservation significant fauna
Fauna Group	Expected	Recorded	Expected	Recorded	Recorded
Fish	3	2	0	0	0
Frogs	5	2	0	0	0
Reptiles	104	52	2	0	0
Birds	158	86	18	5	2
Native Mammals	38	17	8	0	0
Introduced mammals	9	3	0	0	0
Total	317	162	28	5	2

* Data provided by Bamford Consulting Ecologists

Table 36: Conservation significant fauna present or with the potential to occur in the Study area (listed for each taxa in descending order of conservation importance).

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
Reptiles						
Pilbara olive python (*Liasis olivaceus barroni*)	VU	S1	Likely	Olive-brown to pale fawn or rich brown coloured python with white/cream belly, pitted anterial scales bordering the lips and smooth scales in 55-80 rows at mid-body. Up to 4 m in length, but average is 2.5 m.	Gorges and escarpments and rocky outcrops, areas of permanent water which attract sizeable prey.	Recorded from the Weeli Wolli Creek area (DEC 2011b) and was reported to have been seen by Marillana Station personnel from sites within the Study area. Likely to be present within the rocky areas and along water courses in the Project area.
Blind snake (*Ramphotyphlops ganei*)	-	P1	Possible	Blind snake on average 30 cm in length.	Unknown, but possibly associated with moist gorges and gullies.	Species is known only from a small number of voucher specimens collected from the Pilbara region (DEC 2011b). Suitable habitat present in gullies throughout areas of Spinifex.
Birds						
Night parrot (*Pezoporus occidentalis*)	EN	S1	Possible	Medium-sized parrot measuring 22 to 25 cm in length, with a wingspan of 44 to 46 cm. The adults are predominantly bright green in colour, but with black and yellow bars, spots and streaks over much of the body, bright yellow colouring on the belly and vent, and black colouring on the upper surfaces of the periphery of the wings and tail.	Inhabits arid and semi-arid areas that are characterised by having dense, low vegetation. *Triodia* grasslands in stony or sandy environments and of samphire and chenopod shrublands, including genera such as *Atriplex*, *Bassia* and *Maireana*, on floodplains and claypans, and on the margins of salt lakes, creeks or other sources of water.	Recorded northern side of the Fortescue Marsh on Mulga Downs Station (Davis and Metcalf 2008).

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
Fork-tailed swift (*Apus pacificus*)	Mig	S3	Likely (recorded within Study area)	A medium-sized swift, weighing about 30 to 40 g, with a length of approximately 20 cm and wingspan of 40 cm. It has a white band across its rump but is otherwise mostly black. This species has a characteristic deeply-forked tail.	Almost entirely aerial, particularly associated with storm fronts. It may be found near foothills and cliffs in coastal areas.	Small flock (approximately 10 birds) observed in area near site 1 during the Phase 1 surveys on 8 April 2011. This species is mainly aerial and may not utilise habitat in the area directly.
Eastern great egret (*Ardea modesta*)	Mig	S3	Possible (recorded at Fortescue Marsh)	A moderately large bird (83–103 cm in length, 700–1200 g in weight) with white plumage, a black or yellow bill and long reddish and black legs. The colours of the bare parts change during the breeding season. Often occur solitarily, or in small groups when feeding. They roost in large flocks that may consist of hundreds of birds. Colonies may be mono-specific or commonly mixed.	Floodwater, rivers, shallows of wetlands, and intertidal mudflats. Suitable hunting habitat when surface water present in Fortescue Marsh.	Observed on 17 April 2011 during a survey of the Fortescue Marsh. Some potential habitat along creek lines within the Project area.
Rainbow bee-eater (*Merops ornatus*)	Mig	S3	Recorded in the Project Area	A small bird weighing 20 to 25 g and growing up to 24 cm in length. Adults have a pale green forehead extending back as a line over the eye. The crown and nape are orange-brown or cinnamon rufous with the crown sometimes washed with green. A black stripe runs from the bill through eye to ear coverts bordered	Found across the better-watered parts of Western Australia. It prefers lightly wooded habitats, preferably on sandy soils near water. Rainbow bee-eaters are scarce to very common across their range depending on suitable habitat conditions.	Recorded regularly at fauna trapping Site 2 in the River Land System within the Project area, and is expected to be a regular breeding migrant to the project area. It is possibly resident.

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
				below with pale blue. Their lower back is pale blue and becomes darker on tail coverts. The tail is black.		
Peregrine falcon (*Falco peregrinus*)	-	S4	Reorded in the Project Area	A large falcon (wingspan of around 80 to 120 cm), with a blue-gray back, barred white underparts, and a black head and 'moustache'. Its diet consists almost exclusively of medium-sized birds, and will occasionally hunt small mammals, small reptiles or even insects.	Utilises rocky escarpments and gorges, cliffs, tree lined watercourses, open woodland and *Acacia* shrublands. Breeding occurs within cliffs and tree hollows, preferably near to water.	A pair was recorded over Site 2 (Phase 1) on 8 April 2011 which is within the Project area. A pair is regularly observed in Mulga woodland on the northern edge of the Fortescue Marshes on Mulga Downs Station (Appendix G).
Grey falcon *(Falco hypoleucos)*	-	P4	Likely	A medium falcon weighing between 350 and 600 g with grey upperparts and white underparts with darker tips on flight feathers. Diet consists of mainly birds, but also small mammals, reptiles and insects.	Lightly wooded coastal and riverine plains associated with inland ephemeral and permanent drainage systems where annual rainfall is less than 500 mm.	Has been recorded in the vicinity of the project area from the northern side of the Fortescue Marsh (Appendix G). Wide-ranging species. Some suitable habitat for hunting and breeding along creek lines in the Project area.
Australian bustard (*Ardeotis australis*)	-	P4	Recorded in the Study Area	Large ground bird of grassland, woodland and open agricultural country. Males grow up to 1.2 m tall, with a 2.3 m wingspan and a weigh up to 7.5 kg.	Open grasslands, spinifex hummock grassland, chenopod flats, low heath and grassy woodland.	Tracks were found over the Study area during both surveys, and a road-killed juvenile was found alongside the BHP railway in April. Suitable habitat is present in Project area.
Bush stone-curlew *(Burhinus grallarius)*	-	P4	Likely	Large bird standing between 50 and 60 cm high, with long legs, large yellow eyes, and grey-streaked upper parts. Diet consists of frogs, insects,	Open forests and woodlands with a sparse grassy ground layer and fallen timber along ephemeral or permanent watercourses. Day time	The species is likely to be resident along Weeli Wolli Creek, however, this species is notoriously cryptic when not calling.

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
				molluscs, crustaceans, and reptiles, mostly gleaned from soft soil or rotting wood.	shelter of thickets or long grass.	
Star finch *(Neochmia ruficauda subclarescens)*	-	P4	Possible	This finch has a bright red face and beak, an olive green back with a beige-yellow underbelly. Tiny white star like dots cover the crown of the head circling around the outer edge of the eyes to the cheeks and extending from the chin to the chest then down the flanks. The diet consists of seeds, vegetative material, termites and insect larvae.	Lush, green woodland vegetation along temporary or permanent watercourses, the margins of swamps or in green crops, particularly in thick reed beds.	Probably common in the upper reaches of Weeli Wolli Creek.
Mammals						
Northern quoll (*Dasyurus hallucatus)*	EN	S1	Possible	The northern quoll is the smallest of the four smallest of the Australian quoll species where adult males weigh between 340 – 1120 g and females between 240 – 690 g. It has a pointy snout and reddish brown fur, with a cream underside. It has white spots on its back and rump and a long, sparsely-furred, unspotted tail.	Rocky areas, also eucalypt forest and woodland.	Previously recorded in the Hamersley Ranges south of the Fortescue Marshes (DEC 2011b). Areas of rocky breakaways adjacent to southern part of Project area that may provide a small amount of suitable habitat.
Mulgara (*Dasycercus blythi)* / brushtailed mulgara (*D. cristicauda*)	VU -	S1 P4	Likely	A carnivorous marsupial with a pointed snout and short rounded ears. Adults can weigh between 60 and 110 g. May live for more	Spinifex grasslands on sandy soils, constructing burrows on the flats between sand dunes. Sandy habitat such as	There is a recent (2011) record from a few kilometres south of Site 3 (refer to Appendix G) and the species is likely to be

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
				than six years. Light sandy brown fur above greyish white below. The hairs are reddish on the base of tail and black on the distal two thirds. This species lacks a well-defined pouch. The two species were until recently considered the same species (Van Dyck and Strahan 2008).	*Acacia*, Spinifex on Sandplain, particularly where mature, long-unburnt hummocks of Spinifex exist.	resident in low numbers.
Greater bilby (*Macrotis lagotis*)	VU	S1	Unlikely	Rabbit-sized marsupial, long blue-grey fur over most of body with white to cream on the belly. Large ears, long pointed snout and a black tail with a white tip. Grows to 55cm long.	Spinifex hummock grassland and *Acacia* scrub.	There are some historic (early 1980s) records of the Bilby on Marillana Station, but the species is probably locally extinct.
Pilbara leaf-nosed bat (*Rhinonicteris aurantia*)	VU	S1	Unlikely	Moderate-sized bat with short fur, relatively small ears and a fleshy noseleaf structure surrounding the nostrils. It weighs from 8.7–9.3 g and has a forearm length of 45.2–47.8 mm (Armstrong 2008). Sexes are mostly similar in size.	Roosts in caves with high humidity and temperature.	The largest colonies were observed at Bamboo Creek mine and in a small cave in Barlee Range Nature Reserve. No suitable roosting habitat but may forage within the Project area.
Spectacled hare wallaby (*Lagorchestes conspicillatus*)	-	P3	Unlikely	The spectacled hare-wallaby is a medium sized stocky marsupial ranging from 1.6 to 4.75 kg as an adult. It is typically brown above, with white tipped hairs, pale grey to white below with a bright orange to rufous ring around its eyes. Its tail is sparkly	Triodia hummock grasslands and *Acacia* shrublands, Spinifex over sandplain.	Has drastically declined in Pilbara region, although abundant on Barrow Island.

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
				haired. Diet consists of grasses, shrubs and herbs.		
Long-tailed dunnart (*Sminthopsis longicauda*)	-	P4	Possible	Small carnivorous marsupial with a very long (twice its body length), scaly, brush tipped tail. Adults weigh between 15 and 25 g. Dorsal grey colour and ventral pale cream to white colour, the legs and feet are white. It has a flattened head with a long snout.	Rocky habitat with Spinifex or open habitat with a rocky mantle. Occurs in arid rocky areas generally on flat topped hills, plateaus and rocky scree slopes within the Pilbara.	The species is probably resident in the Boolgeeda Land Systems around Site 3 (Phase 1 survey), but may be more common in habitats outside the Project area in the Hamersley Ranges.
Pebble-mound mouse (*Pseudomys chapmani*)	-	P4	Likely	Brown coloured mouse weighing between 12 and 15 g. They construct mounds of pebbles around their burrows.	Restricted to pebbly soils in arid tussock grassland and *Acacia* woodland in non-coastal, central and eastern parts of the Pilbara, Western Australia.	Pebbly soils are typical of the Boolgeeda Land System of Site 3 in the Project area. A few mounds of the species were found in this general location. The mounds did not appear active. Active mounds have been found just south of the Study area (refer to Appendix G).
Northern short-tailed mouse/ Lakeland downs mouse (*Leggadina lakedownensis*)	-	P4	Likely	A grey brown to grey mouse with a pure white underside. Adults on the mainland typically weigh between 15 and 20 g. Their diet comprises primarily of invertebrate material and will consume plants to supplement their water requirements.	Spinifex and tussock grassland on cracking clays. Also *Acacia* shrubland, Samphire, woodlands and stony ranges.	Likely to occur within the some areas of the Project area, particularly Site 2 (Phase 1 survey).
Ghost bat (*Macroderma gigas*)	-	P4	Possible	One of the largest microbats in the world, weighing between 74 and	This species occupies a variety of habitats from the arid Pilbara to the	Record of individual foraging along edge of Fortescue Marsh. Unlikely

Species	Conservation Status EPBC Act	State[2]	Liklihood of occurrence in study area	Description of species	Habitat	Status in study area
				144 g. They have grey backs and pale grey or white fur on their undersides. Largely insectivorous, but will also consume frogs, lizards, and other small animals.	rainforests of Northern Queensland. Roosts in undisturbed caves usually with several entrances, in deep fissures or abandoned mine shafts.	to be suitable roosting habitat within Project area, but a likely forager in the area.

[1] EPBC Act conservation status definitions:

Endangered (EN) A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU) A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.

Migratory (M) Species migrate to, over and within Australia and its external territories.

[2]For State definitions, refer to sections 2.5.2 and 9.1.3..

9.3.5 Occurrence of Short-Range Endemic (SRE) Invertebrates

The desktop survey for short-range endemic species within 150 km surround of the Study area identified 24 SRE species from five taxa. Three species identified as confirmed SRE species, are unlikely to occur within the Study area. Nine species (from Mygalomorphae and two from Gastropoda) taxa were identified as potential SRE fauna and may occur within the Study area. Surveys were designed to include habitats considered favourable to these potential SRE species over the Study area. The number of species for each taxa identified to potentially occur within the Study area include:

- 10 Mygalomorphae
- 5 Scorpiones
- 4 Pseudoscorpionida
- 4 Gastropoda
- 1 Diplopoda

A total of 40 different invertebrate species were collected from 13 trap-sites deployed by Dalcon Environmental during April 2011 within the Study area. One species was identified as a confirmed SRE species at trap site 3 (far north-west area of the Study area), (Appendix H, Figure 24), however, this species was not recorded within the Project area. Three species were recorded from within (or very close to) the Project area. These potential species were from Chernetidae (spider), and Philoscidae (crustacean) and Planorbidae (gastropod) families (Figure 24).

9.3.6 Occurrence of Subterranean Fauna

Troglofauna

Sampling for troglofauna from 121 different bores over the Study area yielded 72 specimens representing 15 species from 12 Orders of invertebrates. Three of the drill holes sampled were within the proposed area for the mine pit and no troglofauna were recorded (Appendix I). The Orders represented included two arachnid Orders (Schizomida and Araneae), one crustacean Order (Isopoda), one Chilopoda species, two Orders of Diplopoda (Polydesmida and Spirobolida), six Orders of hexapods (Diplura, Thysanura, Hemiptera, Coleoptera and Dipter). Five of the 15 species recorded from the Study area are known to occur outside of the Study area within the Pilbara. Four species are known only from bores within the Study area, of which 25 specimens of Polydesmida sp. B7 (millipede) were collected from one bore location (Appendix I). Polydesmida millipedes are rarely collected in the Pilbara, however, it is likely that this species is probably locally restricted but has a larger distribution range than what is understood from data collected within the area (Appendix I). Only single specimens were

collected for three other species known only from within the Study area. These included a centipede (Chilenophilidae sp B4), a pseudocentipede (*Symphyella* sp.) and a bristle-tail (Projapygidae sp. B9). The Chilenophilidae is unlikely to be threatened by mine development, even though species from Chilenophilidae are rarely collected from the Pilbara (Appendix I).

Stygofauna

Sampling for stygofauna from 93 different bores over the Study area yielded 392 specimens representing 19 species from nine Classes/Orders of invertebrates. This included worm species from Nematoda, Aphanoneura and Oligochaeta and crustacean species from Ostracoda, Copepoda, Spelaeogriphacea, Syncarida, Amphipoda and Isopoda. Only one stygofauna species, *Pygolabis* sp. B6, was recorded from one bore within the predicted Project drawdown (Figure 5.2 in Appendix I). *Pygolabis* sp. B6 was also collected outside the Project area and has previously been collected outside the area (in Marillana Creek). It may reasonably be inferred that many of the other 18 species in the vicinity also occur in the drawdown cone. However, all of these species are known, or are considered, to have at least sub-regional distributions and they are not under potential conservation threat.

The critical issue for assessment is whether any uncollected species occur in the drawdown cone and are restricted to it. Given that the area of groundwater drawdown by 1 m is only 15 ha, it is very unlikely that any species is restricted species is present or that such a species would be threatened. No Pilbara species of stygofauna are known to have a range as small as 15 ha and most within the Pilbara have at least catchment-scale distributions.

9.4 Evaluation of Options or Alternatives to Avoid or Minimise Impact

The scope to consider alternative locations for the Project area to avoid or minimise impact is limited as the location of the mine is dictated by the extent of the resource. The proposed location of mine infrastructure including the a significant proportion of the mine pit, the mine waste stockpile, the existing exploration camp and proposed accommodation village are situated within fauna habitat of open low shrubland of mixed acacia over spinifex on red sandy loam plain (Figure 23). One terrestrial fauna species was recorded in this area and listed as Migratory under the EPBC Act, Rainbow Bee-eater (*Merops ornatus*). The bee-eater is also listed as a Schedule 3 species under the WC Act. The second species listed under the WC Act recorded in the Project area was the Peregrine Falcon (*Falco peregrinus*) which is listed as a Schedule 4 species (Figure 22). Both species are widespread outside of the Project area.

The open woodland of eucalypts over buffel grass on brown rocky loam bordering Weeli Wolli Creek will be minimally disturbed (approximately 4 ha; Table 37). This habitat may include trees bearing hollows which a number of fauna species, including conservation significant species, may utilise for breeding and/or habitat use. A water infrastructure corridor (pipeline) is proposed to be built (Figure 23). The pipeline (made from PVC plastic of approximately 100 mm diameter) will be laid on the ground alongside an existing light vehicle road. Clearing of large habitat trees (that potentially have with hollows or may provide roosting sites) within this

habitat will be avoided. An existing track which crosses the creek line will be upgraded to facilitate light vehicle access to the proposed explosives storage area (Figure 3).

The dewatering and injection system has also been designed to minimise impacts to habitats by minimising propagation of drawdown or mounding into the Mulga habitats (Section 6). The predicted drawdown is not expected to significantly negatively impact subterranean fauna species in the area.

9.5 Assessment of Direct Impacts

9.5.1 Clearing of Habitat

Almost all native fauna species rely on native vegetation to provide food, shelter and breeding sites. Loss or degradation of native vegetation may reduce the capacity of the habitat to support the range of species it could support in an undisturbed state. The fauna habitat types identified within the Project area support a range of fauna species, including two recorded species with conservation significance (Appendix G).

Vegetation will be progressively removed from sections of the Project area during building of mining infrastructure and during mining. Up to 370 ha of vegetation will be disturbed for the Project area, including the proposed haul road. Maximum disturbance amounts for each habitat type have been calculated (Table 37).

The majority of disturbance for the Project will occur within open low shrubland of mixed Acacia over spinifex on red sandy loam plains.

Table 37: Maximum disturbance to terrestrial fauna habitats (Ha) within the Project area

Habitat Description	Mine area	Haul road	Water infrastructure	Village infrastructure	Camp stockpile	Total
Open woodland of eucalyptus over buffel grass on brown rocky loam bordering Weeli Wolli Creek.	3.81	0.00	13.84	0.00	0.00	17.65
Open low shrubland of mixed acacia over spinifex on rocky/gravelly lower slopes of hills.	14.40	0.00	7.25	0.46	0.00	22.11
Open low shrubland of mixed acacia over spinifex on red sandy loam plain.	221.28	8.09	4.02	51.31	6.93	291.6
Mulga over buffel grass on red clayey loam.	2.03	33.01	0.00	0.00	0.00	35.04
Total	241.52	41.11	25.12	51.77	6.93	366.43

Habitat identified for having a high potential for SRE species is expected to have the least habitat disturbed within the Project area and for the proposed infrastructure (Table 38). Listed below are three categories of potential SRE habitat and the associated predicted area of habitat disturbance for the Project.

Table 38: SRE disturbance within the Project area

SRE Habitat	Habitat within Project area		Habitat disturbed within Project area		Total habitat disturbed by proposed infrastructure
	Ha	%	Ha	%	Ha
High	273.62	23.29	57.73	21.1	58.47
Moderate	97.43	8.29	71.99	73.89	112.59
Low	802.36	68.30	185.97	23.18	189.14
Total			**316**		

9.5.2 Alteration to Surface Water Flow Regimes

The main vegetation prone to changes to surface water flow regimes occurring in the Project area are the mulga communities that occur in banded patterns across low relief terrain. This distinctive vegetation pattern is comprised of bands or groves of *Acacia aneura* trees. The fauna species that are likely or occur in the Project area that use this type of vegetation include the peregrine falcon, the mulgara, the pebble mound mouse and the Northern short-tailed mouse. The area has been modelled based on typical civil works associated with drainage management, resulting from bund construction around the site only, not connecting roads. The modelling suggests that the banded mulga formations to the north east of the Project area are outside the area where sheet flow is predicted (Appendix F).

9.5.3 Trenching

A pipeline constructed from PVC pipe (approximately 100 mm diameter) crosses three habitat types; open low shrubland of mixed acacia over spinifex on red sandy loam plain, open low shrubland of mixed acacia over spinifex on rocky/gravelly lower slopes of hills and the open woodland of eucalypts over buffel grass on brown rocky loam bordering Weeli Wolli Creek. This pipe will be laid down with minimal habitat disturbance and where large Eucalypt tree species in the area will be avoided. Within the open woodland surrounding the Weeli Wolli Creek, two terrestrial conservation significant species were observed. These species are Priority 4 birds; the peregrine falcon (*Falco peregrinus*) and the rainbow bee-eater (*Merops ornatus*). Both species are known to occur outside of the Project area and construction of the pipeline is unlikely to significantly affect these species.

During installation of other pipelines for water transport within the Project area, ramps will be provided in any section where trenches are made to bury the pipe under road crossings and are left open overnight. This will allow fauna to egress if they fall into the trench. Open trenches will be inspected each morning during construction and any trapped fauna removed and translocated to the nearest possible location of the same habitat type which will not be affected by immediate clearing.

9.5.4 Vehicle Movements

Preparation of the site and the passage of vehicles on haul roads and access tracks have the potential to result in the fatality or injury of individuals. Mortality of small and sedentary fauna unable to move out of the area prior to clearing may occur. There could be a loss of individuals locally due to their limited ability to relocate to neighbouring areas of similar habitat. Such species may include the Blind Snake (*Ramphotyphlops ganei*), Pebble-mound Mouse (*Pseudomys chapmani*), Long-tailed Dunnart (*Sminthopsis longicauda*), and Mulgara (*Dasycercus blythi* / *D. cristicauda*). The Olive Python (*Liasis olivaceus barroni*) is relatively cryptic and sedentary and may not escape vehicle traffic resulting in mortality. However, none of these species were directly observed and only evidence of mounds previously made by the pebble mound mouse was seen within the Project area. These mounds were found outside of the proposed mine footprint. Implementation of speed limits designed to limit the likelihood of fauna road deaths, and restrictions on driving off-road will limit the impact of the Project area. Isolated deaths of individuals (if kept at a minimum) are not expected to affect the conservation status and distribution of any fauna species.

Clearing during the breeding season also has the potential to destroy nests, burrows and chicks of any species breeding within the Project area. Conservation significant species may potential utilise habitat within the Project area to breed and include the Rainbow Bee-eater, Bush Stone-curlew, Australian Bustard, Grey Falcon, and Peregrine Falcon.

9.5.5 Presence of Artificial Water Bodies

Artificial water bodies may attract native fauna, creating the risk of altering fauna behaviour, entrapping or poisoning animals if water quality is not suitable for consumption. The artificial water bodies may also attract and increase introduced fauna numbers.

Water extracted from the production bores will be stored in two turkey nest dams in the Project area with capacity of 5 ML (50 x 50 m) and 7 ML (60 x 60 m) for a total of 12 ML which will provide up to 3 days storage for peak daily demand up to 4,400 kL/day. These dams are expected to be constructed using mine waste material.

Additional artificial water bodies can have a number of impacts upon fauna. They may support additional livestock and feral fauna that rely on the artificial water bodies for drinking. They may also support additional native fauna that rely on the artificial water bodies for drinking e.g. kangaroos and some bird species. Birds may utilise artificial water bodies during dry periods (e.g. if the Fortescue Marsh dried out) that would otherwise be uncommon or absent in the area. Interactions between different bird species may be problematic in this circumstance. For example interactions between granivorous and insectivorous species (e.g. finches and parrots) and large carnivorous birds such as butcherbirds may result in increased mortality for the smaller bird species. Such interferences with natural dispersal are probably of little significance given the usually small numbers of waterbirds expected to use the area. Larger mammals can also become entrapped in mud around artificial water bodies.

Depending on the properties of the mine waste material, the turkey nest dams will be either unlined (i.e. if the dam is water holding) or lined with an imported clay blanket or synthetic liner.

To minimise the potential impacts of artificial water bodies on fauna, the Fortescue will undertake the management measures described below to reduce accessibility or attractiveness of the artificial water body to fauna, with a focus on fauna where there is likely to be a conservation issue:

- Dams will either be landscaped to allow animal egress or have specific animal egress points installed.
- Prevent overflow of artificial waterbodies in dry conditions.
- Artificial water bodies will be removed once no longer required for mining.

With the above management measures in place, the presence of additional artificial water bodies in the Project area is not expected to have a significant impact on fauna.

9.6 Impacts to Fauna of Conservation Significance

The likelihood of impacts to species of conservation significance that have either been recorded or are considered likely to occur at the Project area is discussed below.

9.6.1 Reptiles

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python is listed as vulnerable under the EPBC Act and Schedule 1 under the WC Act. Anecdotal evidence suggests it is resident in the Study area (unconfirmed observation). The python inhabits gorges, escarpments, rocky outcrops, and areas of permanent water which attract sizeable prey. This subspecies is larger (up to 6.5 m long) than the more northern distributed subspecies (*Liasis olivaceus olivaceus*) (Storr,Smith and Johnstone 2002). The habitat of open woodland of eucalypts over buffel grass on brown rocky loam bordering Weeli Wolli Creek may provide habitat for the python within the Project area. This habitat will remain relatively undisturbed. Vehicle movements do, however, pose a likely risk to the relatively sedentary and secretive species.

9.6.2 Birds

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as a Migratory species under the EPBC Act and as a Schedule 3 species under the WC Act. The species was observed within the Project area in the River Land System (Site 2 of survey Phase 1) (Figure 22). The species breeds throughout most of its range following migration to Australia from Japan (and other countries) during the start of spring

(late September-October). It is represented in a wide range of habitats and is thought to adapt well to disturbance (SEWPAC 2012). Given the widespread occurrence of the species in the region and Australia and the range of habitat available, it is considered that the species will not be significantly affected by this mine development.

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed as a Schedule 4 species under the WC Act. This species was observed near Weeli Wolli Creek in the Project area. The removal of potential hunting and breeding habitat is not expected to result in significant impacts to the peregrine falcon as this species has the ability to move away from disturbances and similar habitat is widespread in the surrounding areas. The only potential local impact is the destruction or abandonment of nests as a result of vegetation clearing during the breeding season if it occurs in close proximity to rocky ledges or large trees. The clearing of large trees will be minimal (if any) along the creek line as pre-existing tracks will be utilised for the pipeline.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed as a Migratory species under the EPBC-Act and as a Schedule 3 species under the WC Act. A flock of fork-tail swifts were recorded in the northern area of the Study area during phase 1 of the fauna surveys (Figure 22). The species is almost entirely aerial and is usually found near foothills and cliffs in coastal areas. The development of the Project area should not significantly affect the status of this species.

Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is listed as a Priority 4 species by the DEC. This species was not recorded within the Study area during the two surveys. It may utilise some habitat surrounding creek lines. There may be a small local impact as a result of some minimal vegetation clearing and disturbance for the pipeline, however, this species can move away from disturbances and suitable habitat occurs outside of the Project area. The development of this mine site should not result in significant impacts to the Grey Falcon on a regional scale. The only potential local impact is the destruction or abandonment of eggs and nestlings as a result of vegetation clearing or human disturbance during the breeding season.

Australian Bustard (*Ardeotis australis*) and Bush Stone-curlew (*Burhinus grallarius*)

The Australian Bustard and the Bush Stone-curlew are listed as a Priority 4 species by the DEC. Tracks of the Australian Bustard were recorded over the Study area during both phases of surveys, however, was not directly observed. The Bush Stone-curlew was not observed. These birds are likely to forage and breed in areas associated with Mulga. As these species have the ability to move away from disturbances and suitable habitat is present in areas surrounding the mining impact area, no significant impact to the species is expected. Minimal impacts from water sheet flow are predicted to affect the Mulga vegetation.

Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret is listed as a Migratory species under the EPBC Act and as a Schedule 3 species under the WC Act. The egret was observed during a survey of the Fortescue Marsh. There is some potential habitat along creek lines within the Project area. As this species has the ability to move away from disturbances and suitable habitat is present in areas surrounding the mining impact area, no significant impact to the species is expected.

9.6.3 Mammals

Mulgara (*Dasycercus blythi*) / Brushtailed Mulgara (*D. cristicauda*)

The Mulgara is listed as vulnerable under the EPBC Act, Schedule 1 under the WC Act and listed as a Priority 4 species by the DEC. The Mulgara may occur within the Project area, however, the two surveys of the Study area did not result in positive records of either individuals or secondary evidence (burrows) of this species (refer to Appendix G). There is, however, a recent (2011) record from a few kilometres south of Site 3 (Phase 1 survey), which is close to the Project area (refer to Appendix G). The open low shrubland of mixed Acacia over spinifex on red sandy loam plain may be potential habitat for the Mulgara. Within the Project area 22.11 ha of this habitat type will be cleared for mining infrastructure and the mine pit. This habitat type does, however, have a wider distribution than that of the mine footprint area. If this species does occur within the Project area, it is likely to occur at low numbers. Due to habitat clearing some loss of individuals can be expected.

Pebble-mound Mouse (*Pseudomys chapmani*)

The Pebble-mound Mouse is listed as a Priority 4 species by the DEC. A few mounds were found within the Project area near Site 3 during the first survey phase, but they were not believed to be active. This species inhabits spinifex-covered hill slopes and hummock grassland on pebble soils. Potential habitat is widespread across the Pilbara and the species is relatively common. This species has a very limited ability to move away from disturbance. The mounds recorded were on the very south-west edge of the Project area where there will be limited disturbance. Some vegetation clearing of this habitat type near the mine pit may impact potential local populations, however, it is not anticipated that this will significantly affect the species conservation status in the Pilbara.

Northern Short-tailed Mouse/ Lakeland Downs Mouse (*Leggadina lakedownensis*)

The Northern Short-tailed Mouse is listed as a Priority 4 species by the DEC. This species inhabits spinifex and tussock grassland on cracking clays and Acacia shrubland and samphire, woodlands. This type of habitat is present within the Project area, however, the species was not recorded during the two phases of surveys. As the species is generally common in the Pilbara, limited regional impacts to the species are anticipated.

9.6.4 Short Range Endemic (SRE) Species

Habitat indicative of SRE fauna within the Study area was predominantly restricted to drainage lines, areas of high moisture content, boulders and rock piles isolated hills, vegetated gullies and depressions with deep leaf litter, south facing slopes, hills, ranges, caves, mountainous terrain, granite outcrops and unique habitats and landforms in relation to surrounding habitats. Up to 60 ha of what is considered to have a high potential for SRE fauna habitat may be disturbed within the Project area. Only three potential SRE species and no confirmed SRE species were recorded within (or very close to) the Project area.

9.6.5 Subterranean Fauna

Stygofauna and troglofauna may be affected by pit excavation. The mine pit will not extend past the level of the water table and therefore dewatering is not anticipated. One stygofauna (*Pygolabis* sp. B6) and no troglofauna species were recorded within bores located inside the Project area and most species found across the Study area are known, or probably occur beyond the Study area. Aquifers within the Study area are well connected and should assist the dispersal of stygofauna and in broad terms the habitat that may support troglofauna species is similar within and outside of the Study area.

9.7 Cumulative Impacts

All habitat types that will be affected by the Project area occur in the wider Study area. The predicted 370 ha of habitat that will be cleared will have some cumulative impact to the local representation of these habitat types. However, all of these habitats occur in the wider region and cumulative impacts are not expected to have significant impacts on the distribution and abundance of fauna species.

9.8 Management Measures and Performance Standards

9.8.1 Ground Disturbance

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a GDP). Under the permitting process areas of vegetation which may comprise high value flora and vegetation, including ‘habitat’ trees, may require ground-truthing surveys to assess its value. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC.

9.8.2 Environmental Management Plan

Fortescue's existing EMP *Biodiversity Management Plan* will be implemented for the Project and includes the following key management actions:

- Clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above).
- Significant fauna habitat will be spatially identified and where appropriate demarcated on site.
- All lined surface water storage areas will have fauna egress points.
- Vehicles speeds will be restricted across the Project area.
- Off road driving or driving on restricted access routes will be prohibited other than for emergency situations.
- Rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented.
- Appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes.
- Low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards.
- Lighting will be directed onto construction or operational areas.

9.9 Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards and Procedures

After mitigation measures have been applied, the Project area is expected to result in the following outcomes in relation to fauna:

- Up to 370 ha of fauna habitat will be disturbed with the majority of this occurring in open low shrubland of mixed acacia over spinifex on red sandy loam plain.
- There will be minimal loss of creek line habitat for pipeline and upgrades to existing tracks. This may affect breeding habitat for bee-eater birds and the peregrine falcon, and habitat for the potentially occurring EPBC-listed reptile, the Pilbara olive python.
- There will likely be some localised impacts to potential habitat of the Priority fauna species the pebble-mound mouse and mulgara potentially found in the area due to clearing activities. However, these species do occur outside the Project area within the Pilbara region and the development of the Project area is unlikely to significantly affect their regional abundance or range.
- Significant regional impact to fauna is unlikely as habitats that occur within the Project area also occur extensively outside the Project area.

- The Project itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Project area.
- Significant regional impact to SRE, stygofauna and troglofauna species is not expected to occur as a result of the Project area.

It is unlikely that the Project area will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act or listed as Scheduled under the WC Act or Priority fauna listed by the DEC. Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

10. FORTESCUE MARSH WETLAND

10.1 Relevant Environmental Objectives, Policies, Guidelines, Standards and Procedures

10.1.1 EPA Objectives

The EPA applies the following objectives in assessing Projects that may affect areas of natural heritage:

- To protect the environmental values of areas identified as having significant environmental attributes.
- To maintain the integrity, functions and environmental values (of the Fortescue Marsh).

10.1.2 Legislation, Policy and Guidance

The following policies are relevant to the identification and protection of the Fortescue Marsh.

Directory of Important Wetlands

A comprehensive inventory of Australia's nationally important wetlands was undertaken in the 1990s under the auspices of the National Wetlands Program. This resulted in the publication of the *Directory of Important Wetlands in Australia* (the Directory) (Environment Australia 2001).

The Directory is designed to be a source of information for policy makers, biodiversity professionals and the wider community. Its fundamental purpose is to inform policy development and decision making on wetland protection and the sustainable utilisation of wetland resources.

A wetland may be considered nationally important if it meets at least one of the following criteria (Environment Australia 2001):

- It is a good example of a wetland type occurring within a biogeographic region in Australia.
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- The wetland supports 1% or more of the national populations of any native plant or animal taxa.

- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- The wetland is of outstanding historical or cultural significance.

The Fortescue Marsh has been identified as meeting criteria 1, 2 and 6 and is therefore considered as a Wetland of National Importance.

Register of the National Estate

The Register of the National Estate (the Register) is a list of natural, Indigenous and historic heritage places throughout Australia. The Register is maintained by the Australian Heritage Council, which is the principal adviser to the Australian Government on heritage matters.

The Fortescue Marsh is listed as an 'Indicative Place' on the Register of the National Estate due to its importance as a habitat for migratory birds (SEWPAC 2010b). Nomination for inclusion on the Register is based on the following:

- Importance for conservation of waterbirds.
- Importance for periodic breeding by colonial waterbirds, especially Australian pelican (*Pelecinus conspicillatus*) and black swan (*Cygnus atratus*). It is the only pelican breeding area in the bioregion and is isolated by large distances from other pelican breeding areas.
- Comprises an unusual type of wetland and natural landscape, being a large arid-zone floodplain contained in a broad valley between ranges, with no outlet (i.e. a terminal drainage basin), which is unique in WA. It is a good example of its type in terms of size, condition and integrity.
- Possibility that other cultural values, both indigenous and non-indigenous, of National Estate significance may exist in this place (SEWPAC 2010b).

Ramsar Conventions on Wetlands of International Importance

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation of wetlands and their resources. Australia was one of the first countries to sign the Convention, adopted in 1971, and has been an active member since it came into force in 1975.

Signatories to the Ramsar Convention commit to maintaining the ecological character of their Wetlands of International Importance, and to plan for the "wise use" of all of the wetlands in their territories (SEWPAC 2010c). The Fortescue Marsh has been proposed as a future Ramsar wetland but there has been no formal nomination at this stage (DEC 2009). If listed, the Fortescue Marsh will become legally recognised as an area of National Environmental Significance, subject to the provisions of the EPBC Act.

JAMBA, CAMBA and ROKAMBA Treaties

The Japan Australia Migratory Bird Agreement (JAMBA), *China Australia Migratory Bird Agreement* (CAMBA) and *Republic of Korea Australia Migratory Bird Agreement* (ROKAMBA) are Treaties for the protection of certain migratory bird species. The Treaties require each country to take appropriate measures to preserve and enhance the environment of bird species subject to the Treaty provisions.

The Fortescue Marsh is recognised as providing habitat for several bird species listed under the JAMBA and CAMBA Treaties; and possibly also the ROKAMBA Treaty which came into force in 2007 (SEWPAC 2010a).

All species listed under the JAMBA, CAMBA and ROKAMBA Treaties are subject to the legislative protection of the EPBC Act. Species listed under JAMBA Treaty are also protected under Schedule 3 of the Wildlife Conservation Act 1950.

Threatened and Priority Ecological Communities

A TEC is defined as “a naturally occurring biological assemblage that occurs in a particular type of habitat - which is found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”” and listed TECs are defined under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* as environmentally sensitive areas (DEC 2007).

For an ecological community to be classified as a TEC, there is a requirement for detailed biological surveys to be completed. DEC maintains a list of PECs that have been identified as possible TECs but have not been adequately surveyed or evaluated under the TEC listing criteria. PECs are ranked in order of priority, with Priorities 1, 2 and 3 denoting the order of priority for further investigation (DEC 2007).

The Fortescue Marsh has recently been classified as a Priority 1 PEC and comprises an area from east of Mulga Downs to Marillana and Roy Hill Stations. The Fortescue Marsh PEC classification was based on the following:

- Occurrence of endemic *Eremophila* species (locally restricted) and several near endemic and new to science Samphire species.
- It is a recorded locality for the night parrot and greater bilby, both of which are listed as rare and endangered under State and Commonwealth legislation.
- Occurrence of several locally restricted aquatic invertebrates.
- Occurrence of specific vegetation types (of conservation interest) found only around the marsh on Mulga Downs station and an unusual vegetation system further downstream.

- The significance of vegetation types within the Fortescue Marsh is further described in 10.2.1.

Fortescue Marsh Strategic Planning

The EPA has initiated a strategic planning process focused on protection of the Fortescue Marsh from mining activities in the Upper Fortescue River Catchment. Under the process, a project working group has been established including representatives from the EPA, DoW, DEC, DMP, Fortescue, Rio Tinto Iron Ore (RTIO), BHP Billiton, Roy Hill Iron Ore (RHIO), Brockman Resources and BC Iron. Advice has been provided by DEC to the working group regarding the values of the Fortescue Marsh as summarised in Table 39.

Table 39: Summary of DEC advice regarding the values of the Fortescue Marsh

Value	Advice
Biogeographical Significance	The Samphire shrubland is the largest ephemeral wetland in the Pilbara Bioregion. Fringing Mulga woodlands (floristic community types) are at the northern limits of their continental distributional range and at the northern limits of the '*Acacia-Triodia* transition zone'.
Flora	An endemic genus may possibly occur (i.e. *Eremophila spongiocarpa*). Three to four endemic Samphire species have been recorded with another two near-endemic taxa known. Numerous Priority flora taxa have been recorded. Several range end – disjunct outlying plant populations occur.
Floristics and Vegetation	The Samphire community of the marsh is unique. The fringing Mulga woodland to the north is in excellent condition – with little or no Buffel Grass.
Fauna	The marsh constitutes an arid wetland for waterbirds of national importance: 260 000 – 276 000 individuals from 47 species were recorded when the, marsh was inundated in 1999 and 2003. The marsh is the second largest nesting sites for Pelicans recorded in Western Australia. Contemporary records have been made of the Critically Endangered Night Parrot from the marsh. Suitable habitat for the Bilby and Mulgara is present on the apron to the marsh. Significant aquatic invertebrate assemblages are associated with the marsh. Endemic taxa of macro-invertebrates are known only from the marsh and there is high species richness.
Threatened and Priority Ecological Communities	The marsh has recently been listed as a PEC.
Landscape/land systems	Three land systems are unique to the marsh (the Marsh, Marillana and Turee Land Systems). Only two of the twelve land systems associated with the marsh occur in the conservation estate.

Value	Advice
Status and Reservation	The marsh is: A wetland of National Significance in the Directory of Important Wetlands in Australia. • An “Indicative Place” on the Register of the National Estate – Waterbirds • Nominated for RAMSAR listing. • Earmarked for reservation under pastoral lease renewal arrangements scheduled for 2015.

10.2 Potential Sources of Impact

The Project area lies within the Upper Fortescue Catchment. The Weeli Wolli Creek intersects the south-west extent of the Project area and meanders in a general north-west direction forming a broad out wash fan at the foot of the Hamersley Ranges draining towards the Fortescue Marsh. The Fortescue Marsh is approximately 30 km downstream from the Project and no springs or pools are known to exist in the Project area (MWH 2011).

The predicted impacts on surface water are considered to be minimal and therefore the potential impact on Fortescue Marsh are also minimal.

There is no predicted impacts in relation to groundwater as there is no proposed dewatering or reinjection of groundwater.

There is a low risk of impact from chemicals or hydrocarbons by the Project.

10.3 Findings of Surveys and Investigations

10.3.1 Surface Water

The Fortescue Marsh is an intermittently inundated wetland with broad-scale inundation occurring approximately one year in ten for a period of three to six months (SEWPAC 2010b). During smaller rainfall and runoff events, isolated pools form on the Fortescue Marsh at the main drainage inlets. Surface water runoff to the Fortescue Marsh is typically of low salinity but high turbidity (SEWPAC 2010b). Outflow from the marsh into the Lower Fortescue River does not occur (SEWPAC 2010b) as the marsh is internally draining with water discharging through evaporation and evapotranspiration.

The Fortescue Marsh and some semi-permanent water pools along its northern shoreline have been identified as having cultural significance. The semi-permanent water pools or “yintas” are considered to be associated with seasonal surface water flows and superficial aquifer expression rather than regional groundwater levels (FMG 2010).

10.3.2 Groundwater

The Fortescue Marsh is both a groundwater discharge and recharge zone. In the upslope areas, water percolates into the aquifer during rainfall events and flows towards the marsh and is then removed from the system by evaporation and evapotranspiration processes (FMG 2010). Following a flood event, it is considered that a portion of the ponded surface water in the Fortescue Marsh will infiltrate (FMG 2010) although this may be slowed by the presence of low permeability layers below the marsh surface.

Salinity in the upper aquifer underneath the marsh is greater than 50 000 mg/L (FMG 2010). Groundwater under the marsh is stratified, with groundwater salinity below the marsh increasing with depth (FMG 2011b).

10.3.3 Fortescue Marsh Vegetation

Vegetation of the Fortescue Marsh is dominated by Samphire species. The marsh also includes extensive areas with little or no vegetation that occur in lower elevation areas and appear to correlate with prolonged inundation areas associated with historical flood events. The marsh has recently been classified as a Priority 1 PEC. The Fortescue Marsh PEC is characterised by the presence of endemic and new to science *Eremophila* and Samphire (*Tecticornia*) species occurring on the fringe of the Fortescue Marsh (FMG 2011b).

10.3.4 Fortescue Marsh Fauna

The Fortescue Marsh is potentially utilised by the Night Parrot (*Pezoporus occidentalis*), which is a nomadic species listed as Endangered under the EPBC Act. The Greater Bilby (*Macrotis lagotis*) and Mulgara/Brushtailed Mulgara (*Dasycercus blythi*/*D. cristicauda*) are listed as vulnerable under the EPBC Act. Both species are likely to occur in areas along the edge of the Fortescue Marsh. Waterbird species including the migratory species Eastern Great Egret (*Ardea modesta*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*), Red-Necked Stint (*Calidris ruficollis*) and White-Bellied Sea-Eagle (*Haliaeetus leucogaster*) are common at the edge of the Marsh, particularly following rain.

10.3.5 Further Investigations

The Fortescue Marsh is recognised as having a range of important ecological values. Because of this, Fortescue is undertaking further studies to better understand the Marsh and associated vegetation communities. Fortescue's work has identified the following areas that would benefit from further investigation to manage any potential impacts of mining on the marsh:

- Composition and spatial extent of vegetation types.
- Water sources used by the vegetation and the relative importance of these sources.

- Vegetation recruitment ecology.
- Marsh hydrogeology.
- Potential response of watertables in the marsh to dewatering and injection activities.

Fortescue is undertaking additional monitoring and modelling and investigations on the marsh to assist in further understanding of the marsh. This includes:

- A drilling investigation program for the Fortescue Marsh is consequently planned to progressively enhance the understanding of the Fortescue Marsh hydrology and water requirements of the Samphire.
- Funding work by UWA on the relationships between Samphire populations and water salinity and availability.
- Modelling of marsh water balances to determine vegetation response to changing groundwater and surface water conditions.

Until the relationship between ecology and hydrology on the Marsh is better understood, Fortescues' impact assessments are taking a precautionary approach that assumes the Samphire to be groundwater-dependent (FMG 2011b).

10.4 Evaluation of Options or Alternatives to Avoid or Minimize Impacts

The Fortescue Marsh is located 30 km to the north of the Project area. The key management strategies to limit impact on the Fortescue Marsh is to have no dewatering processes, no injection of groundwater and locating infrastructure away from the Weeli Wolli Creek.

Vegetation within the marsh area will not be directly impacted. Threats to the ecology of the Fortescue Marsh from the Project are not likely from changes in surface or groundwater alterations or from secondary effects on vegetation and fauna.

10.5 Assessment of Likely Direct and Indirect Impacts

As stated above the potential impact to the marsh is minimal, although there is a potential risk associated with fuel and chemicals.

10.5.1 Vegetation and Flora

The Fortescue Marsh is located approximately 30 km to the north of the Project area. No clearing of vegetation will occur within the marsh as a result of this Project.

There are no predicted impacts on the Marsh vegetation from groundwater drawdown effects from the Project.

10.5.2 Terrestrial Fauna

No impact on terrestrial fauna in the Fortescue Marsh is expected from the Project development because:

- There is no clearing of vegetation within the marsh and only small areas may be affected by groundwater drawdown.
- There is no impact expected on the extent or duration of surface water inundation in the marsh, therefore, the value of this ephemeral waterbody for birds and other fauna will be maintained.

10.6 Cumulative Impacts

There is potential for cumulative impacts on the Fortescue Marsh due to the presence of four mines in the vicinity of the Fortescue Marsh, being Cloudbreak, Christmas Creek (Fortescue), Roy Hill mine (Hancock) and Marillana (Brockman Resources). However, impacts from the Project are expected to be negligible. Refer to Section 7 for more information on surface water information.

10.7 Management Measures and Performance Standards

The most likely impact to the Fortescue Marsh is from the impact of surface water from the mine. The management strategy for the Fortescue Marsh will be focused predominantly on the management of surface water and in particular:

- flood waters from Weeli Wolli Creek and other ancillary catchments; and
- mine site stormwater

Management of potential impacts on surface water from the Project will include the following key management actions:

- Divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible.
- Separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection.
- Minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas.
- Locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation.

- Ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding.
- Disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required.
- Ensure that chemical storage is undertaken in a manner that limits potential surface water contamination.
- Manage clearing and earthworks to minimise erosion.

10.8 Predicted Environmental Outcomes Against Environmental Objective, Policies, Guidances, Standards and Procedures

No threats to the ecology of the Fortescue Marsh from the Project are likely to be due to changes in groundwater levels a surface water quality nd secondary effects on vegetation and fauna.

The integrity, function and environmental values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.

11. ABORIGINAL HERITAGE

11.1 Impact Assessment, Relevant Environmental Objectives, Policies, Guidelines, Standards And Procedures

11.1.1 EPA Objective for Aboriginal Heritage

The EPA applies the following objective to the assessment of Projects that may affect Aboriginal Heritage:

To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

EPA Guidance Statement No. 41

EPA Guidance Statement No. 41 (EPA 2004a) provides guidance on the process for the assessment of Aboriginal heritage as an environmental factor. Where Aboriginal heritage is determined to be a relevant factor, the EPA will expect the proponent to properly consider how to minimise any impact to heritage values resulting from the Project.

Aboriginal Heritage was identified as a key environmental factor in the Scoping Document. EPA Guidance Statement No. 41 (EPA 2004a) details actions that may be pertinent to the factor of Aboriginal heritage, including:

- Consulting with Department of Indigenous Affairs (DIA) staff and conducting a desktop review of sites.
- Undertaking an Aboriginal heritage and/or archaeological survey in consultation with relevant Aboriginal representatives.
- Informing relevant Aboriginal people of the Project and conduct an appropriate consultation.
- Demonstrating that any concerns raised by the Aboriginal people have been considered in the environmental management of the factor and that this is made known to the relevant Aboriginal people.

11.1.2 Regulatory Framework

The Minister for Indigenous Affairs is responsible for the administration of the Aboriginal Heritage Act 1972 (WA) (AH Act). The Minister's responsibility is to ensure that all places of traditional or current sacred, ritual or ceremonial significance to Aboriginal people should be recorded and their importance evaluated on behalf of the community. Under Section 18 of the AH Act, consent from the Minister is required to use land containing Aboriginal sites.

11.2 Potential Sources Of Impacts

The primary aspects of the Project that may potentially affect Aboriginal heritage values are:

- **Physical disturbance of the land surface** during clearing and removal of topsoil and overburden has the potential to disturb heritage sites and affect ethnographic values.
- **Presence of construction and operational personnel** has the potential to disturb heritage sites and affect ethnographic values.
- **Alteration of surface water flows** has the potential to result in erosion of Aboriginal heritage sites.

Other indirect impacts on Aboriginal heritage sites from dust and vibration are not expected to occur. No impact from the Project is expected on the semi-permanent pools of Aboriginal heritage value on the Fortescue Marsh (Yintas).

11.3 Outcomes Of Heritage Surveys

Comprehensive Aboriginal Heritage surveys (archaeological and ethnographic) have been conducted over all land within the Project area. All surveys were conducted in collaboration with Heritage Consultants and Nyiyaparli Traditional Owners to ensure sites of heritage significance have been recorded. Results of the heritage surveys have been uploaded into Fortescue's Geospatial Information System (GIS) and communicated to appropriate Fortescue personnel and contractors to ensure Aboriginal heritage sites are protected.

11.4 Assessment Of Likely Direct And Indirect Impacts

11.4.1 Disturbance to Land Surface

All new ground disturbances require a Fortescue Ground Disturbance Permit (GDP) prior to works commencing. Approvals to disturb ground will be managed through Fortescue's Business Management System (BMS) which facilitates a rigorous GDP application/approval process prior to commencement of works. Areas proposed for ground disturbing activities are subject to both an archaeological and ethnographic survey prior to approval. Aboriginal heritage sites are also avoided by GDP works.

Any blasting required in Project development will also be managed through the GDP approval process in BMS. Blasts have the potential to impact heritage sites in close proximity through vibration and fly rock; however this risk has been minimises by Fortescue through the development of a comprehensive procedure for Blasting in the vicinity of heritage sites, which ensures that specific Blast Management Plans (BMPs) are developed by blasting contractors for each blast. BMPs must include measures to avoid impact to sites through vibration and fly rock

and any deviation from the plan or unexpected outcome is reported to the Heritage Compliance Superintendent for investigation.

11.4.2 Disturbance by Personnel

Fortescue does not consider unauthorised visitation as a significant issue for the Project. Construction/mining workers are managed with a series of management controls in place including inductions, training and the clear delineation of heritage sites.

To ensure all Fortescue personnel and contractors give consideration to Aboriginal Heritage matters, Fortescue requires all personnel and contractors to attend their Heritage Induction Training program prior to undertaking any ground disturbing work. This training program provides Fortescue personnel and contractors with an understanding of Aboriginal heritage sites, Aboriginal people and their country. This training program also informs Fortescue personnel and contractors of Fortescue's obligations under the *Aboriginal Heritage Act (1972)*.

11.4.3 Indirect Disturbance

Alteration of surface water flow may potentially affect Aboriginal Heritage sites through erosion.

Erosion is a common process in the Pilbara due to the intense nature of cyclonic rainfall events and the lack of vegetation that holds soil in place. This is shown by the high turbidity of surface flows. Reducing the area over which a stream can spread in a storm event by construction of mining landforms can result in an increase in stream velocity, and hence erosion potential around the location of the change. If large enough, these changes could potentially result in erosion of Aboriginal heritage sites such as middens or artefact scatters.

11.5 Management Measures And Performance Standards

11.5.1 Cultural Heritage Management Plan

The Cultural Heritage Management Plan (CHMP), developed in consultation with the Nyiyaparli Heritage Sub-Committee, guides the management of heritage matters within the Project area and ensures effective compliance with DIA guidelines and obligations under the *Aboriginal Heritage Act (1972).* The CHMP provides for Nyiyaparli Aboriginal monitors to oversee Project ground disturbance activities where appropriate, to ensure that known Aboriginal sites are not inadvertently impacted.

Other key mitigative measures presented in the CHMP include:

- Identification of Aboriginal Heritage sites for inclusion in the Fortescue Aboriginal Sites Register.

- Regular consultation with Traditional Owners together with their chosen heritage professionals.
- Compulsory GDP approval prior to ground disturbing works commencing (managed through the Environmental Management System).
- Implementing heritage compliance procedures including the appointment of Heritage Field Officers and Aboriginal Monitors, whose primary roles include facilitating heritage surveys and enforcing obligations under the AH Act and the Land Access Agreements.
- Installing protected buffer zones and delineating heritage sites.
- Regular compliance auditing and reporting to ensure no direct ro indirect impacts have occurred as a result of construction or operational activities.
- Heritage incident reporting (through the Business Management System) and assessment, including the development of preventative actions to improve the heritage management plan.
- Cultural heritage education, training and inductions of all Fortescue employees and contractors prior to commencing work on any Fortescue site.

Additionally, the entire mine site will be protected from surface water flow by a bund which will cover approximately 240 ha (Section 7). This will prevent erosion to heritage sites by sheetflow. All drainage throughout the mine will be designed to divert surface water flow from Heritage sites.

11.5.2 Fortescue Operations Aboriginal Sites Register

The Fortescue site register manages the status of heritage sites located within the Fortescue Project areas and includes the following details:

- Heritage site details.
- Reporting details (consultant, Tradtional Owner involvement, recording level)
- Mitigative measures undertaken (e.g. fencing, site inspections, field audits) by Heritage Field Officers and Aboriginal Monitors.
- Any DIA submissions made in relation to that site (Section 16, Section 18).

11.6 Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures

The Project will be carried out in accordance with EPA Guidance Statement No. 41(EPA 2004a) through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group LAAs. Fortescue continues to consult regularly with the Nyiyaparli People over all aspects relating to the identification, protection and management of their cultural heritage.

Fortescue has committed to avoid impacts to Aboriginal heritage sites identified through ethnographic and archaeological surveys. The Fortescue-Nyiyaparli Heritage Sub-committee will continue to meet regularly throughout implementation of the Project.

12. LANDFORM, MINE CLOSURE PLANNING AND REHABILITATION

12.1 Relevant Environment Objectives, Policies, Guidelines, Standards And Procedures

The following section provides an overview of the relevant guidelines used in the preparation of the Mine Closure Plan (MCP).

12.1.1 EPA/DMP Objectives

The DMP, in conjunction with the EPA, has established the Mine Closure Plan Guidelines to provide expectations of MCPs and how best to manage the closure process.

The Guidelines state that the preparation of a MCP should give specific consideration to the following list of key principles and approaches:

- At all stages, from the project approval stage onwards, the MCP should demonstrate that ecologically sustainable mine closure can be achieved consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State;
- Planning for mine closure should be fully integrated in the life of mine planning, and should start as early as possible and continue through to final closure and relinquishment. For new projects, closure planning should start in the project feasibility stage (before project approvals);
- MCPs must be site-specific. Generic “off-the-shelf” closure plans will not be acceptable;
- Closure planning should be risk-based taking into account results of materials characterisation, data on the local environmental and climatic conditions, and consideration of potential impacts through contaminant pathways and environmental receptors;
- Effective consultation should take place between proponents and stakeholders which should include acknowledging and responding to stakeholder’s concerns. Information from effective consultation is central to closure planning and risk management;
- Proposed post-mining land uses need to be identified and agreed upon through consultation before approval. This should also include consideration of opportunities to improve management outcomes of the wider environmental setting and landscape, and possibilities for multiple land uses;
- Characterisation of materials needs to be carried out prior to project approval to a sufficient level of detail to develop a workable closure plan. This is fundamental to effective closure planning. For existing operations, this work should start as early as possible. Characterisation of materials should include materials with potential to produce acid, metalliferous or saline drainage, dispersive materials, fibrous and

asbestiform materials, and radioactive materials, as well as benign materials intended for use in mine rehabilitation activities;

- Closure planning should be based on adaptive management. MCPs should identify relevant experience and research, and how lessons learned from these have been/will be applied; and
- MCPs should demonstrate that appropriate closure performance monitoring and maintenance systems and record keeping and management systems are in place.

12.1.2 Other Guidelines

In addition to the MCP Guidelines, there are also a number of other mine closure guidelines used by industry that have been considered during mine closure planning. These include:

- Mine Closure and Completion: Leading Practice Sustainable Development Program for the Mining Industry (2006) Commonwealth Department of Industry, Tourism and Resources;
- Strategic Framework for Mine Closure (2000) Australian and New Zealand Minerals and Energy Council (ANZMEC); It's Not Over When It's Over: Mine Closure Around the World (2002) World and International Finance Corporation; and
- Planning for Integrated Mine Closure: Toolkit; International Council on Mining and Metals (ICMM, 2008).

12.2 Closure Overview

Fortescue has engaged Tetra Tech Pty Ltd (Tetra Tech) to formulate a Mine Closure Plan (MCP) for the Io Project. The MCP has been developed to meet the requirements of the DMP/EPA *Guidelines for Preparing Mine Closure Plans* (June 2011). Other industry guidelines relevant to mine closure planning have also been consulted in the development of the MCP to ensure the mine closure planning is best practice.

Fortescue's overall mine closure objective is to re-establish the Project area back to native local provenance vegetation and to engineer the landscape to reflect as close as practicable to its original form.

The key aspects of the closure planning include:

- The pit void will be completely backfilled and will be free draining.
- There will be no benificiation of ore on site and hence no tailing storage facility.
- At closure there will be no above ground waste landforms.
- All mining will be above the water table.

- Geochemical characterisation indicates the waste material is for the most part benign.
- Geotechnical analysis indicates that waste material is generally competent.

The Project will involve the mining of approximately 12 Mt of iron ore from a single open pit over four (4) years. Ore will be transported to Fortescue's Cloudbreak mine site for beneficiation and hence no tailing storage facility will be constructed at the site.

Throughout the life of the project up to 17.5 Mt of waste rock will be mined. Waste rock will be used initially for bulk earthworks including a flood levee, or stored within the TWRD until closure works commences. The TWRD will be constructed so as to facilitate effective backfilling of the pit. It is anticipated that backfilling would commence in approximately year 3 of Life of Mine. Backfilling will be completed, as far as is practicable, to recreate a stratigraphy within the backfilled pit that mimics the original, in-situ weathering profile. As such, waste rock will be returned to the pit so that waste taken from depth is returned to the base of the pit and the near-surface waste is placed into the pit last. At closure, nearly all waste rock, inclusive of that stored in the TWRD and that used to construct the flood levy will be returned to the pit. As a result, the pit will be entirely backfilled and will have a free draining final topography. Waste rock used to upgrade roads will be left in situ.

The geochemistry of the waste rock is in the most part environmentally benign. Notwithstanding this result, to ensure the effective closure of the pit, in-situ waste rock will be characterised as part of an ongoing process over the life of mine. This waste characterisation process will result in the various waste lithotypes being classified as either 'benign' or 'mineralised'. Mineralised waste shall include any waste rock that has potentially or unacceptably elevated levels of salinity, sodicity, asbestiform minerals, acid metalliferous drainage potential, or likely to be dispersive.

The planned pit shell includes a small hill on its south western wall and hence the mass of waste rock excavated and subsequently returned to the pit is sufficient to backfill the pit entirely. Once all of the infrastructure and TWRD has been removed and the pit is backfilled, the landscape will be re-contoured to create a free draining final topography. Rehabilitation works will include the reconnection of existing upstream and downstream drainage lines.

Following the completion of the major civil works to re-contour the site, previously stockpiled topsoil will be spread across the disturbance footprint. Fortescue will employ a combination of direct broadcast seeding and planting. The species proposed in the seeding and planting program, timing and methodology will be subject to investigation and based on flora and vegetation mapping conducted within the Project area (Appendix E). Where direct seeding or planting is employed, species of local provenance (defined as seed material collected within 20 km of the project area) will be used. It is also expected that natural re-colonisation will occur from residual seeds within the topsoil and seeds naturally transported into the affected area.

Once the closure earthworks have been completed and vegetation is re-established, the only visual impact on the landscape will be the truncated hill created as part of the pit's highwall during mining. This surface will be constructed to final design geometry during mine operations

and will be geotechnically stable. A safety bund will be left in place above this wall in accordance with the DMP Guideline (DMP Document No. ZMA048HA)

The design of final re-contoured surface of the project site, and supporting engineering, is addressed in Section 12.5.

12.3 Closure Obligations and Commitments

Legal requirements arise from State and Commonwealth legislation, mining tenement conditions, commitments made in mining proposals and conditions of environmental approvals (such as Ministerial Statements, pollution licences and clearing permits).

A register of closure obligations relevant to the Io Project has been completed. The register includes specific requirements from: Licence Condition, Programme of Works (PoWs), tenement conditions, and management plans. The register is a dynamic document that will continually be updated with regard to future approvals and conditions.

12.4 Collection and Analysis of Closure Data

Baseline studies have been described in section 2. In a mine closure context baseline studies have been used to:

- Establish achievable closure outcomes and goals in a local and regional context;
- Establish baseline conditions for closure monitoring programs, including identification of reference sites; and
- Identify the issues to be managed through the mine closure process.

An additional study specific to mine planning and closure includes:

- Waste rock characterisation

12.4.1 Waste Rock Characterisation

Geochemical characterisation of all potential waste material has been undertaken over the Project area. This included a high level statistical analysis of assay data from the geological block model with respect to sulphide distribution. Detailed geochemical testing was then carried out on 23 samples of materials representing the range of potential waste material types (Detritals, Joffre and Whaleback shale) likely to be encountered within the pit. The testing programme included:

- Determination of total metal content.
- Determination of Metalliferous Leaching (ML) potential by using the Australian Standard Leaching Procedure (ASLP).

- Determination of Acid Rock Drainage (ARD) potential.
- Determination of asbestos content.

Total Metal Content and Metalliferous Leaching

Inductively coupled plasma mass spectroscopy (ICP-MS) was used to determine the total metal composition of the 23 samples. This analysis was conducted to ascertain any elevated quantities of metals in the samples that could potentially be released from the waste rock materials as a result of leaching (i.e. as consequence of contact with water infiltrating run-off, surface waters, or ground water).

Trace metals identified from the ICP-MS were analysed by comparing them with the average crustal abundance for that element. A total of 14 samples exceeded the average crustal abundance including:

- seven samples of elevated arsenic (As);
- one sample of elevated lead (Pb);
- five samples of elevated antimony (Sb); and
- one sample of elevated selenium (Se).

Although the abovelisted samples are elevated they pose little environmental risk unless the contaminant is made bio-available following dissolution into surface or groundwater. To test the leachability of the elements within the samples they are subjected to ASLP testing methodology.

A total of 47 metals were analysed after a static water extraction (ASLP) was performed on the samples. For the most part, metals of concern such as arsenic, bismuth, cadmium, copper, lead, antimony and selenium were present in the effluent from the ASLP process, but all were below the Australian Drinking Water Standard 2004 guidelines. Elements found in elevated levels from the ICP-MS analysis are discussed below with respect to the ASLP results.

Arsenic

ASLP extractable arsenic tested across all lythologies showed that no sample exceeded the Australian Drinking Water Standard 2004 guidelines of the 7 micrograms per litre (µg/L) threshold. Based on this result, it is unlikely that arsenic will be a significant leachate from the waste rock either whilst in the TWRD or once replaced back into the pit. However, as the total digest samples generated arsenic concentrations above the average crustal abundance, Fortescue has commenced humidity cell (kinetic) testing as a precautionary measure.

Selenium

Selenium leached from all samples was reported below the detection limit of 2 µg/L. The Australian Drinking Water Standard guidelines place the safe limit at 10 µg/L. No apparent hazard exists for these materials with regard to selenium.

In terms of total Selenium content identified from the ICP-MS test, one sample from the Hc lithology returned a value of 2 mg/kg, whilst all other samples were below the NATA average crustal abundance. In view of the short period of time that these materials will be subject to surface leaching processes, together with the results received from ASLP tests, Selenium is unlikely to pose a material environmental threat.

Lead

Lead was flagged in the ICP-MS total metals data as being above the trigger level based on average crustal abundance for one sample of Whaleback Shale. ASLP data for this sample however showed that soluble lead is negligible and that all samples were below the method detection limit of 1 µg/L. The lead as recorded in the total metals data is most likely tied up in the goethite present in the sample and hence is unlikely to pose an environmental threat.

Antimony

Antimony was flagged in the ICP-MS total metals data as being above the trigger level based on average crustal abundance. However, none of the ASLP analyses exceed the Australian Drinking Water Standard guidelines and thus antimony is unlikely to pose a material environmental threat.

Acid Rock Drainage Potential

Based on detailed analysis of the geochemical, geological and hydrogeological data it is considered that the risk of acid generation (ARD) with respect to the proposed mining activities within the Io pit area, are relatively low. This assumption based on the following:

- The pit lies close to the ground surface and above the groundwater table, and comprises a large component of reworked and weathered materials (detritals and alluvium). As a result, the mineralogy of much of the deposit is likely to be well oxidised. Any sulfides that were naturally present are likely to have been oxidised as a result of weathering and leaching processes.
- No dewatering is required to achieve the required pit excavation depths, and as a result groundwater risks with respect to ARD are likely to be negligible.
- A high level statistical analysis of the geochemical assay data indicates that the majority of the materials within the pit shell have a Net Acid Producing Potential (NAPP) value close to or below zero.
- The results of the detailed geochemical testing support the high level assessment completed (which was based on the exploration assay data), and confirms that the lithology types likely to be encountered during mining of the pit are likely to present low risk with respect to AMD. The results are summarised as follows:
    - All Net Acid Generation (NAG) pH results were above 4.5 (indicating low potential for acidity generation).

- All samples classified as NAF except one sample of Joffre (this was the only sample with a marginally positive Net Acid Producing Potential (NAPP) value).
- X-Ray Diffraction (XRD) analysis indicates dominant mineral phases are quartz, hematite, goethite and kaolinite, no sulfide materials were identified.
- 14 of the 23 samples had NAG pH of greater than 8 indicating the majority of samples have a tendency to produce alkaline rather than neutral or acidic leachates upon oxidation. This is supported by ASLP leach testing which indicates the sample will generate alkaline leachate on initial contact with water.
- The material is not likely to present a high risk of saline drainage based on low EC and TDS results from leach testing, low soluble mg, na and ca levels from leach testing, and considering the low risk of acidity generation of the material.
- All potential waste material types have been identified on a bulk analysis basis as being NAF, with the detritals and dolerite being identified to have a moderate acid consuming potential (NAF-NAC).

Asbestos

All 23 samples underwent visual asbestos fibre testing. None were found to contain asbestos.

12.5 Stakeholder Consultation

Throughout the project planning, Fortescue has been consulting with stakeholders directly affected by the Io Project and used face-to-face modes of engagement wherever practicable. A register of stakeholder consultation to-date has been developed and is presented in Section 4.

12.6 Post-Mining Land Use

The Io Project area lies wholly within the Marillana Pastoral Lease and hence the current land use is for pastoral activities. Post-mining, Fortescue is proposing to reinstate the land use to support pastoral activities.

12.7 Closure Objectives and Completion Criteria

The over arching closure objectives for the closed project site will be as follows:

- Safe to humans and animals.
- Geo-technically stable, geo-chemically nonpolluting.
- Capable of sustaining the specified post-mining land use.
- No residual liabilities relating to the site.

- The final re-contoured site will be designed, constructed and rehabilitated to ensure that subsequent natural erosion processes will not expose mineralised waste.
- The site will be rehabilitated to a final shape, height, stability and ability to support native vegetation that is comparable to natural landforms in the area.
- To reinstate the “natural” ecosystems as similar as possible to the original ecosystem for pastoral use.

Specific objectives that support the overarching closure objective are shown in Table 40. As more information becomes available, for example as a result of the research and rehabilitation trials, specific quantitative metrics will be applied to each of the completion criteria.

It is important that the framework for closure be consistent with the key drivers for closure and rehabilitation requirements. Legal and other obligations are key drivers that establish closure requirements, so those relating to closure have been sorted to correspond with the aspects identified in Table 40 to demonstrate this connection.

The completion criteria for the project are specified in Table 40.

Table 40: Closure Objectives and Completion Criteria

Aspect	Objective	Completion Criteria
Compliance	Comply with all relevant legal obligations	All applicable obligations are met.
		All applicable conditions and commitments are met.
Landforms	Backfill the pit to proposed design	The pit is backfilled to create a free draining surface
	Return all waste rock to the pit void	No waste landforms are left on site
	Landforms will be constructed to encourage the establishment and sustainability of local native vegetation and fauna habitat consistent with surroundings.	Rehabilitated landform surfaces will utilise materials that provide suitable growth medium. These will be used in such a way as to maximise their resilience to erosion, fire, drought and grazing by native animals.
Revegetation	Disturbed areas will be revegetated with local native species in a way that enables communities to establish that as similar as possible to baseline/target communities.	Suitable monitoring and analogue sites are established for the purposes of Landform Function Analysis. Flora species in rehabilitation areas are representative of the range of flora from target sites. Foliar cover is within or consistently progressing towards the foliar cover on target sites.

Aspect	Objective	Completion Criteria
	All disturbed areas will be revegetated unless otherwise agreed with DMP.	Written agreement from DMP for areas to be retained without revegetation.
	Revegetation does not introduce any new or additional weed or feral animal burden to the surrounding landscape.	Weed and feral animal burdens are consistent with or less than at analogue sites.
Fauna	Specific native fauna habitat for species of high conservation or ecological value will be included in rehabilitation areas where practicable and in accordance with approval conditions.	Dependent upon approval conditions.
Hydrology	Surface water flow patterns and quality do not significantly adversely impact on upstream or downstream environmental values or uses.	Surface water flow and quality as measured at agreed locations is within agreed ranges.
	Groundwater flow patterns and quality do not significantly adversely impact on downstream environmental values or uses.	Groundwater flow and quality as measured at agreed locations is within agreed ranges.
	Surface and groundwater resources within the disturbed area are of similar quality as the surrounding water sources.	Surface and groundwater sampled within the disturbed area is of similar quality as samples from surrounding water sources, for a twelve month period.
Infrastructuer and waste	Infrastructure locations will be rehabilitated such that no construction materials remain above ground.	No constructed materials above ground unless agreed in writing with DMP to be retained.
	No contaminated or hazardous materials are left on site.	Any contaminated sites are classified as remediated.
Social and Access	No disturbance of heritage sites during rehabilitation and access to sites of significance preserved by agreement with the Traditional Owners and DMP.	Site heritage register maintained and no impact on sites from rehabilitation. Site access plan agreed with Traditional Owners and DMP.
	Access for management purposes as agreed with the post-closure land manager	Site Access Plan approved by DMP.

12.8 Identification and Management of Closure Issues

The Project has been considered in terms of potential risk to the environment by utilising expertise of experienced environmental and mining personnel, including staff from Fortescue, GHD and Tetra Tech. Fortescue has specifically designed the project to have minimal environmental issues. This has been achieved by:

- Planning to backfill the mine void.
- Avoiding the creation of permanent waste landforms.
- Ensuring that the geochemical composition of the waste rock is environmentally benign.
- Removing all infrastructure post closure.
- No mining below the water table.
- Returning waste material, in the most part, to their place of origin in the pit.
- Designing the backfilled pit to be water shedding.

Notwithstanding the above, the following mine closure risks have been identified which may impact on achieving closure criteria:

- Geotechnical stability of the backfilled mine pit.
- Geochemical stability of the temporary waste rock dump.
- Geochemical stability of the backfilled mine pit.
- Geochemical stability of the remnant pit wall.
- Stability of the remnant pit wall.
- Public safety and the remnant pit wall.
- Hydrocarbon and other chemically contaminated sites.
- Identification and management of problematic materials.
- Erosion of revegetated areas.
- Unsuccessful revegetation.
- Impeding natural water courses.
- Insufficient waste to backfill the mine pit.
- Stakeholder expectations.

The Mine Closure Plan specifically addresses these risks in terms of how they are likely to affect closure, and how they will be managed and or mitigated.

12.9 Financial Provisioning for Closure

The objective of financial provisioning for closure is to ensure that adequate funds are available at the time of closure and that the community is not left with an unacceptable liability.

Cost estimates for unplanned closure of the Io Project, was calculated using the Bond Calculator provided on the Victorian Department of Primary Industries (DPI) website.

As some costs will vary for a project located in isolated rural Western Australia compared to other projects in Victoria, Fortescue have used a schedule of rates compiled specific to Fortescue operations.

12.10 Closure Tasks and Implementation

The implementation of closure requires specific activities to be undertaken to ensure it can be completed successfully. Topsoil and growth medium are an integral aspect of closure implementation. In addition the site has been divided into domains of similar rehabilitation requirements.

12.10.1 Topsoil Budget and Growth Medium Management

Topsoil management will be in accordance with Fortescue's 'Io Land Clearing and Topsoil Recovery Procedure'. The procedure specifies that vegetation clearing and topsoil stripping will be restricted to the footprints of specified Project Domains. In general this will include:

- Topsoil will be recovered in a single phase for all areas except the Mine Pit footprint. Topsoil recovered to a depth of 30 cm.
- Within the Mine Pit footprint, materials will be recovered in two phases. The first will see materials recovered to a depth of 50 cm. Thereafter a second phase of 'subsoil' salvage will occur to a depth of approximately 2.5 m. It should be noted that subsoils consist of approximately 61 percent gravel and 39 percent sand and fines.
- Topsoil will placed in one of three designated topsoil stockpile areas as shown in with the exception of that topsoil stripped from linear infrastructure. All linear infrastructure will have topsoil stored adjacent it.
- Topsoil placed in Soil Stockpiles 1 & 3 will be windrowed to a maximum depth of approximately 2.5 m. Soils from the pit will be placed into Soil Stockpile 2 to a height of up to 10 m. Soil Stockpile 2 will be divided into two parts, true top soils (Soil Stockpile 2a) and subsoils (Soil Stockpile 2b).

12.10.2 Topsoil Budget

A topsoil budget and movement plan has been prepared for the Project. The total volume of topsoil to be stored during the Io Project is estimated at 3.6 Mt. This includes:

- Approximately 2.3 Mt of subsoils and topsoils to be stripped from the 53 ha footprint of the Mine Pit and placed in Soil Stockpiles 2a & 2b.
- Approximately 1.3 Mt will be stripped from the other project domains within the Project Area covering an area of approximately 133 ha. This will be placed into Soil Stockpiles 1 & 3.

12.10.3 Closure Domains

The site has been broken down into domains, sub-domains and finally individual items. This breakdown enables the closure requirements to be identified at an appropriate level of detail for mine closure planning and is consistent with the Guidelines. For each domain, sub-domain and item, one or more tasks have been identified that represent the key steps toward meeting the objectives and completion criteria for the site. This will assist in the post-mining land use to be implemented. The domains include:

- Domain 1: Mine Pit.
- Domain 2: TWRD and Topsoil Stockpile footprints.
- Domain 3: ROM Pad and Processing Plant.
- Domain 4: Industrial infrastructure.
- Domain 5: Accommodation Camp.
- Domain 6: Bores and water supply infrastructure.
- Domain 7: Roads and tracks.

The closure planning for each domain is specifically discussed in the Mine Closure Plan.

12.11 Closure Monitoring and Maintenance

Environmental performance will continue to be monitored during decommissioning, rehabilitation and post-closure stages of the Project until completion criteria have been met and tenure relinquished. Closure tasks and targets or guidelines for acceptance for each task have been identified. Auditing will ensure that a particular task has been completed to the required standard. This approach is suitable for the initial closure stages of removing infrastructure, earthmoving and creating surfaces for rehabilitation.

The results of closure monitoring will be reported through Fortescue's Annual Environmental Reports (AER) and will be used to show progress against the agreed completion criteria and rehabilitation targets. Any remediation where results are outside the agreed targets will also be reported in accordance with the DMP's AER Guidelines.

Anticipated post-decommissioning monitoring includes:

- Landscape Function Analysis; and
- Surface water and groundwater monitoring.

It is also noted that additional audits and monitoring may be required following corrective action if completion criteria are not met as planned. In the event that it appears that completion criteria are not being met, corrective actions will be identified and implemented, objectives and targets re-set and fed into the subsequent versions of this MCP. The MCP will be reviewed and updated on a regular basis and will include monitoring and assessment of progress, corrective actions for failures, consideration of risks and stakeholder input.

Maintenance of the Project site is expected to be necessary post closure for a limited duration until relinquishment or handover is able to be completed as the closure intention is to leave the company and the State with no unacceptable liability.

Maintenance programs for the Project which have been budgeted for include:

- Small scale landform remediation;
- Drainage system maintenance;
- Erosion control activities; and
- Road maintenance activities.

12.11.1 Relinquishment of the Associated Leases

Once rehabilitation has been successful with stabilisation and revegetation meeting the completion criteria, Fortescue, at its discretion, may then seek to relinquish or to dispose otherwise of the associated lease(s) in accord with and subject to normal statutory processes.

12.12 Closure Considerations for Specific Aspects of the Proposal

The key outcomes at mine closure are as follows:

- There will be no permanent landforms created by the project and all project related infrastructure will be removed.
- Waste rock will be largely returned to place of origin.
- Mining will be restricted to above the water table.

- The pit will be backfilled.
- The final surface will be water shredding.

Given these circumstances, the key closure consideration is the performance of the cover design placed over the backfilled pit in respect of potential erosion.

12.13 Unexpected Closure

It is considered highly unlikely that the Project will cease operations prior to the planned 4 year life of mine. However, in such an event, Fortescue may elect to place the Project into a care and maintenance whilst options are identified and evaluated. A detailed Care and Maintenance Plan would be provided to DMP in these circumstances.

In the event of the unexpected early closure of the Project, the Project will be closed in accord with this Closure Plan.

12.14 Review and Improvement of the Mine Closure Plan

Fortescue will review and update the Closure Plan annually. Given the Life of Mine is only four (4) years, Fortescue will re-submit the closure plan in year three.

13. NOISE IMPACT ASSESSMENT

SLR Consulting Australia completed an environmental noise and vibration impact assessment of the Project, the report for which is provided in Appendix K. SLR Consulting Australia assessed the potential noise and vibration impacts associated with the operation of the Project on the nearest sensitive receivers and identified any mitigation and management measures that are to be implemented to meet the relevant noise and vibration criteria. Refer to Figure 33 which shows the extended Study area for this assessment.

The noise assessment examined operational plant noise, road product transport noise and blast overpressure and ground borne vibration effects in accordance with the requirements of the *Environmental Protection Act 1986* (the Act) and the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

The major sources of noise and vibration from the Project will include:

- Vehicle movements and onsite equipment.
- The crushing and screening plant.
- Blasting operations.
- Transportation of product.

Potential negative noise and vibration impacts (of material consequence) resulting from the construction and operation of the Project are as follows:

- Excessive noise levels experienced at the sensitive receptor from blasting, crushing and screening.
- Vehicle and equipment usage.
- Altered fauna behaviour.

13.1 Sensitive Receptors

The noise assessment identified the following nearest potential known sensitive human receptors in relation to the mine site and haul road options:

- The Project Accommodation Village within the Project Area and approximately 2.5 km from the mine workings.
- Marillana Station approximately 7.5 km north of the Project area and 700 m south-east from the proposed haul road options.
- Rio Tinto owned Yandicoogina Accommodation Village which is approximately 13 km south-east from the Project area.

- Fortescue Marsh which is approximately 30 km north of the Project area and 15 km from the proposed haul road options.
- Roy Hill Station which is approximately 4.5 km north from the proposed haul road options.
- Auski Road House which is approximately 350 m north-west from the proposed haul road options.
- Along the haul road routes some structures unknown in land use were identified, for the purpose of this study these were included as receptors and described as follows:
  - Unknown Building 1 – Geographical co-ordinates 0725625, 7505254.
  - Unknown Building 2 – Geographical co-ordinates 0729829, 7502666.
  - Unknown Building 3 – Geographical co-ordinates 0773003, 7484528.
  - Unknown Building 4 – Geographical co-ordinates 0800343, 7491492.
- Structures that were associated with the BHP Iron Ore rail line have not been included as potential receptors.

13.2 Findings and Mitigation Measures

13.2.1 Mine

The assessment carried out by SLR found that the predicted noise levels at Marillana Station and Yandicoogina Accommodation Village are compliant with the criteria contained within the *Environmental Protection (Noise) Regulations 1997.*

The noise levels at the proposed Io Accommodation Village were found to exceed the criteria by 10 dBA, however the proposed Accommodation Village is located within the mining tenement area and therefore falls outside the definition of an external sensitive receptor for the purposes of the Regulations. Subsequently the Regulations do not apply to the proposed Accommodation Village given it is classified as a Project facility rather than a sensitive receptor. However, the *EPA Guidance for the Assessment of Environmental Factors Environmental Noise, Draft No.8* states that camps for operational staff should be located and designed so as to achieve compliance with the assigned levels.

In order to achieve compliance with the Criteria at the Accommodation Village construction of a noise bund or barrier has been recommended. Preliminary calculations by SLR indicate that the bund would need to be 3.5 m high and extend the length of the northern and western perimeters of the village facing the mine site. Despite the predicted external noise levels at the proposed Accommodation Village exceeding the criteria within the Noise Regulations, SLR indicate that the internal noise levels within the accommodation units are likely to comply with *AS2107 Acoustics – Recommended design levels and reverberation times for building interiors (for sleeping areas).* This criterion is considered adequate to protect the acoustical amenity of

people in the mine site accommodation i.e. to achieve restful sleep during the day or night. The proposed residential areas will have split system air conditioning, and the noise generated will assist to provide a degree of 'acoustic masking', helping to improve the overall internal acoustic amenity of the accommodation areas. No further mitigation works are necessary, however this will need to be reviewed during detailed design to ensure the facade Transmission Loss of the building is adequate.

13.3 Roads

The predicted noise levels at the nearest sensitive receivers for the Solomon and Cloudbreak haul road options compared against the relevant night time (most stringent) criteria are within both the Noise Target (50 dBA) and Noise Limit (55 dBA) criteria contained within the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning.*

The vibration levels from passing road trains at the nearest receptor are negligible and are therefore compliant with both the structural damage and human comfort vibration criteria.

14. DUST IMPACT ASSESSMENT

An Air Quality Assessment has been carried out by SLR Consulting Australia Pty Ltd (SLR Consulting) assessing the potential air quality impacts associated with the proposed Haul Road options associated with the Project area (refer Figure 33 and attached in Appendix L). The assessment identifies the potentially affected sensitive receptors to the proposed haul road options and assesses the potential air quality impacts associated with the haul road options.

As discussed in the SLR Consulting assessment report, the WA DEC routinely adopts ambient air quality goals in the assessment of new Projects, and in the management of both local and regional ambient air quality. The DEC has adopted the objectives set by the National Environment Protection Measure for Ambient Air Quality (NEPM) for ambient air quality. Adopting the NEPM goals is an interim approach while the DEC, in conjunction with the Department of Health, develops ambient air quality guidelines for WA. As explained in the SLR Consulting assessment report, the National Environment Protection Measures are broad framework-setting statutory instruments defined in the National Environment Protection Council (NEPC) legislation.

In the absence of an NEPM standard, the WA DEC will adopt the World Health Organisation (WHO) Guidelines for Air Quality (2000) which was updated in 2005. In the absence of a NEPM standard or a WHO guideline, the WA DEC will adopt goals from another jurisdiction (once it has been assessed and determined to be applicable to the WA context).

The assessment report also indicates that the proposed haul road options are not in the region covered by the Kwinana EPP. The Policy defines three geographical areas, as defined by WA EPA:

- Area A is the area of land on which heavy industry is located.
- Area B is outside area A and is zoned for industrial purposes from time to time under a Metropolitan Region Scheme or a town planning scheme.
- Area C is beyond Areas A and B, predominantly rural and residential.

The criteria specified in Kwinana EPP for Area C may be applied by the WA DEC in lieu of other standards for an area such as the Project area.

As discussed in Section 13, a number of potential known sensitive human receptors have been identified in relation to the mine site and the proposed haul road options.

Due to the length of the proposed haul road, it was not feasible to undertake detailed modelling for the entire road lengths, as the scale of the length of the routes would result in a lack of detail at the critical locations where the localised traffic may cause air quality impacts. The assessment therefore focused on the identification of locations where sensitive receptors are located in close proximity to the haul road. The location and distance of the sensitive receptors

to the haul road was used to determine discrete sections of road which have been assessed in much greater detail. The locations of each detailed assessment are summarised below:

- Marillana Section (heading east, 1.6 km from road, 10 source nodes at 180 m spacing).
- Roadhouse East Section (1.1 km from road, 12 source nodes at 100 m spacing).
- Roy Hill Station Section (1.9 km from road, 11 source nodes at 110 m spacing).

A direct comparison of impacts between the two options is problematic, as it would not consider comparable receptors.

Where opportunities for route realignment are not feasible, the assessment report recommend that further mitigation should be considered, including the following measures in close proximity to the potentially affected receptors:

- Considerate road design to minimise mechanical erosion of the road surface and maximise surface drainage to prevent puddling of rainwater.
- Considerate selection of road surface materials to use materials with lower silt content.
- Regular road maintenance, including repair of ruts and holes, and regular compaction and resurfacing.
- Provision of a sealed road surface.
- Watering of the haul road, and the application of appropriate surface dust suppression treatments and additives.
- Imposition of speed limits to 40 km/h and 25 km/h close to the receptors.
- Reduced traffic along the route through the use of fewer and heavier trucks.

15. SUMMARY OF LIKELY ENVIRONMENTAL MEASURES AND CONTROLS

15.1 Environmental Management Framework

15.1.1 Overview

In addition to implementing the requirements of specific environmental conditions set by the EPA if the Project is approved, the Proponent will minimise environmental impacts through:

- Maintaining an Environmental Management System (EMS).
- Implementing the Environmental Management Plan (EMP) for the Project.
- Regularly reviewing the performance of the EMS, EMP and developing environmental improvement plans for priorities identified in the reviews.
- Continually updating mine plans and closure, progressively rehabilitating and measuring success.
- Training staff and contractors in environmental requirements and considerations of their work.
- Ensuring that stakeholder views are sought, respected and considered.
- Reporting regularly to stakeholders on performance.
- Aligning with the Fortescue Environmental Policy.

Fortescue will abide by all relevant current and future statutory requirements.

15.1.2 Environmental Policy

The Fortescue Environment Policy communicates what Fortescue are committed to achieving:

1. Fortescue is committed to maintaining sound environmental management practices and meeting our responsibilities.
2. Fortescue recognise the importance of minimising environmental impacts as it is important in ensuring the company's longevity, success, growth and positioning in the domestic and global markets.
3. Fortescue decision making processes will incorporate sustainability principles and the implementation of new and better technologies where feasible. Fortescue aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning.

4. Fortescue encourage employees to engage in positive attitudes and behaviour concerning respect for the environment. We recognise sustainability cannot be achieved without the contribution and action of the entire team.

15.1.3 Environmental Management Plan (EMP)

The proposed management of the key issues associated with the Project will be documented in an EMP to be implemented to manage specific environmental aspects of the Project. Implementation of the Project in accordance with the EMP will ensure that the Project meets all respective environmental obligations including internal objectives, legislation, regulations, and conditions of approval relating to operation of the Project.

The EMP will be comprised of management sub-plans that describe the specific environmental objectives and targets for each environmental factor, the management measures to be applied to avoid and minimise the environmental impact of the Project, monitoring measures to measure the performance of management against the targets, and contingency measures to mitigate unavoidable or accidental impact. The sub-plans are as follows:

- Groundwater Management
- Surface Water Management
- Fortescue Marsh Management
- Biodiversity Management
- Closure Management
- Cultural Heritage Management.

The EMP will be regularly reviewed and revised where appropriate. There are existing management plans in place for the Cloudbreak mine which will be implemented for this Project.

15.2 Summary Of Likely Environmental Control Instruments

Fortescue has identified the regulatory controls that will be applied to ensure appropriate management of the Project (Table 41). The key controls include (but are not limited to):

- Any conditions of DEC Works Approval(s) (under Part V of the EP Act) for construction of works on prescribed premises (ore processing, and sewage facility).
- Any conditions of DEC Licence(s) (under Part V of the EP Act) for the operation of activities on prescribed premises (ore processing and sewage facility)
- Any conditions of the DoW Licences and Permits for activities relating to the abstraction of groundwater (under the RIWI Act).

- Any conditions of Mining Projects approved by Department of Mines and Petroleum (DMP), including closure management plans.

Management controls to be implemented as part of the Project to ensure key environmental factors are managed as described in this report include measures and/or actions contained within the following documents:

- Design and feasibility reports.
- Environmental management plan.
- Mine closure plan.

Table 41: Statutory and Environmental Management Controls for the Project

Factor	Topic	Commitments	CEMP/ EMP/ Mine Closure Plan	Works Approval/ Licence (Part V)	Other Relevant Legislation and Regulations
Key environmental factors					
Groundwater	Extent of groundwater drawdown	✓	✓		✓ Licence under RIWI Act
	Groundwater quality		✓	✓	
Surface water	Diversion of creek lines	✓	✓		
	Site drainage		✓	✓	
	Surface water quality	✓	✓	✓	
Vegetation and flora	Extent of vegetation clearing	✓	✓		
Terrestrial fauna	Extent of habitat removal	✓	✓		
	Rare and endangered fauna		✓		✓ WC Act
Conservation areas	Protection of Fortescue Marsh	✓	✓		
Aboriginal heritage	Aboriginal heritage sites		✓		✓Aboriginal Heritage Act
Closure	Decommissioning, decontamination/ remediation, and rehabilitation	✓	✓		✓ Mining Act
Other management coniderations					
Dust	Emissions management	✓	✓		
Noise	Emissions management	✓	✓		✓ EP (Noise) Regulations

15.3 Summary of Potential Impacts, Proposed Management Commitments and Environmental Outcomes

A summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed is presented in Table 42.

Table 42: Summary of the Impacts and Proposed Management Commitments

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Groundwater	• To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. • To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.	• National Principles for the Provision of Water for Ecosystems (ANZECC/ ARMCANZ 1996) • National Water Quality Management Strategy (ANZECC/ ARMCANZ 2000) • State Water Quality Management Strategy 2001 • Department of Water's Water Quality Protection Notes • Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000.	The hydrogeology of the Study area is part of a regional groundwater system, including the aquifers within the Weeli Wolli palaeo-valley located to the south of the study area and Upper Fortescue Valley located to the north of the Study area. The main groundwater-related (hydrogeological) units in the study area are Upper Tertiary Alluvium, Lower Tertiary Alluvium, Tertiary Detritals, Channel Ore Deposits, Mineralised/fractured Brockman Iron Formation, Fresh Brockman Iron Formation, and Siliceous breccia/weathered dolomite. Approximately 0.15 GL of recharge is estimated from rainfall recharge. Under natural conditions it is estimated the study area receives an average net recharge of 10 GL/a, which is largely attributable to flow events in the Weeli Wolli system. Mine water discharge occurring upstream in the Weeli Wolli catchment is estimated to be in the order of 43 GL/a. Given that evapotranspiration losses are expected to be up to 10 GL/a, it is estimated that 33 GL/a enters the aquifer system and flows through the project area. The mine water discharge from mines upstream is the most dominant component of the water balance. Mine water discharge is forecasted to at least 2025.	The proposed mine void will be excavated to a maximum depth of 33 m which is above the water table. There will be no direct interaction with groundwater in the pit void reducing the potential for contamination and eliminating the need for ongoing dewatering. The geology of the mine is considered to be geochemically benign. Hence, there is not expected to be groundwater contamination from metalliferous drainage or PAF materials. A chemical or hydrocarbon spill could potentially impact on groundwater quality if surface water flows were sufficient enough to carry it into the groundwater system. The potential for chemicals and/or hydrocarbons to enter the groundwater system is considered low. This is based on the limited avenues in which these substances could enter the groundwater system and the mitigation due to the implementation of Fortescue's Hydrocarbon and Chemical Management Plan. No changes to water quality are predicted from the proposed abstraction activities. The proposed abstraction represents less than 4% of total inflow into the study area. Saline groundwater located to the north will not be drawn into the Study area. Groundwater is proposed to be drawn from three supply bores. The proposed abstraction represents less than 4 % of total inflow that recharges the aquifer in the study area. Therefore no change to the natural groundwater flow regime or water balance is expected Predicted drawdown of the water table is within the flutuations currently experienced as a result of natural cycles will be minimal.	A groundwater operating strategy for the Project will be submitted as part of a Department of Water abstraction permit (5C licence). These strategies will include a detailed description of the following items: • Identifying and Managing Impacts • Operating Rules for Abstraction • Monitoring and Reporting • Contingency and Trigger Levels Fortescue will implement a Hydrocarbon and Chemical Management Plan to minimise the risk of spills and subsequent groundwater contamination. Fortescue will implement a Hydrocarbon and Chemical Management Plan to minimise the risk of spills and subsequent groundwater contamination. Pumping from the three Project water bores will be managed to minimise drawdown, which may affect other beneficial uses in the area (i.e. livestock watering). Management will consist of continuous water level monitoring and ongoing adjustment of pump tensing rates that significant drawdown does not occur through over abstraction.	The assessment has drawn the following conclusions: • The risk of potential impacts to groundwater within the mining area is considered low. • The mineral deposit is located above the regional water table. Consequently, there is no need for dewatering during mining. Therefore groundwater levels and quality should not be impacted by the direct mining of the deposit. • A Hydrocarbon and Chemical Management Plan will be implemented to limit any impact on groundwater as a result of hydrocarbon and chemical use within the mine area. • An assessment of the acid generating potential of the ore and waste was undertaken over the proposed mine pit area. Based on this assessment the potential for acid generation is considered low. • Based on this assessment, it is predicted that Fortescue will maintain the quantity of groundwater so that existing and potential environmental values are protected. In addition, the quality of ground water is expected to be maintained so that Fortescue meets statutory requirements and acceptable standards.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Surface water	• To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected • To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards	• National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996) • National Water Quality Management Strategy (ANZECC/ARMCANZ 2000) • Water Quality Protection Notes and Guidelines – Mining and Mineral Processing (2000) • Department of Water's Water Quality Protection Notes • Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000.	The Project Area lies within the Upper Fortescue Catchment The major tributaries contributing to the Fortescue Marsh are Weeli Wolli Creek, Yandicoogina Creek and Mindy Mindy Creek. The Weeli Wolli Creek flows through the Study area and drains into the central-southern part of the Fortescue Plain area, forming a broad out wash fan at the foot of the Hamersley Ranges draining towards the Fortescue Marsh. The Marillana and Weeli Wolli Creeks converge approximately 10 km upstream from the Study Area. Fortescue Marsh is approximately 30 km north of the Project and no springs or pools are known to exist in the Study area. Fortescue Marsh is included in the Australian Heritage Commission Register of the National Estate as an "Indicative Place", and in the Directory of Important Wetlands in Australia The existing case and operational case including the bund around the mine site were modelled with the critical outputs (flood depth, velocity, flood discharge, flood duration) gathered at specific locations around the proposed mine site. The modeling shows, the proposed infrastructure is located outside the 1 in 20 year flood extents, and in shallow flood extents in a 1 in 50 year event.	The main environmental value of Surface Water in the Project area is supporting the ecology of the Fortescue Marsh. • Construction of infrastructure on the floodplain can impede flood flows or increase/decrease flood levels adjacent to, upstream and downstream of the infrastructure; • Mining pits filling up with flood waters reducing peak flows and volume of water moving downstream; • Flood protection infrastructure can isolate areas of the catchment reducing the peaks flows downstream. The following activities could potentially impact on the surface water quality of Weeli Wolli Creek System: • Hydrocarbon spills if not contained • Runoff from Stockpiles and Waste dumps if discharged untreated • Discharge of in-pit stormwater if untreated • Runoff from roads • Explosive spills • Spills from sewage treatment plant	The surface water management strategy for the Project will be designed to: • Minimise significant delays to mining operations subject to economic constraints • Ensure the safety of personnel on site; and • Does not result in impact to the receiving environment downstream that is outside natural conditions. The surface water management strategy will be focused on two main areas: • flood waters from Weeli Wolli Creek and other ancillary catchments; and • mine site stormwater Management of potential impacts on surface water from this Project are also addressed in the EMP and includes the following key management actions: • Divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible. • Separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection. • Minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas. • Locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation. • Ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding. • Disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required. • Ensure that chemical storage is undertaken in a manner that limits potential surface water contamination. • Manage clearing and earthworks to minimise erosion.	Through the mitigation measures, the Project is expected to result in the following outcomes in relation to surface water: • No significant impact on water quality and quantity of water entering Fortescue Marsh. • No increases in velocity of peak flows in major creek lines during the project. • No expected impact to protected species utilising the tributaries or Marsh systems. • All surface flow from potentially contaminated areas contained. • Minimal risk in increase in turbidity during high flow events, although flows in the area are already highly turbid. These impacts are considered to be acceptable as the key environmental values surrounding the Project will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms. More information on closure management is provided in Section 12. It is expected that the EPA objective for this factor will be met.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Vegetation and Flora	• To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• National Strategy for the Conservation of Australia's Biological Diversity • National Strategy for Ecologically Sustainable Development • EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000) • EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) • EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c).	The vegetation is typically open, and frequently dominated by Spinifex, Wattles and occasional Eucalypts. Five broad floristic vegetation categories occur in the project area (Cardno, 2012) including: • Hummock grassland on sand plains. • Acacia woodlands in flowlines. • Major creeklines. • Hummock grassland on rocky hills. • Mulga on clay/clay loam Plain vegetation. The condition of the vegetation in the Project area ranges from Poor to Excellent in condition as per Trudgen (1991) condition scale (Cardno, 2012). • No TEC listed as matters of national significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) or under the *WA Wildlife Conservation Act 1950* were identified in the desktop assessment or recorded during the surveys (Cardno, 2012). Two Priority Ecological Communities (PECs) were identified in the desktop assessment in the search area. No PECs were recorded within the Project area (Cardno 2012) • No Threatened Species or species listed as threatened under the *Wildlife Conservation Act 1950* or the EPBC Act were recorded within the Project Area during the flora and vegetation survey (Cardno 2012). A targeted search for the DRF species *Lepidium catapycnon,* which was identified from the DEC database search as having been previously recorded from the vicinity of the Project Area, did not result in the identification of plants at the location where it had been previously recorded (Cardno 2012). • One introduced species, *Cenchrus ciliaris* (Buffel grass) was recorded in the Project Area.	The likely impacts of the Project will include: • Vegetation clearance activities; • Alterations to surface hydrology; • Alterations to groundwater hydrology; • Introduced species; • Alterations to natural fire regimes; and • Dust Vegetation clearing is a direct impact that will result from the implementation of the Project. Vegetation clearance will be required for the purpose of establishing mining infrastructure and the camp facilities. Although there will be a slight shadowing effect on sheet flow from the placement of infrastructure, there will be no impact to the Priority 3 Fortescue Marsh. Ecological Community or the Priority 3 Fortescue Valley Sand Dune Ecological Community One introduced species was recorded within the project area, *Cenchrus ciliaris* (Buffel grass). This weed is not listed as a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*.	A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required • All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing. • Clearing and disturbance of vegetation will be kept to a minimum. • Impacts to vegetation and flora will be managed under the Biodiversity Plan in the EMP. To minimise the potential for adverse changes to the structure and floristic composition of the vegetation of the Project Area a fire management/prevention plan will be implemented. This plan will aim to: • Eliminate (or actively suppress) uncontrolled fires originating from mining activities; and • Dust suppression measures will be implemented to minimize the impact of dust from cleared areas and vehicle movement.	The proposed project is expected to result in the following outcome in relation to flora and vegetation: • Approximately 370 ha of vegetation will be disturbed by the Project, with the majority of this occurring in Triodia hummock grassland Sand Plain vegetation. • Mulga vegetation will be directly affected by the proposed project by a slight alteration to the surface water regime. This change is expected to me minor, and therefore will have negligible impact on the Mulga. • Mulga vegetation will not be subject to injection of surplus water into aquifers and will therefore not be affected by groundwater mounding beneath vegetation. • No Priority Ecological Communities, DRF or Priority listed flora will be affected by the proposed project. Proposed vegetation clearing and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the "threshold level" of 30% of its pre-clearing extent

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Terrestrial Fauna	• To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. • To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.	• EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) • EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a) • EPA Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA 2009) • .EPA Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003) • Draft Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007c).	The vertebrate fauna assemblage of the Study area was expected to comprise of 317 species based on the desktop review. The review of possible fauna diversity included three fish, five frogs, 104 reptile, 158 bird, 38 native mammal and eight introduced species. The initial field survey recorded 103 species in the project area, consisting of two fish, two frog, 43 reptile, four mammal and 56 bird species. An additional five species (two reptiles and three mammals) were recorded during the second phase of sampling. Two conservation significant species were recorded during the surveys within the Project area. These species were the Rainbow Bee-eater (*Merops ornatus*) and the Peregrine Falcon (*Falco peregrinus*).	• Each stage of the Project (construction, operation and closure/rehabilitation) has the potential to affect the abundance, distribution and condition of conservation significant fauna within the Project area and surrounds. Potential impacts of the Project on terrestrial fauna of conservation significance are: • Loss and/or degradation of regional representation of fauna habitat resulting in a direct loss of species, fragmentation effects and reduced breeding and foraging habitat. • Altered conservation status of fauna species and regional conservation significance of populations. • Injuries to and mortalities of fauna caused by interactions with vehicles, infrastructure, machinery and the workforce. • Reduced diversity or abundance of foraging resources due to an altered hydrological regime. • Presence of artificial water bodies (turkey dams) may result in the impact to native fauna through increases in introduced fauna, entrapment, or alteration of fauna behaviour. • Alteration in behaviour of fauna due to dust, noise, vibration and light emissions. • Increased presence of non-indigenous species due to introduction of workforce and vehicles, inappropriate waste collection and disposal practices, and inadequate rehabilitation of disturbed land, resulting in fauna mortality and/or competition for resources. • Increased fire potential from the presence of human activity in the area, resulting in the modification or loss of fauna habitat and conservation significant fauna. • Increased levels of dust may affect the quality of available habitat for shelter and foraging.	A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a GDP). Under the permitting process areas of vegetation which may comprise high value flora and vegetation, including of habitat value such as Mulga and 'habitat' trees, may require ground-truthing surveys to assess its value. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC. FMGs existing EMP "Biodiversity Management Plan" will be implemented for the Project and includes the following key management actions: • Clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above). • Significant fauna habitat will be spatially identified and where appropriate demarcated on site. • All lined surface water storage areas will have fauna egress points. • Vehicles speeds will be restricted across the Project area. • Off road driving or driving on restricted access routes will be prohibited other than for emergency situations. • Rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented. • Appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes. • Low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards. • Lighting will be directed onto construction or operational areas.	After mitigation measures have been applied, the Project area is expected to result in the following outcomes in relation to fauna: • Approximately 370 ha of fauna habitat will be disturbed with the majority of this occurring in open low shrubland of mixed acacia over spinifex on red sandy loam plain. • There will likely be some localised impacts to the Priority fauna species the pebble-mound mouse due to clearing activities. However, this species is widespread in the region and the Project area is unlikely to significantly affect its regional abundance or range. • Significant regional impact to fauna is unlikely as habitats that occur within the Project area also occur extensively outside the Project area. • The Project itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Project area. • Significant regional impact to SRE, stygofauna and troglofauna species is not expected to occur as a result of the Project area. • It is unlikely that the Project area will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act or listed as Scheduled under the WC Act or Priority fauna listed by the DEC. Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Fortescue Marsh Wetland Area	• To protect the environmental values of areas identified as having significant environmental attributes. • To maintain the integrity, functions and environmental values (of the Fortescue Marsh).	• Environment Protection and Biodiversity Conservation Act 1999 • Directory of Important Wetlands in Australia (Environment Australia 2001) • Register of the National Estate • The Japan Australia Migratory Bird Agreement (JAMBA), China Australia Migratory Bird Agreement (CAMBA) and Republic of Korea Australia Migratory Bird Agreement (ROKAMBA).	The Fortescue Marsh is the largest ephemeral wetland in the Pilbara Bioregion: • The Fortescue Marsh is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an "Indicative Place" on the Register of the National Estate – Waterbirds • The Marsh constitutes an arid wetland for waterbirds of national importance: 260 000 – 276 000 individuals from 47 species were recorded when the Marsh was inundated in 1999 & 2003. The Fortescue Marsh is an intermittently inundated wetland with broad-scale inundation occurring approximately one year in ten for a period of three to six months. The marsh has recently been classified as a Priority 1 Priority Ecological Community.	The Project Area lies within the Upper Fortescue Catchment. The Weeli Wolli Creek intersects the south-west extent of the Project Area and meanders in a general north-west direction forming a broad out wash fan at the foot of the Hamersley Ranges draining towards the Fortescue Marsh. The Fortescue Marsh is approximately 30 km north from the Project and no springs or pools are known to exist in the Project area (MWH, 2011). The predicted impacts on surface water are considered to be minimal and therefore the potential impact on Fortescue Marsh are also minimal. There is no predicted impacts in relation to groundwater as there is no proposed dewatering or injection of groundwater.	The surface water management strategy will be focused on two main areas: • flood waters from Weeli Wolli Creek and other ancillary catchments; and • mine site stormwater Management of potential impacts on surface water from this Project will include the following key management actions: • Divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible. • Separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection. • Minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas. • Locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation. • Ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding. • Ensure that chemical storage is undertaken in a manner that limits potential surface water contamination. • Manage clearing and earthworks to minimise erosion	The key potential impact to the Fortescue Marsh from the Project is the potential for changes in groundwater levels, and secondary effects on vegetation and fauna. Hydrogeological studies have predicted that there will be no impact on marsh hydrology from groundwater draw down. No threats to the ecology of the Fortescue Marsh from the Project are likely to be due to changes in groundwater levels and secondary effects on vegetation and fauna. It is expected that the integrity, function and environmental values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Aboriginal Heritage	• To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• Aboriginal Heritage Act 1972 (WA) Guidelines, Interaction between Section 18 of the Aboriginal Heritage Act 1972 (WA) and Part IV of the Environmental Protection Act 1986 • EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage.	The Project area is located within areas subject to the Federal Court Native Title Claims - Nyiyaparli (WC99/4). The Project area including associated infrastructure, camps and roads is located within Nyiyaparli country. Fortescue has formed a strong relationship with the Nyiyaparli people during the development and operation of the Cloudbreak and Christmas Creek mines. Heritage surveys have occurred over the Project area and all sites have been identified. The Nyiyaparli people have advised of a site with special significance that is located outside of the Project area to the north west. This site is outside of the project area and no disturbance will be conducted in or around this area.	The primary aspects of the Project that may potentially affect Aboriginal heritage values are: • physical disturbance of the land surface during clearing and removal of topsoil and overburden has the potential to disturb heritage sites and affect ethnographic values • presence of construction and operational personnel has the potential to disturb heritage sites and affect ethnographic values • Alteration of surface water flows has the potential to result in erosion of Aboriginal heritage sites. • Other indirect impacts on Aboriginal heritage sites from dust and vibration are not expected to occur. • No impact from the Project is expected on the semi-permanent pools of Aboriginal heritage value on the Fortescue Marsh (Yintas).	The Cultural Heritage Management Plan (CHMP) will be implemented within the Project. This will also ensure that changes to the physical environment do not affect Aboriginal heritage and culture. The key measures of the CHMP include: • identification of Aboriginal Heritage sites for inclusion into the Fortescue Aboriginal Sites Register • undertaking additional survey work within impact areas required to identify additional heritage sites • undertaking ongoing consultation with Traditional Owners together with their chosen heritage professionals • implementation of compulsory GDP prior to works commencing which is managed through the Business Management System • preventing unauthorised ground disturbance through the implementation of the heritage disturbance procedures • implementing heritage compliance procedures including the appointment of dedicated Heritage Field Officers whose primary roles include both supporting the heritage surveys and to enforce the obligations under the AH Act and the Land Access Agreements • delineation of heritage sites and implementing standards for identifying and assessing appropriate mitigation measures for each delineated site • ongoing auditing and reporting to ensure no further impact has occurred as a result of construction or operational activities • ongoing improvement of Aboriginal Heritage management procedures and reporting through the Business Management System • heritage incident reporting and response which would include the development of preventative actions to improve the heritage management plan • cultural heritage education, training and inductions of all staff with programs developed by local traditional owners employed by Fortescue.	The Proponent has conducted ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and DIA Fortescue maintains a site avoidance policy for this Project. The Project will be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group LAA.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Landform, Mine Closure Planning and Rehabilitation	• To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values. • To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.	• EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA 2006b) • Draft Guidelines for Preparing Mine Closure Plans (DMP 2010) • Environmental Notes on Mining – Waste Rock Dumps (DMP 2009a) • Other key government and industry guidelines relevant to mine closure and rehabilitation include: Strategic Framework for Mine Closure (ANZMEC and MCA 2000) Enduring Value – the Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia 2004) Best Practice Environmental Management in Mining Series (EPA 1995, Environment Australia 1998, 2002).	Throughout the life of the project up to 17.5 Mt of waste rock will be mined. Most of the waste rock will be placed in a single temporary waste rock dump (TWRD). The TWRD will be constructed so as to facilitate effective backfilling of the pit. Specifically the TWRD will be constructed such that, as waste rock is recovered, the mineralized waste can readily be placed in the lower areas of the pit whilst benign waste rock will form the upper layers and cap of the backfilled pit. At approximately year 3 within the life of the mine, work will commence on removing waste rock from the TWRD and replacing this material back into the pit. The reminder of the waste rock will be used in bulk earthworks, such as road upgrades and pads.	• Altered landform and the effect on surface water flows and erosion potential. • Erosion potential of the altered landform and associated potential water quality effects.	Closure management will assist in ensuring that disturbed areas are safe and suitably rehabilitated for the long term end land use as determined in consultation with relevant stakeholders and the community. Fortescue's environmental objectives in relation to rehabilitation and closure are to: • establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term • re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment • leave site in a safe, stable, non-polluting and tidy condition with no remaining plant or infrastructure that is not required for post-operational use • minimise downstream impacts on vegetation due to interruption of drainage • continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the approved completion criteria have been met. • the closure objectives will be achieved through the implementation of the decommissioning and rehabilitation measures specified in a Closure Management Plan to be developed two years prior to mine closure. A Mine Closure Plan has been developed, identifying the key aspects of closure.	The Project is not likely to result in significant environmental impact following closure when management measures are considered. The key outcomes at mine closure are as follows: • There will be no permanent landforms created by the project and all project related infrastructure will be removed. • Waste rock will be largely returned to their place of origin. • Mining will be restricted to above the water table. • The pit will be backfilled. • The final surface will be water shredding. • The key closure consideration is the performance of the cover design placed over the backfilled pit in respect of potential erosion
Noise	• To protect the amenity of nearby residents from noise impacts resulting from activities associated with the Project by ensuring the noise levels meet statutory requirements and acceptable standards.	• Environmental Protection (Noise) Regulations 1997 • EPA Draft Guidance Statement No. 8 (EPA 2007a).	The Project area is relatively remote from sensitive premises.	The mine is expected to be sufficiently remote to not impact on any nearby residences. The predicted noise levels at the nearest sensitive receivers for the Cloudbreak haul road compared against the relevant night time (most stringent) criteria are within both the Noise Target (50 dBA) and Noise Limit (55 dBA) criteria contained within the State Planning Policy 5.4 "*Road and Rail Transport Noise and Freight Considerations in Land Use Planning*". The vibration levels from passing road trains at the nearest receptor are negligible and are therefore compliant with both the structural damage and human comfort vibration criteria	Use low-noise equipment where practicable. Monitor blast noise near sensitive receptors to determine allowable blasting mass.	Noise emissions from this Project are not expected to result in noise impacts to sensitive receptors.

Environmental Factor	Management Objectives	Relevant Standards and Guidance Documents	Existing Environment	Potential Impacts	Management Strategies / Project Commitments	Predicted Outcomes
Dust	• To ensure that emissions do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	• Ambient Air Quality National Emission Protection Measure (NEPM) • Draft State Environmental (Ambient Air) Policy 2009.	The Project is in an arid area where background dust levels are relatively high. Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads and pastoral activities.	Mining, handling of ore and overburden, and exposed cleared areas have the potential to create a dust nuisance for workers and adjacent land users. Due to the remoteness of the sites, the potential for dust impacts on neighbours is expected to be low.	The following measures will be implemented in close proximity to potentially affected receptors: • Considerate road design to minimise mechanical erosion of the road surface and maximise surface drainage to prevent puddling of rainwater. • Considerate selection of road surface materials to use materials with lower silt content. • Regular road maintenance, including repair of ruts and holes, and regular compaction and resurfacing. • Provision of a sealed road surface. • Watering of the haul road, and the application of appropriate surface dust suppression treatments and additives. • Imposition of speed limits to 40 kph and 25 kph close to the receptors • Reduced traffic along the route through the use of fewer and heavier trucks	Dust emissions from this Project are not expected to result in impacts to potentially affected receptors.

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SHORT TITLES AND ACRONYMS

Short Title/ Acronym	Full Title
AH Act	*Aboriginal Heritage Act 1972*
AMD	Acid Mine Drainage
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARI	Average Recurrence Interval
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
ASS	Acid Sulphate Soils
BIF	Banded Iron Formation
BoM	Bureau of Meteorology
CALM	Department of Conservation and Land Management
CAMBA	China Australia Migratory Bird Agreement
CAR	Comprehensive Adequate Representation
CHMP	Cultural Heritage Management Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Cloudbreak	Cloudbreak Iron Ore Mine
cm	Centimetres
CMCP	Conceptual Mine Closure Plan
CO_2-e	Equivalent CO_2 (CO_2e) is the concentration of CO_2 that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas.
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and the Arts
DIA	Department of Indigenous Affairs
DMP	Department of Mines and Petroleum
DO	Dissolved Oxygen
DoW	Department of Water
DRF	Declared Rare Flora
DSD	Department of State Development
EMP	Environmental Management Plan
EMS	Environmental Management System
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Fortescue	Fortescue Metals Group Ltd

Short Title/ Acronym	Full Title
GDP	Ground Disturbance Permit
GHG	Greenhouse Gas
ha	Hectare
In-pit TSFs	In-pit Tailings Storage Facilities
IUCN	International Union for Conservation of Nature
JAMBA	Japan Australia Migratory Bird Agreement
kg	Kilogram
kL/a	Kilolitres per year
kL/d	Kilolitres per Day
LAAs	Land Access Agreements
LANDSAT	Land Observing Satellite
LIDAR	Light Detection And Ranging – a highly accurate airborne topographic survey technique
m	Metre
mAHD	Metres Above Australian Height Datum
mbgl	Metres Below Ground Level
mg/L	Milligrams per Litre
mm	Millimetres
MMF	Marra Mamba Formation
MNES	Matters of National Environmental Significance
Mt	Million Tonnes
Mtpa	Million Tonnes Per Annum
MW	Megawatts
NEPM	National Emission Protection Measure
NES	National Environmental Significance
NHMRC	National Health and Medical Research Council
NMBSC	National Minimum Bore Specifications Committee
NRMMC	Natural Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
OEPA	Office of Environmental Protection Authority
OPF	Ore Processing Facility
P	Priority
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
PAF	Potential Acid Forming
PECs	Priority Ecological Communities
PER	Public Environmental Review

Short Title/ Acronym	Full Title
pers. comm.	Personal Communication
RHIO	Roy Hill Iron Ore
RIWI Act	*Rights in Water and Irrigation Act 1914*
RO	Reverse Osmosis
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
ROM	Run of Mine
RTIO	Rio Tinto Iron Ore
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities
skyTEM	helicopter-borne electromagnetic and magnetic surveys
SPRAT	Species Profile and Threats Database
SRE	Short-Range Endemic
TDS	Total Dissolved Solids
TECs	Threatened Ecological Communities
The Proposal	Cloudbreak Expansion Proposal
TSS	Total Suspended Solids
TSSC	Threatened Species Scientific Committee
UWA	University of Western Australia
WAH	Western Australian Herbarium
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950*