HANCOCK PROSPECTING PTY LTD

Mulga Downs Project

Section 38 Referral Supporting Document

June 2013

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This document has been prepared based on the best knowledge that was available to Hancock Prospecting Pty Ltd at the time that the report was written.

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	Rev A	Client review	L Taylor/ H Ventriss	Electronic	18/12/12
Draft Report	Rev B	Client review	L Taylor / M Dunlop / H Ventriss	Electronic	8/03/13
Final Draft Report	Rev C	Client review	L Taylor/H Ventriss	Electronic	20/05/13
Revised Final Draft Report	Rev D	Client review	L Taylor	Electronic	24/06/13
Final Report	Rev 1	Submission to EPA	L Taylor	Electronic + hard copy	27/06/13

Filename: HPG12172_02 R003 Rev 1 - 27 June 2013

Executive summary

Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Project (the Project) on the Mulga Downs pastoral station in the Shire of Ashburton, approximately 230 kilometres (km) south of Port Hedland and 100 km north-east of Tom Price.

This document has been prepared to provide supporting information for the referral of the Project under s 38 of the *Environment Protection Act 1986* (WA) (EP Act). In considering the minimal effect of the Project on the relevant environmental factors, the regulatory controls that can be applied and the implementation of relevant management actions, HPPL is of the view that the Project does not require formal environmental impact assessment.

HPPL proposes a conventional open mining pit on tenement M47/206 and to transport the ore by truck via:

- a private haul road (Fenceline Road) to the Great Northern Highway
- north along the Great Northern Highway
- a railway access road from the Great Northern Highway to the proposed Mulga Downs Rail Siding for loading onto the Roy Hill Infrastructure Railway.

The Project involves mining five million tonnes per annum (Mtpa) of ore above the watertable using drill and blast. Construction and operation of a mobile dry crushing and screening plant and development of associated mine infrastructure will also form part of the Project.

The key characteristics of the Project are summarised in the table below.

Key characteristics table

Summary of the Project		
Project Title	Mulga Downs Project	
Proponent Name	Hancock Prospecting Pty Ltd	
Life of mine	5 years including decommissioning and rehabilitation	
Short Description	The Project is to mine iron ore from the Murray's Hill deposit at Mulga Downs, located approximately 230 km directly south of Port Hedland and 100 km north-east of Tom Price, and comprises the following components: • open pit mining above the watertable • on site screening and crushing • construction of associated mine infrastructure (including ROM, crushing and screening plant, stockpile areas, laydown areas) • transport of ore by road to the existing Roy Hill Infrastructure Railway where it will be loaded onto trains and transported to Port Hedland.	
Physical elements		
Element	Proposed Location	Proposed maximum extent
Total Ground Disturbance Area	Development envelope and conceptual disturbance footprint is shown in Figure 2 and Figure 3.	No more than 890 hectares (ha).
Mine pit and associated plant infrastructure	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 370 ha within a 3018 ha development envelope.
Overburden storage area/waste dumps	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 213 ha within a 3018 ha development envelope.
Fenceline Road	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 145 ha within a 3018 ha development envelope.
Railway access road (two options)	The location of the Coonarrie railway access road option is shown in Figure 3.	Disturbance of approximately 8 ha within a 57.01 ha development envelope.

Summary of the Project		
Project Title	Mulga Downs Project	
	The location of the Two Camel railway access road option is shown in Figure 3.	Disturbance of approximately 8 ha within a 58.53 ha development envelope.
Accommodation camp and access road	Location is shown in Figure 2.	Disturbance of approximately 18.9 ha within a 3018 ha development envelope.

Baseline surveys and investigations for environmental aspects have been conducted as part of the current Project. Consultation with relevant stakeholders has been undertaken through the development of the Project.

The environmental factors considered relevant to the Project are:

- groundwater
- surface water
- vegetation and flora
- fauna, including subterranean fauna and short-range endemics (SRE).

Groundwater

The open pit mining operation will not extend below the watertable, eliminating the need for dewatering. Water supply required for construction and operation of the mine site will be sourced from groundwater.

The average monthly water demand associated with construction is 89 megalitres (ML) (3 ML/day) over a period of approximately six months. The annual abstraction during operation of the mine is 1075 ML, which also equates to 3 ML/day.

Preliminary investigations have been undertaken to characterise the quantity and quality of groundwater resources within the mining tenement. Minimal drawdown was observed in the pumped aquifers during testing (0.1 metres (m) drawdown in Murray 1 test bore) at discharge rates of 10 litres per second (L/s) (0.8 ML/day). Hydraulic characteristics of the stratigraphic sequence along Fenceline Road are expected to approximate those of the mine area.

Additional investigations are ongoing to define acceptable long-term abstraction rates and effects and to identify a water source for the proposed camp.

Previous investigations have been undertaken to characterise the quantity and quality of the groundwater resources in the vicinity of the proposed rail siding area near the Roy Hill Infrastructure Railway Siding C. Three bores are likely to be used as construction water supply at this location. Test pumping indicates that abstraction from two bores will meet projected operational water demand for the ore handling and loading operations. Water requirements for construction of the chosen railway access road forms a minor component (11%) of the total projected water requirements for construction activities associated with the Project at this location.

Overall, the quantity and quality of groundwater should be maintained so that existing and potential environmental values are protected and statutory requirements and acceptable standards are achieved.

Surface water

The Murray's Hill mine and Fenceline Road are located in the Goodiadarrie Swamp sub catchment of the Lower Fortescue River Catchment. The Goodiadarrie Swamp catchment has a total area of 4138 square kilometres (km^2). The railway access road is located within the Yule River Catchment, which has a total area of 8860 km^2.

A small loss of surface water flows is expected as a result of the area occupied by the mine pit, waste rock dump and processing area. The conceptual disturbance footprint represents less than 0.2% of the overall catchment of the Goodiadarrie Swamp catchment.

Either railway access road option constitutes a 0.003% disturbance in the Yule River catchment. Any alteration to catchment hydrology as a result of the access road will be insignificant.

Given the minimal effects to surface water catchments within which the elements of the Project are located and the proposed surface water management measures, effects of the Project on catchment surface hydrological regimes (quantity and quality) are expected to be insignificant.

Vegetation and flora

No Threatened Ecological Communities (TEC), Priority Ecological Communities (PEC) or Declared Rare Flora (DRF) were identified during field surveys. Three potential and three known Priority flora were recorded in the Maia (2012) flora survey area. Two Priority species are located within the section of the development envelope associated with the Fenceline Road. Given the known locations and linear nature of Fenceline Road, impacts to these species can be avoided or minimised.

The Project is not expected to significantly reduce the extent of land systems, with less than 1% of the total area mapped being affected.

Three Beard vegetation associations occur within the Project area (562, 29 and 93). The Project will result in the removal of a maximum of 0.6%, 0.2% and 0.002% of the pre-European extent of these vegetation associations respectively.

All nine of the site-specific vegetation types mapped by Maia (2012) within the development envelope are likely to extend beyond the area surveyed and the impacts to these vegetation communities are expected to be less than predicted.

Assuming a worst case scenario that all vegetation within the development envelope will be cleared, impacts are less than 20%, with the exception of H2 (*Triodia* hummock grassland) and H3 (*Triodia* hummock grassland) at 60.1% and 100% respectively.

Disturbance to community H2 is predominantly associated with clearing within the portion of the development envelope associated with the upgrade to Fenceline Road. The known mapped extent of community H3 occurs within tenement L45/316 and has the potential to be affected by the construction of a new section at the eastern extent of the Fenceline Road alignment.

The upgrade to Fenceline Road is linear in nature and is based on a 50 m wide disturbance corridor. This width is conservative with an actual road width likely to be 20 m. Based on the conceptual disturbance footprint (Figure 23), impacts to community H2 and H3 are 29.39% and 2.32%. Impacts to communities H2 and H3 will be minimised as far as possible through final detailed design of the Fenceline Road and the location of borrow pits.

The disturbance to vegetation associations associated with either railway access road option is not considered significant.

The overall disturbance to flora and vegetation is not expected to be significant. The Project is not expected to significantly affect the abundance or diversity of flora or vegetation at a local or regional level.

Fauna, including subterranean and short-range endemics

The vertebrate fauna assemblage in the project area is considered typical of the region. Seven fauna species listed under the *Environment, Protection and Biodiversity Conservation Act 1999* (EPBC Act) or scheduled under the *Wildlife Conservation Act 1950* (WC Act) are considered likely to occur in the area. Of these, three species could be found in the area of Murray's Hill mine and Fenceline Road. All seven species could be found in the area of the area of the railway access road options. The Peregrine Falcon and Fork-tailed Swift may visit both areas infrequently. An additional nine Priority listed species potentially occur in the project area.

A habitat assessment has been undertaken on the basis of species likely to be present in each land system. Specific assessment was undertaken to determine the habitat of Northern Quoll. Conservation significant species are not expected to occur in the Boolgeeda and Jamindie land systems. The Newman land system is potential habitat for Northern Quoll. The McKay land system is potential habitat for Ghost Bat, Northern Quoll and Pilbara Olive Python. The Macroy land system, in which the railway access road options occur, is potential habitat for Mulgara, Bilby, Ghost Bat and Northern Quoll.

The Project may result in the loss of up to 890 ha of habitat for fauna. Based on the habitat assessment undertaken, the loss of potential habitat for identified conservation species is approximately 193.89 ha. Specific habitat analysis in the area of the Murray's Hill mine and Fenceline Road has determined that the loss of habitat for the Northern Quoll is likely to be less than 1% based on the conceptual disturbance footprint.

Surveys of the Project area did not confirm the presence of any Short-range endemics (SRE) species. There are no known, likely or potential SRE fauna recorded from, or within the vicinity of, the Project. The Project will not directly affect habitat that may be suitable for SRE invertebrate fauna.

The Project is for mining above the watertable and is not expected to affect stygofauna.

A local troglofauna community exists at Murray's Hill that occurs across a mix of geologies and is low in abundance. The distribution of species provides strong evidence of biological connection between the different geologies. The majority of species were found from both impact and reference survey sites. Six species were recorded only from within the disturbance area; however, these species are expected to have a range that extends beyond the disturbance area.

The Project is not expected to significantly affect the distribution of fauna species.

A summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed is presented in the following table.

Summary of the key environmental issues, potential impacts and management

Environmental factor	EPA objective	Existing environment	Potential impacts	Proposed management	Predicted outcome
Groundwater	To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure the quality of water emissions (surface, ground and marine) does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.	**Murray's Hill mine and Fenceline Road** The main aquifers of the project area are: • surficial aquifers (comprising alluvium, calcrete/silcrete and detritals) • Wittenoom formation (dolomitic aquifer) • the Marra Mamba Iron Formation comprising mineralised (aquifer) and unmineralised (aquitard) members • Jeerinah formation aquitard (considered the basement for this region). Recharge of groundwater in the area occurs from infiltration of rainfall into the surficial aquifer, and subsequently into the underlying Marra Mamba Iron Formations. Depth to groundwater varies from 35 to 40 metres below ground level (mbgl) near the base of the Chichester Range to at 3 – 10 mbgl at the southern extent of the mine. Shallow groundwater within the saturated alluvium, detritals and upper mineralised Marra Mamba Formation varies from fresh (<1 000 mg/l Total Dissolved Solids (TDS)) to brackish (1 000 to 2 000 mg/l TDS), with higher concentrations recorded at the southern edge of the mine. Salinity generally increases south towards the Goodiadarrie Swamp. **Railway access road** The area of the railway access road options is underlain by pockets of superficial alluvium comprising sand, silt and clay floodplain deposits, saprolitic clays, with sand and gravel alluvial channel deposits. These deposits, along with the upper weathered section of the underlying granitoid complex, form the primary water bearing aquifer in the area and are underlain by relatively low permeability granitoid bedrock. Depth to groundwater is relatively shallow at 3 to 9 mbgl. Groundwater quality ranges from brackish (8 400 mg/l TDS) to fresh (1 to 560 mg/l TDS) approximately 6 km to the south.	The Project has the potential to affect groundwater through: • changes to groundwater levels (drawdown) from abstraction for water supply • contamination of groundwater from the use of hydrocarbons and chemicals.	A water resources management operating strategy for the Project will be submitted to the Department of Water (DoW) as part of a water abstraction licence application (5C licence). The operating strategy will address the following: • identifying and managing impacts • operating rules for abstraction • monitoring and reporting • contingency and trigger levels (MWH 2012, p. 49). HPPL will adopt appropriate management practices to minimise the risk of spills and potential groundwater contamination. Abstraction from water supply bores will be managed to minimise drawdown, which may affect other beneficial uses in the area. Management will include continuous water level monitoring and ongoing adjustment of pumping rates to eliminate the potential for over-abstraction (MWH 2012, p. 49). Field investigations are also ongoing and include drilling and installation of hydrogeological test bores, test pumping, and collection of water samples for hydro-chemical assessment. These investigations are designed to provide additional data for a detailed evaluation of the hydrogeological system and groundwater regime in the area and will aid in further evaluation of the effect of abstraction on the water balance, groundwater quality and groundwater levels. Existing piezometers will be used to enhance the groundwater monitoring network (MWH 2012, p. 49). Field investigations will also be undertaken to identify a suitable water source for the accommodation camp.	After application of management measures, the Project is expected to result in the following outcomes in relation to groundwater: 1. Water abstraction for the purpose of water supply will have minimal effect on groundwater levels and will be managed through the development and implementation of a water resources management operating strategy. 2. All necessary approvals will be obtained from DoW. 3. The Environmental Management Plan (EMP) will contain specific measures relating to the use and management and of hydrocarbons and chemicals within the mine area to limit any potential for contamination of groundwater. 4. Overall, the quantity and quality of groundwater will be maintained so that environmental values are protected and statutory requirements and acceptable standards are achieved. The effect of the Project on groundwater will be insignificant and; therefore, EPA objectives are expected to be achieved.

Environmental factor	EPA objective	Existing environment	Potential impacts	Proposed management	Predicted outcome
Surface water	To maintain the quantity of water (surface and ground) so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure the quality of water emissions (surface, ground and marine) does not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.	**Murray's Hill mine and Fenceline Road** The Murray's Hill mine and Fenceline Road are located within the Goodiadarrie sub-catchment of the Fortescue River regional drainage basin. The Goodiadarrie sub-catchment which is believed to be a separate hydrological system to the Upper and Lower Fortescue River Catchment. Three main drainage lines flow within and around the proposed mine site area. Drainage within the mine site lease boundary is primarily radial with sheet flows emanating downstream of the mining area as flows move towards the plains of the Goodiadarrie Swamp. A total of 68 catchments of various sizes have been identified along Fenceline Road. The alignment of the road closely follows the break between the Chichester Range and the sandy plains of the Goodiadarrie Swamp. Flows upstream of the road present in defined drainage lines, with sheet flow characteristics commencing downstream of the road. **Railway access road** The railway access road options are located within the Yule River Catchment of the Port Hedland Coast regional drainage basin. The Two Camel railway access road intersects seven sub-catchments all of catchment sizes less than 0.1 km^2. The Coonarrie railway access road crosses Two Camel Creek and intersects three sub-catchments, all of which are less 0.16 km^2 in extent. Due to the location and nature of these catchments, sheetflow is not expected to be a predominant form of runoff.	The Project has the potential to affect surface water through: • alterations to surface water flows a result of placement and design of new infrastructure • increased sediment runoff and scour due to the construction of infrastructure • contamination of surface water from the use of hydrocarbons and chemicals.	Impacts of the Project on surface water will be managed through engineering design and adherence to engineering design standards. A stormwater management strategy will be developed for the Project focussing on: • minimising the risk of flood to the mining operations to ensure the safety of personnel and efficiency of mining • minimising potential impacts to the receiving downstream environment. To achieve this, mitigation measures will be implemented to ensure flood flows are safely diverted around the operations and best practices will be adhered to ensure the minimisation of any potential environmental impacts (MWH 2012, p. 38).	After application of management measures, the Project is expected to result in the following outcomes in relation to surface water: 1. There will be no significant effects on the surface water regime within the Goodiadarrie Swamp catchment. 2. There will be no significant effects on the surface water regime within the Yule River catchment. 3. The Project will not result in significant effects to the quality and quantity of surface water. 4. Engineering and design measures will be implemented to reinstate surface water flows immediately downstream of the Project. The impacts of the Project on surface water regimes will be insignificant and; therefore, the EPA objectives for this factor will be achieved.

Environmental factor	EPA objective	Existing environment	Potential impacts	Proposed management	Predicted outcome
Flora and Vegetation	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.	The Murray's Hill mine and Fenceline Road is situated in the Fortescue Plains subregion of the Pilbara biogeographic region. The railway access road options are located within the Chichester subregion of the Pilbara biogeographic region. Vegetation across the Murray's Hill mine and Fenceline Road comprises 14 communities, ranging in condition from completely degraded to excellent, with the majority of vegetation considered to be in very good condition (41.27 %). Nine vegetation associations occur within the development envelope option railway access road option alignments, ranging in condition from good to excellent/very good. No TECs were recorded in the survey area. Two PECs are located in the vicinity of the Project. The development envelope impacts (1%) the buffer of the PEC 'Four Plant Assemblages of the Wona Land System'. Based on the conceptual disturbance footprint, 0.09% would be impacted. The Project is located 5 km from the nearest point of the Wona Land System. Neither PEC will be directly affected. No EPBC Act listed plant taxa or gazetted DRF pursuant to the WC Act have been located within the survey area. Three confirmed and three potential Priority Flora species were recorded within the area surveyed by Maia (2012b). Two Priority species have been identified within the development envelope. A total of 15 weeds were recorded during surveys, none of which are listed as a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*.	The Project may affect flora and vegetation values through: • clearing of vegetation for the mine pit, waste rock dumps, access roads and associated mine infrastructure will directly reduce the extent of vegetation communities, and may disturb conservation significant flora species • changes to groundwater levels (lowering) from abstraction for construction and operational water demand has the potential to affect vegetation communities • alterations to surface water flows and disruption of sheet flows from the presence of mine pit, waste rock dumps, access roads and associated mine infrastructure has the potential to have an effect on downstream vegetation communities • increased sediment load from ground disturbance has the potential to cause infilling of pools and smothering of vegetation in downstream catchments • dust generation due to earthworks, mining, processing and vehicle movements during construction and operation has the potential to smother vegetation. • introduction and spread of weeds from vehicle movements and earthworks • increased incidence/frequency of fire from on-site ignition sources may favour the establishment of weeds and prevent the regeneration of native vegetation, particularly fire-sensitive species, such as mulga.	HPPL will implement the following management measures in order to minimise potential impacts flora and vegetation within the Project area: • vegetation clearing will be minimised so that only areas that are considered absolutely necessary for safe construction and operation are cleared • existing access tracks and cleared areas will be utilised where possible to minimise clearing • clearing will be managed through an internal ground disturbance permit (GDP) procedure • boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries and provided to dozer operators • no unauthorised clearing will be permitted and clearing beyond approved limits will be reported using the Environmental Incident/Non-conformance Report • ground disturbance or access will be limited to the extent absolutely necessary within the buffer of the Priority 1 PEC 'Four plant assemblages of the Wona Land System' • all employees/contractors will be inducted on the importance of significant vegetation and flora, minimising vegetation clearing and disturbance, and "no access" areas • a significant flora and weed identification guide will be made available for all employees and contractors • areas disturbed for construction but not required for permanent infrastructure will be rehabilitated as soon as practicable after use • following rehabilitation, areas will be monitored and treated for weeds • revegetation and rehabilitation activities within the mine area will be undertaken as per the EMP and closure planning • vegetation and topsoil will be stripped and immediately placed on areas to be rehabilitated or stockpiled for later use in rehabilitation. • vegetation will be stockpiled in windrows or used as cover on topsoil stockpiles • vehicles and machinery will only use designated tracks/roads • appropriate dust suppression methods will be implemented where necessary to minimise dust lift-off • a Minesite Stormwater Management Strategy will be developed to manage surface water flows around the mine site area and minimise downstream effects. Weed management and fire risk will be managed under the EMP developed for the Project. In the event that the Project is not assessed under the EP Act, HPPL will apply to the Department of Mines and Petroleum (DMP) for a clearing permit for any clearing associated with the Project. Under this process, native vegetation proposed to be cleared will be assessed against the ten clearing principles under the Environmental Protection (Clearing of Native Vegetation) Regulations 2007.	After application of management measures, the Project is expected to result in the following outcomes in relation to flora and vegetation: 1. Up to 890 ha of vegetation will be disturbed by the Project. 2. Clearing will not significantly affect the local or regional distribution of any vegetation community. 3. There are no Conservation Estates, Schedule One Areas or EPA Redbook Areas located within the Project area. 4. No TECs will be affected by the Project. 5. No PECs will be directly affected. 6. Groundwater drawdown from the Project will be minimal and is unlikely to significantly impact groundwater dependent ecosystems. 7. Conservation significant flora identified during baseline surveys are not expected to be affected as a result of the Project. 8. The potential for indirect impacts resulting from the Project are not expected to be significant and can be addressed through the implementation of appropriate engineering design and management standards and the EMP. The Project will not significantly affect the local or regional distribution of flora or vegetation communities present and; therefore, the EPA objective for this factor will be achieved.

Environmental factor	EPA objective	Existing environment	Potential impacts	Proposed management	Predicted outcome
Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement of knowledge.	No fauna species scheduled under the WC Act or species listed under the EPBC Act were recorded during surveys. However, a Northern Quoll was detected by motion sensitive camera in the northern section of the fauna survey area. Seven fauna species listed under the EPBC Act or scheduled under the WC Act are considered likely to occur in the area. Of these, three species may be found in the area of Murray's Hill mine and Fenceline Road. All seven species could be found in the area of the railway access road options. The Peregrine Falcon and Fork-tailed Swift may visit both areas infrequently. An additional nine species listed as Priority fauna by the Department of Environment and Conservation (DEC) potentially occur in the Project area. No confirmed short range endemic fauna (SRE) were recorded in areas directly affected by the Project.	Potential effects of the Project on fauna include: • loss and fragmentation of habitat from vegetation clearing resulting in a direct loss of species, and reduced breeding and foraging habitat • increased injuries and mortalities from vehicle movements, infrastructure, machinery and the workforce • degradation of habitat from altered hydrological regimes, increased human access, noise, dust and weed invasion • 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 • introduction of feral 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.	Management and mitigation measures for fauna include: • clearing will be minimised so that only areas considered necessary for safe construction and operation are cleared • using existing access tracks in preference to constructing new ones to prevent fragmentation • 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 and movements limited to defined tracks • vehicle access will be limited to existing or purpose built access roads and tracks • clearing will be managed through an internal ground disturbance permit procedure • once activities have ceased on a cleared area it will be rehabilitated • rehabilitation will include placing cleared vegetation and logs within the area to provide fauna refuge • appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes • lighting will be directed onto construction or operational areas • contractors and staff shall be advised of specific habitat locations to avoid.	After application of management measures, the Project is expected to result in the following outcomes in relation to fauna: 1. Up to 890 ha of habitat will be disturbed. 2. Conservation significant fauna are not expected to be significantly affected as a result of the Project. 3. The potential for indirect effects resulting from the Project will be insignificant and can be addressed through the implementation of engineering design standards and management actions. The Project will not significantly affect the local or regional distribution of fauna present and; therefore, the EPA objective for this factor will be achieved. The Project has also been assessed against the Department of Sustainability, Environment, Populations and Communities (DSEWPaC) 'Test of Significance criteria and the Northern Quoll Impact Assessment Guidelines. DSEWPaC has concurred with the HPPL assessment that the Project is unlikely to significantly affect identified Matters of National Environmental Significance (MNES).
Subterranean 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 in knowledge.	Mining will occur above the watertable and therefore dewatering is not required. Impacts to stygofauna are not expected. A local troglofauna community exists at Murray's Hill that occurs across a mix of geologies and is low in abundance. The distribution of species provides strong evidence of biological connection between the different geologies. The majority of species were found from both impact and reference survey sites. Six species were recorded only from within the disturbance area; however, these species are expected to have a range that extends beyond the disturbance area.	The following effects of the Project may affect subterranean fauna values: • loss of habitat from the excavation of overburden and ore and blasting • surface and groundwater contamination, through the spills of hydrocarbons and discharge of wastewater, may degrade the subterranean environment • reduction of organic inputs from clearing of vegetation beyond the mine footprint.	Potential effects on subterranean fauna within, and adjacent to the Project will be mitigated through the management measures implemented under an EMP. The key management measures relevant to subterranean fauna include: • restricting mine pit disturbance to areas approved, in compliance with legislative requirements • containing and bunding hydrocarbon storage facilities, re-fuelling locations and areas of stationary hydrocarbon usage in compliance with corporate policy, relevant standards and legal requirements • investigating and documenting opportunities to further reduce the clearing of previously undisturbed and rehabilitated vegetation within approved boundaries.	After application of management measures, the Project is expected to result in the following outcomes in relation to subterranean fauna: 1. No direct loss of stygofauna habitat. 2. Habitat for troglofauna within M47/206 will be removed within the mine pit footprint. 3. The Project will have a limited impact on the extent and availability troglofauna habitat within the local Murray's Hill area. The Project will have a limited localised impact on subterranean fauna and; therefore, EPA objective is expected to be achieved.

Other factors

Other relevant environmental factors have been identified as requiring less detailed assessment on the basis that they can be managed through standard operating procedures and adherence to regulations. These include:

- Aboriginal heritage
- dust
- noise
- hydrocarbons and hazardous materials management
- solid and liquid waste management
- mine closure and rehabilitation.

To minimise the potential effects of the Project, HPPL has developed management measures for risk control and reduction, which are described in this document and will be further detailed through an Environmental Management Plan (EMP).

Environmental management and regulation framework

The table below provides an overview of the proposed regulatory framework for the Project and applicable environmental approvals for each of the identified relevant factors.

Proposed regulatory framework and environmental approvals

Environmental factor	Proposed Approvals/ Management	Legislation	Agency
Vegetation and flora	A Clearing Permit application will be submitted under Part V of the EP Act if the Project is not assessed. Under this process, the proposed clearing will be assessed against the 10 clearing principles and any management, mitigation and residual impacts can be conditioned in any approved permit. Rehabilitation will also managed under a Mining Proposal and Mine Closure Plan which will be submitted to the Department of Mines and Petroleum (DMP) under the *Mining Act 1978* (Mining Act).	EP Act Mining Act.	DMP
Terrestrial Fauna	A Clearing Permit application will be submitted under Part V of the EP Act if the Project is not assessed. Under this process, the proposed clearing will be assessed against the 10 clearing principles, which includes impacts to fauna and fauna habitat. Any management, mitigation and residual impacts can be conditioned in any approved permit. Rehabilitation will also be addressed under a Mining Proposal and Mine Closure Plan, which will be submitted to the DMP under the Mining Act. The Project has also been assessed against the DSEWPaC 'Test of Significance criteria and the Northern Quoll Impact Assessment Guidelines. DSEWPaC has concurred with the HPPL assessment that the Project is unlikely to significantly affect identified MNES.	EP Act Mining Act EPBC Act	DMP DSEWPaC
Subterranean Fauna	The potential effects of the Project on subterranean fauna will be managed in accordance with an EMP which will be submitted to DMP.	Mining Act	DMP

Environmental factor	Proposed Approvals/ Management	Legislation	Agency
Surface water	A Mine site Stormwater Management Strategy will be developed consistent with the Department of Water (DoW) Water Quality Protection Guidelines No. 6 Mining and Mineral Processing – Mine site Stormwater (DoW, 2000). Stormwater management will be addressed in the Mining Proposal which will be submitted to the DMP.	Mining Act *Rights in Water and Irrigation Act 1914* (RIWI Act)	DMP DoW
Groundwater	Applications made to DoW for the construction of wells (26D). A Groundwater Operating Strategy will be submitted as part of a DoW abstraction permit (5C Licence).	RIWI Act	DoW
Mine Closure and Rehabilitation	A Mine Closure Plan will be submitted to the DMP as a requirement of the Mining Proposal under the Mining Act which will address mine closure and rehabilitation relevant to the Project.	Mining Act	DMP
Aboriginal heritage	Section 18 application(s) will be made to the where Aboriginal heritage sites are to be affected.	*Aboriginal Heritage Act 1972* (AH Act)	Department of Aboriginal Affairs (DAA)/Minister for Aboriginal Affairs
Dust	Dust can be managed under Part V of the EP Act	EP Act	DEC
Noise	Noise emissions are regulated under the Environmental Protection (Noise) Regulations 1997 (Noise Regulations).	Noise Regulations	DEC/Shire of Ashburton
Geochemical risk	Geochemical characterisation of waste rock and ore has concluded that the materials are geochemically benign. AMD can be addressed under a Mining Proposal and Mine Closure Plan.	Mining Act	DMP
Hydrocarbons and hazardous materials management	Explosives storage, fuel storage, explosives transport and fuel transport will comply with relevant requirements/standards.	*Dangerous Goods Safety Act 2004*	DMP
Solid and liquid waste management	Solid and liquid waste can be managed under the provisions of Part V of the EP Act, local government and Department of Health (DoH)	EP Act *Health Act 1911*	DEC DoH Shire of Ashburton

The key regulatory controls that will be applied to ensure appropriate management of the Project include (but are not limited to):

- conditions of works approval(s) issued under Part V of the EP Act for construction of works on prescribed premises (ore processing, landfill and sewage facility).
- conditions of licence issued under Part V of the EP Act for the operation of activities on prescribed premises (ore processing, landfill and sewage facility)
- conditions of the licences and permits for activities relating to the abstraction of groundwater under the RIWI Act
- conditions of Mining Proposal approved by DMP, including a Mine Closure Plan.

The potential environmental impacts of the Project can be adequately managed to meet EPA environmental objectives through the regulatory framework described above. Therefore, HPPL is of the view that this Project does not require formal assessment.

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Appendix 7 Subterranean fauna report
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1. Introduction

1.1 Background

Hancock Prospecting Pty Ltd (HPPL) intends to mine iron ore from a pit on the Mulga Downs pastoral station in the Pilbara (Figure 1). The mined product will be Direct Shipping Ore (DSO) with which will undergo crushing and screening at the mine site prior to being transported by private road (Fenceline Road) and north along Great Northern Highway to be loaded on to the Roy Hill Infrastructure Railway. Ore will then be transported to Port Hedland where available port space will be utilised while the Roy Hill mine reaches full capacity production.

The Project comprises construction and operation of the mine, ancillary infrastructure and haulage roads.

1.2 Purpose and scope of this document

This document has been prepared to provide supporting information for the referral of the Project under s 38 of the *Environment Protection Act 1986* (WA) (EP Act).

The completed s 38 referral form is presented in Appendix 1.

1.3 Proponent details

The Proponent for the Project is HPPL. HPPL is a privately owned Western Australian company and has been engaged in the exploration of mineral resources for more than 60 years. HPPL and its activities have focused predominately on delineation and development of prospects within its iron ore portfolio in the Pilbara region of Western Australia.

Mining Lease 47/206 was granted to Mulga Downs Iron Ore Pty Ltd and Mulga Downs Investments Pty Ltd, a wholly owned subsidiary of HPPL, on 10 May 1989.

The Proponent contact for the Project is:

Ailan Tran

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West Perth WA 6872
Telephone: (08) 9429 8222
Email: *ailan_tran@hancockprospecting.com*.au

1.4 Rationale for Project

HPPL has identified an opportunity to develop a small DSO mine with a maximum resource of 50 million tonnes (Mt) which will provide important early tonnages for the company and make use of available port space at Port Hedland while the Roy Hill mine reaches full production capacity.

The mine has been designed to minimise impact to the environment through:

- limiting mining to above watertable (AWT),
- avoiding conservation significant features
- utilising previously cleared areas and existing infrastructure where possible.

1.4.1 Demand for product

Over the past ten years, the Western Australian iron ore industry has experienced a period of unprecedented growth, fuelled in the main by demand from China. On average, the annual growth in the value of sales from the Western Australian iron ore industry during this period has been 33% per annum (DMP 2011, p. 12)

Iron ore continues to be the most valuable resource sector in Western Australia, accounting for 57% of the total value of the mineral and petroleum sales, the majority of which is produced in the Pilbara. China will continue to play a pivotal role in the future of the Western Australian iron ore industry. In 2010–11, iron ore accounted for 68%, or almost $39 billion, of the total iron ore shipped from Western Australia (DMP 2011, p. 12)

1.4.2 Social and economic benefits of Project

The Mulga Downs Project is expected to create several hundred jobs through employment and training opportunities during construction and through the operating life of the mine. Local business and indigenous participation in construction and operation will be encouraged, ensuring that the income generated from the Project remains within the region to benefit the regional and state economies through taxation and royalty payments. The Project will also benefit the Federal economy by contributing to Australian exports through the strong export performance of the region.

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Mulga Downs Project
Figure 1
Location of Mulga Downs Project

660000
680000
7600000
7580000
7560000

Regional Overview
Port Hedland
Great Northern Highway
Marble Bar Road
North West Coastal Highway
Kariyarra People
Marble Bar
Map Area
Fortescue Marsh
Tom Price
R 30082
Karijini National Park
Banjima People
Great Northern Highway
Marble Bar Road
Paraburdoo
Newman

COCKERAGA RIVER
YULE RIVER
COONARRIE CREEK
BEABEA CREEK
WEST YULE RIVER
WALL CREEK
FORTESCUE RIVER

R 22626
Abydos - Woodstock Reserve
R 22627
Abydos - Woodstock Reserve
R 31428
Yandeyarra Reserve

Two Camel Railway Access Road
Coonarrie Railway Access Road

WAD6169/98
Kariyarra People
WC99/3

WAD6096/98
Banjima People
WC11/6

Mulga Downs Pastoral Lease
Mulga Downs Homestead
M 47/206
L 47/675
E 47/1244
L 47/339
L 45/316

Great Northern Highway
Port Hedland 230km
Newman 220km

Homesteads
Mulga Downs
Topography
Highway
Minor road
Track
River
Native Title Applications
Banjima People
Kariyarra People
RHI Tenure
RHI Railway
RHI SRL
HPPL Project
HPPL tenements
Land Tenure
Mulga Downs Pastoral Lease
Abydos - Woodstock Reserve
Yandeyarra Reserve

N
0 5 10
Kilometres
Datum GDA 94 MGA Zone 50

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

prepared by: vanessa.donley

MD0244_1

2. Project description

2.1 Location

The Project is situated on the Mulga Downs pastoral station in the Shire of Ashburton, approximately 230 kilometres (km) south of Port Hedland and 100 km north-east of Tom Price. The mining lease (47/206) covers nine square kilometres (km^2) of the Fortescue Valley, on the southern slopes of the Chichester Ranges with Karijini National Park to the south- west (Figure 1).

Mining and associated infrastructure will be located almost entirely within M47/206 with camp facilities and water supply borefields located within Exploration Lease 47/1244[1]. Ore will be transported north along the Great Northern Highway with a private haulage road (Fenceline Road) linking the highway with mining areas through miscellaneous licences 45/316, 47/339 and 47/675. An area of approximately 8 hectares (ha) will require excision from the Abydos-Woodstock Protected Area 33 for an access road from Great Northern Highway to the proposed Mulga Downs rail siding and stockyards[2] located within the Roy Hill Infrastructure Special Railway Licence (SRL). The Roy Hill Infrastructure Railway is approved under Ministerial Statements 847 and 864. Two options are being considered for the access road: Coonarrie or Two Camel (Figure 1).

The Fortescue River intersects the southern extent of E47/1244 and meanders in a general north-west direction towards the coast before eventually discharging into the ocean. Figure 1 shows the various tenements relevant to the Project.

2.1.1 Area of disturbance

To ensure that sufficient flexibility is provided in the final design, the impact assessment presented is based on a development envelope approach.

The Murray's Hill mine development envelope is approximately 3018 ha and generally aligns with the following mining tenements[3] (Figure 2):

- L47/339 – 1264 ha
- L47/675 – 66 ha
- L45/316 – 732 ha
- M47/206 – 900 ha.

Some minor disturbance is proposed within E47/1244. The Coonarrie and Two Camel railway access road options are located within development envelopes of 57.01 ha and 58.53 ha respectively. Locations of these aspects of the Project are shown on Figure 2 and Figure 3.

The Project will require disturbance of up to 890 ha, including mine and associated infrastructure, haul roads, the accommodation camp and access road and one railway access road option. The proposed Murray's Hill mine development envelope also encompasses partially disturbed land and includes existing infrastructure used to support exploration activities.

[1] HPPL has lodged an application with the Department of Mines and Petroleum (DMP) to convert E47/1244 into mining lease 47/1486.

[2] The proposed Mulga Downs rail siding and stockyards does not form part of this Project.

[3] The development envelope also incorporates the accommodation and access road and indicative locations of two borrow pits and borefield access roads that are located within E47/1244.

A conceptual disturbance footprint is also presented in this document. The conceptual disturbance footprint represents the location and extent of the mine pit and the likely configuration of other key mining and support infrastructure and access roads.

A breakdown and conceptual layout of the key elements of the Project is provided in Table 1 and shown in Figure 2 and Figure 3.

2.2 Mining overview

The Project includes one mine pit (Murray's Hill mine), waste dump, crushing and screening plant, 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 five million tonnes per annum (Mtpa).

The Project will involve the disturbance of up to 890 ha. Mining activities and associated infrastructure will occur within a development envelop of 3018 ha. One of two railway access road options are being considered: Coonarrie and Two Camel. Each option is located within respective development envelopes of 57.01 ha and 58.53 ha. Previously cleared areas and existing infrastructure will be utilised wherever possible. Ore will be transported to Port Hedland by:

- upgrade of an existing access road from the mine site to the Great Northern Highway (Fenceline Road) (30 km) then
- 60 km north along the Great Northern Highway then
- east along one of the railway access road options through the Abydos-Woodstock Protected Area 33 to the Railway SRL Corridor for transportation via the Roy Hill Infrastructure Railway (1.5 km).

Mining will occur above the watertable and dewatering will not be required. Water supply will be sourced from four borefields at the Murray's Hill mine, Fenceline Road and accommodation camp. Existing bores located within the Roy Hill Infrastructure Corridor will be used for construction of the railway access road.

The key characteristics of the Project are summarised in Table 1.

Table 1 Key characteristics table

Summary of the Project		
Project Title	Mulga Downs Project	
Proponent Name	Hancock Prospecting Pty Ltd	
Life of mine	5 years including decommissioning and rehabilitation	
Short Description	The Project is to mine iron ore from the Murray's Hill deposit at Mulga Downs, located approximately 230 km directly south of Port Hedland and 100 km north-east of Tom Price, and comprises the following components: • open pit mining above the watertable • on site screening and crushing • construction of associated mine infrastructure (including ROM, crushing and screening plant, stockpile areas, laydown areas) • transport of ore by road to the existing Roy Hill Infrastructure Railway where it will be loaded onto trains and transported to Port Hedland.	
Physical elements		
Element	Proposed Location	Proposed maximum extent
Total Ground Disturbance Area	Development envelope and conceptual disturbance footprint is shown in Figure 2 and Figure 3.	No more than 890 ha
Mine pit and associated plant infrastructure	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 370 ha within a 3018ha development envelope.
Overburden storage area/waste dumps	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 213 ha within a 3018 ha development envelope.

Summary of the Project		
Project Title	Mulga Downs Project	
Fenceline Road	Development envelope and conceptual disturbance footprint is shown in Figure 2.	Disturbance of approximately 145 ha within a 3018 ha development envelope.
Railway access road (two options)	The location of the Coonarrie railway access road option is shown in Figure 3.	Disturbance of approximately 8 ha within a 57.01 ha development envelope.
	The location of the Two Camel railway access road option is shown in Figure 3.	Disturbance of approximately 8 ha within a 58.53 ha development envelope.
Accommodation camp and access road	Location is shown in Figure 2	Disturbance of approximately 18.9 ha within a 3018 ha development envelope.

The conceptual layout of the key elements of the Project is presented in Figure 2 and Figure 3.

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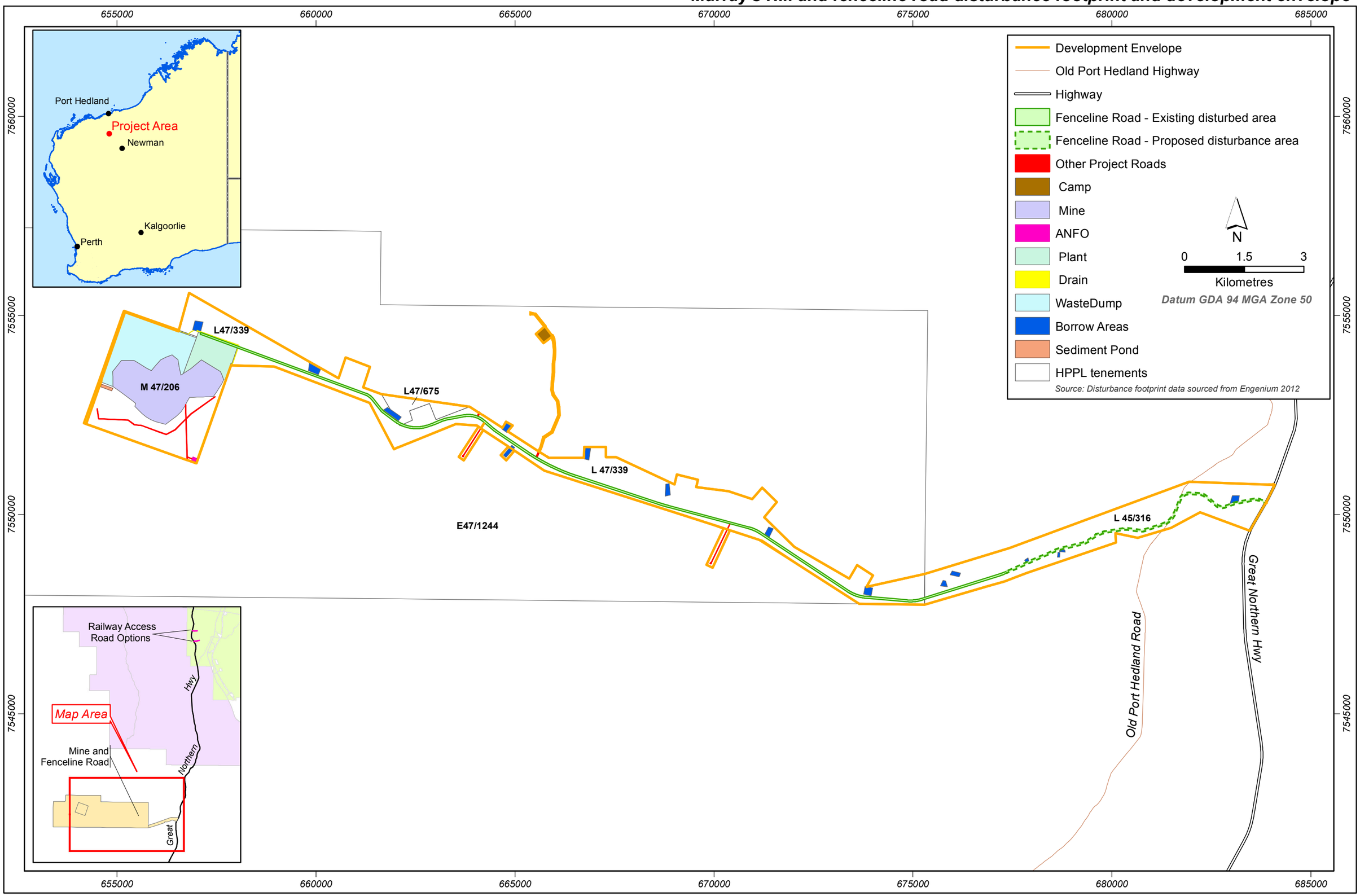
Mulga Downs Project
Figure 2

Murray's Hill and fenceline road disturbance footprint and development envelope



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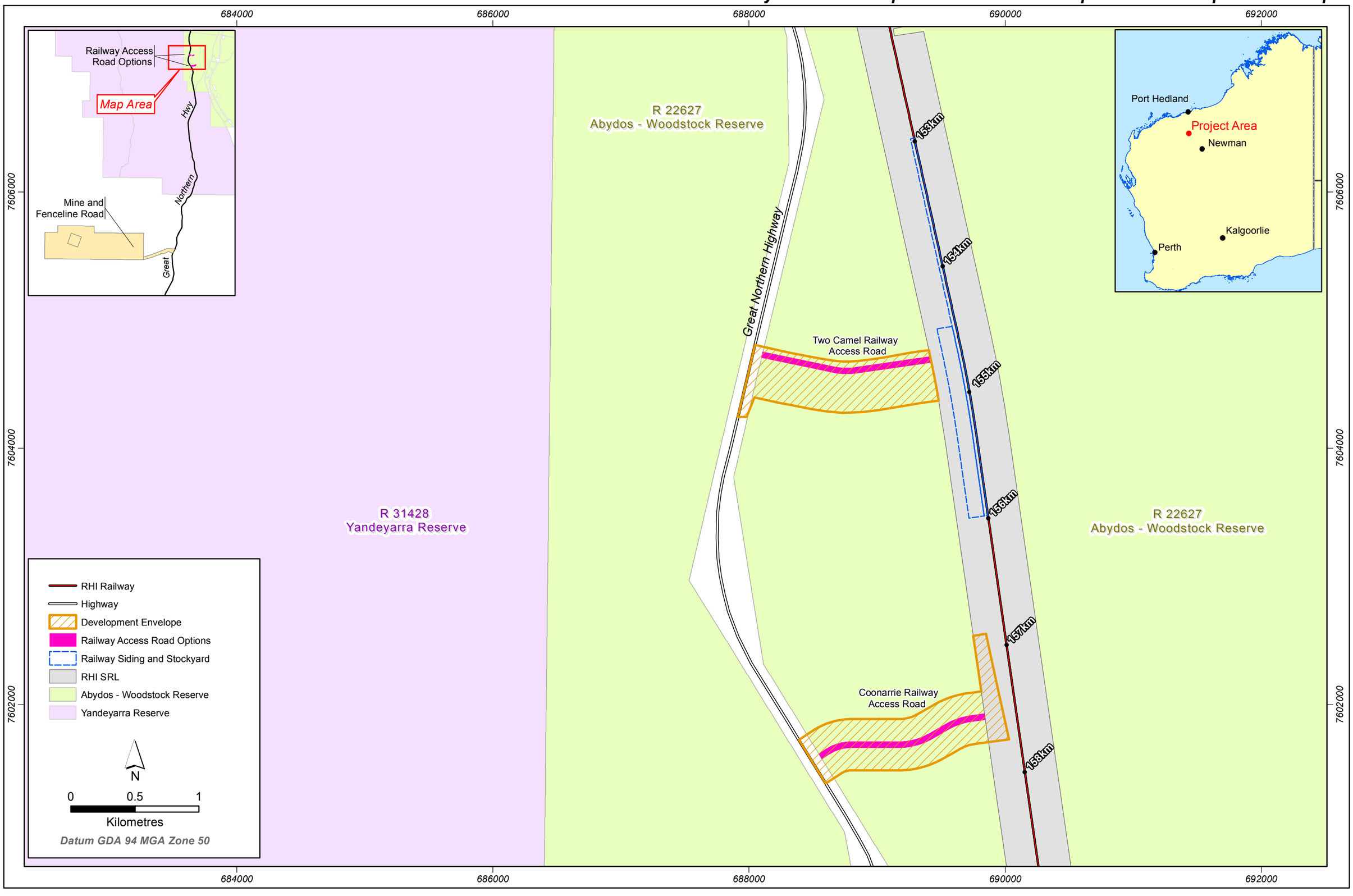
Mulga Downs Project
Figure 3

Railway access road options disturbance footprint and development envelope



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MD0244_3

2.2.1 Project timing

The Project schedule includes:

- commence early pioneering earthworks – Q3 2014
- commence pre-stripping and mining – Q1 2015
- first production of DSO – Q2 2015
- completion of mining – Q3 2018.

2.2.2 Ore reserve

An ore reserve statement based on a 2009 Resource Block Model is provided in Table 2. The table also indicates the average ore inventory expected to be recovered from the reserve. This Project relates only to the above watertable portion of the ore reserve.

Table 2 Ore reserve statement

	Ore	Waste
Tonnes (Grade 55)	35 400 000	31 900 000
Fe (%)	58-59	
Silica (%)	6-7	
Aluminium (%)	2-2.5	
Phosphorous (%)	0.05-0.07	
Manganese (%)	0.5-0.8	
Loss on Ignition (LOI) (%)	4-7	

2.2.3 Mining method

The Project will produce a fines only ore product at a rate of 5 Mtpa. In total, there is approximately 14 Mt of bedded and detrital ore and 7 Mt of waste rock to be mined from the AWT open pit.

Conventional open pit mining techniques of: drill, blast, load and haul will be employed. Ore processing will comprise dry crushing and screening of Run of Mine (ROM) material. The fines product will be hauled by road train to a rail siding from where it will be railed to a port in Port Hedland for export.

Pre-stripping

Pre-stripping includes topsoil removal and developing of the pit.

Prior to commencement of mining, topsoil and vegetation will be removed and stockpiled in designated topsoil stockpiles. Topsoil stockpiles will be managed in accordance with mining and environmental approvals. Stockpiled topsoil will be progressively used during the rehabilitation of waste dumps and other areas of ground disturbance.

The material removed during the pre-stripping will be stockpiled according to the chemical and physical characteristics of the material. Some detrital ore and low-grade bedded ore will be mined during the pre-stripping process. Pre-stripped waste and low-grade material will be used as fill for roads, construction pads and stockpile bases where possible.

Open pit mining

The Project involves development of a single open pit, approximately 2.5 km in length and 1.8 km in width.

A minimum of two benches are expected to be open at any time to maintain productivity and grade control.

Mining will be conducted with a digger in excavator configuration. Excavator configuration allows the digger to be used for both production mining and tasks such as maintaining pit walls and pulling batters.

Drilling and blasting

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 mining fleet will comprise a range of excavators, loaders and ancillary plant typical of iron ore mining in Western Australia.

Dewatering

As mining will be AWT, 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.

Waste rock management

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 in the designated waste rock dumps which will be rehabilitated in accordance with mining and environmental approvals

2.2.4 Ore stockpiling and processing

Ore stockpiling and management

Ore will be transported via haul trucks to the ROM facility, where it will be stockpiled prior to processing according to iron grade and other physical and chemical characteristics.

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 before being released into the natural environment. Sedimentation ponds will be sized for a 5-year average recurrence interval (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 crushing and screening plant sprinkler system, or via water carts. Trafficked areas around these stockpiles will be watered by the water carts on a regular basis.

Crushing and screening

Considering the short mine life and projected total throughput, crushing and screening of ore is proposed through either mobile plant or semi-mobile or modular/skid mounted plant.

2.2.5 Tailings storage

No tailings will be produced.

2.2.6 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. These facilities are discussed below.

Construction facilities and utilities

Construction is anticipated to take six months and will require a number of temporary facilities. The construction workforce will initially be housed at the existing 40-person exploration camp. The accommodation camp will be constructed early in the construction period to allow construction teams to use the new site accommodation.

Accommodation camp

A camp for up to 400 persons will be constructed for the construction and mine operations workforces (Figure 2).

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

Mine operations centre

The mine operations centre will comprise of transportable buildings. Potable water will be reticulated to the mine operations centre office buildings and amenities from the mine infrastructure treatment plant. Storage tanks will be used to ensure adequate back-up supply in case of service disruption.

Contractor facilities

Contractors (crushing, mining and product transport) will be responsible for providing their own offices, amenities, ablutions, services and facilities. The contractor facilities will also contain fuel storage and refuelling area, workshop, washdown area and laydown areas.

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 for heavy vehicles (fast fill bowser) as well as for light vehicles. A contracted fuel supplier will transport diesel fuel to site on a regular basis by tanker road train deliveries.

Workshop, stores and washdown areas

Separate heavy vehicle and light vehicle workshops, stores and washdown areas will be established for the maintenance of contractor plant and equipment.

The washdown areas 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 areas

The parking and laydown areas will primarily be used for heavy vehicles and the storage of waste materials to be transported offsite.

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.

Wastewater management

All sewage and wastewater will be treated in a packaged wastewater treatment plants (WWTP). The WWTP will be constructed and operated in accordance with the EP Act through relevant works approval and registration. The plant will also meet Department of Health (DoH) 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.

Explosives magazine

The explosives magazine has been located in a designated area 1.5 km away from the mine bund wall and vulnerable/critical infrastructure. 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).

Water production bores and pipelines

Water demand for the Project is described in Section 2.2.8. Water supply has been designed to meet the peak water demand of approximately 150 megalitres (ML) per month occurring in the fourth quarter 2013.

Water supply for the purpose of mine and road construction, mine operations and camp supply will be provided by up to 10 bores. 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.

Hydrogeological bore drilling and testing was completed end of 2012 for the mine area and along Fenceline Road. The bores will be steel cased to a depth of approximately 100 m.

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 disposed of at an on-site landfill facility. Landfill facilities will be registered or licensed as required under the EP Act. Waste storage will be designed to minimise wildlife access, with closed lids on any putrescibles and crib waste collection and storage vessels.

Should a reverse osmosis plant be used for water supply treatment, HPPL will investigate disposal options for the small volumes of brine that will be produced, including dilution through addition to the process water stream.

Workforce

The construction workforce will consist primarily of contractor employees, supplemented with a small number of HPPL personnel and totalling up to 400 persons. Due to the remote location of the Project, personnel will generally 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 HPPL 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, seven days per week.

2.2.7 Haulage and access roads

Product transport and export

HPPL is proposing to haul iron ore by road from the mine to the proposed Mulga Downs rail siding. The haulage operation will be on a 24-hour basis with quad-configuration road trains. The trucking frequency will be in the order of one truck every 7.5 minutes. The haul route distance is 91.5 km one-way and will comprise the following:

- Fenceline Rd – 30 km (to be upgraded)
- Great Northern Highway – 60 km
- railway access road – approximately 1.5 km.

HPPL will comply with all Main Road Western Australia (MRWA) notifications and permits for concessional load haulage.

Fenceline Road and the railway access road will be constructed to be suitable for Class 1, 2 or 3 traffic. Speed on the roads are proposed to be limited to 60 or 80 kilometres per hour (km/hr).

Sections of Fenceline Road will require sheeting with a road sub-base type material of approximately 300 mm thickness. Sheeting material will be sourced from the mine or borrow pits. Construction water for re-sheeting works and road maintenance will also be sourced from the mine site. A 15 m wide constructed road pavement will be required to allow for access of heavy haulage trucks and light vehicles.

Regulation 13.7 of the Mines Safety and Inspection Regulations 1995 (WA) sets responsibility with 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 will be designed to meet this requirement.

In consideration of the short mine life, the access road basis of drainage design will account for a 1-in-5-year ARI rain event. Drainage requirements (e.g. floodways and/or culverts) will be installed to maintain sheet flow.

Access ramp

A skyway access ramp will be constructed between the mine pit and ROM facility to provide access for load and haul of material from the pit to the crushing and screening plant.

Access roads and tracks

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

Roads will be aligned to avoid trees where possible. Construction will commence by stripping and stockpiling groundcover vegetation and topsoil 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. floodways and/or culverts) will be installed to maintain sheet flow.

2.2.8 Resource requirements and regional infrastructure

Water usage

As no reticulated water supply is located within a reasonable distance of the Project area, process and potable water requirements will be sourced from local groundwater.

A summary of the water demand for construction and operation is presented in Table 3. The average demand during construction is estimated to be approximately 120 Megalitres per month (ML/month) at the mine area and 30 ML/month at the rail area. The average demand during operations is estimated to be approximately 80 ML/month at the mine area and 5 ML/month at the rail area. Construction activities in the fourth quarter of 2014 result in a peak demand of approximately 130 ML/month at the mine area and 35 ML/month at the rail area.

Table 3 Mine area construction and operations groundwater demand

Demand Item	Average Monthly Demand (ML)	Annual Abstraction (ML)	Demand Duration
Construction			
Earthworks mine Area	119	715	6 months
Earthworks rail Area	31	185	6 months
Construction Total	150	900	Q3- Q4 2015
Operations			
Mining	30	360	
Processing plant	18	220	
Mine Infrastructure	1	12	
Road dust suppression	30	360	
Camp	5	60	
Rail Stockyard (including construction of Coonarrie railway access road)	5	60	
Operations Total (+ 20%)	89	1075	Q1 2015 – LOM

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

Bulk earthworks material required for sheeting will be pre-conditioned prior to transport to sheeting locations.

Water extracted from the production bores will be stored in turkey nest dams that will provide storage for peak daily demand. These dams are expected to be constructed using mine waste or borrow pit material. Dams will be either landscaped to allow animal egress or will have specific animal egress points installed.

Water extracted for potable water purposes will be piped to the mine infrastructure area and camp where it will be treated to meet the minimum requirements of the Australian Drinking Water Guidelines.

Energy usage

Power distribution assets are not located within a reasonable distance of the Project area; therefore, power supply will be sourced from various power stations with multiple diesel generators.

The power demand for the Project will be up to 10 megawatts per annum (MWpa), which includes:

- processing – up to 6 MWpa
- mining Infrastructure – up to 1.5 MWpa
- camp – up to 1.5 MWpa
- rail stockyard – up to 1 MWpa.

All electrical installations will conform to Australian Standards, Western Australia Electrical Requirements, and the *Mines Safety and Inspection Act 1995* and associated regulations.

Diesel fuel usage

Up to 50 MLpa of diesel will be required for the Project. The anticipated fuel demand is shown in Table 4.

Table 4 Fuel Demand

Description	Fuel demand (MLpa)
Camp	2.2
Mining fleet	5.2
Mining explosives	0.9
Processing	12.1
Mine infrastructure	3.5
Road haulage	15
Rail stockyard	2.9
Contingency (+20%)	50

Site tank storage will be based on two weeks site storage for 50 MLpa, which will require up to 18 x 110 kL double skinned (self-bunded) tanks. These tanks will be located at different geographical locations (e.g. at the camp power station, mining infrastructure power station, etc.).

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 tanks consisting of an on-board bowser for dispensing fuel to light vehicles and/or 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 or borrow pits as outlined in Table 5.

Table 5 Bulk earthworks material

Source	Volume (m^3)
Mine area (e.g. ROM pad, skyway and stockpile bases)	300 000
Fenceline Road	450 000
Camp	100 000
Rail access road	22 500
Total	**872 500**

3. Consideration of alternatives and avoidance of impact through design

Several alternative designs or approaches were considered in developing the Project. The analysis of alternatives took into account financial, logistic, environmental and surrounding land uses considerations.

3.1 Haulage

AECOM was engaged by HPPL to conduct a desktop haulage study on ten potential haul road alignments between the mine site and the Roy Hill Infrastructure Railway based on social, environmental, hydrological and topographical factors.

The study (HPPL 2012) indicated that while the shortest alignment may be most attractive from a capital cost perspective, it presented scheduling risks with respect to third party land access agreements. Longer alignments required additional capital but had less access impediments. The original haul road options also traversed the Yandeyarra Reserve which raised a number of stakeholder concerns during consultation. Consequently, it was concluded that all ten proposed alignments between the Mulga Downs site and the Roy Hill Infrastructure Railway were problematic from an engineering, environmental, stakeholder, cost or scheduling perspective.

As a result, the use of the Great Northern Highway was further investigated involving financial analysis and consultation with MRWA (HPPL 2012, p. 1). The financial analysis considered two production throughputs to assess the efficiency of:

1. Haulage to Port Hedland via the Great Northern Highway.
2. Hauling to the Roy Hill Infrastructure Railway via private road.

The financial analysis revealed that hauling up to 5 Mtpa via the Great Northern Highway (and railway access road) to the Roy Hill Infrastructure Railway will return the greatest net present value. Through discussions, Main Roads Western Australia (MRWA) also confirmed that capacity exists for use of the Great Northern Highway (HPPL 2012, p. 2). Use of the Great Northern Highway will also minimise the footprint of the Project, reducing additional ground disturbance and consequent environmental and heritage-related impacts (HPPL 2012, p. 2).

3.2 Mine pit

Limited alternatives are available for the proposed mining and processing components of the Project. The location of major infrastructure is governed by the location of the iron ore deposit, with the requirement to locate supporting infrastructure within proximity to the deposit being a governing factor. Siting of infrastructure has been carried out to limit the disturbance footprint. The final mine pit footprint considered the following:

- location and extent of the existing mining lease
- minimising total area of native vegetation disturbed
- minimising effects on groundwater and surface water
- economic cost.

The selected configuration consists of one mine pit to provide access to the AWT resource only.

3.3 Accommodation camp

Eleven locations were initially considered for the accommodation camp to support the mining operation. These were subsequently narrowed down to two options following financial, logistic and environmental considerations.

Following the completion of the relevant studies and investigations relevant to the Project, camp option 2 was chosen on the basis that this option:

- avoids disturbance to potential habitat for the WC Act listed Northern Quoll
- sits within a smaller surface water catchment area with minimal diversion of surface water flows required.

3.4 Railway access road

Two options for the proposed railway access road are currently being considered to provide access from Great Northern Highway to the proposed Mulga Downs rail siding: Coonarrie and Two Camel. Both options are located within the Abydos-Woodstock Protected Area 33.

The final railway access road option will be chosen taking into consideration of a range of factors including: environmental, social, heritage, engineering, hydrological and topographical factors.

4. Stakeholder consultation

4.1 Stakeholder engagement process

HPPL has actively maintained a stakeholder consultation program throughout development of the Project, from concept to detailed design. The objectives of the stakeholder consultation are to:

1. Provide interested parties with information on the Project so that they are able to raise issues and concerns and obtain feedback at the development stage.
2. Establish relationships with key stakeholders that enable ongoing dialogue throughout the implementation and regulation of the Project.

HPPL has undertaken a broad consultation program with key stakeholders. Stakeholders were identified through previous experience with exploration work in the local area. Consultants and project engineers also participated in the identification of stakeholders. The stakeholder groups identified include:

- State government agencies
- Australian government agencies
- Native Title parties and representative organisations
- community stakeholders
- land owners
- mining tenement holders.

The methods for consultation and communication included:

- face-to-face meetings
- direct mail and email
- group emails
- telephone calls
- site visits.

Table 6 summarises the key consultation events, topics raised and the response to matters raised.

HPPL will maintain a stakeholder consultation program throughout the life of the Project as part of normal business practice, providing updates to relevant stakeholders as required. The list of stakeholders will continue to be developed and revised as required.

Table 6 Summary of Key Consultation Events

Date	Stakeholder	Topics Raised	Proponent Response
20 February 2012	HPPL internal	List of key stakeholders developed.	Stakeholder feedback throughout consultation addressed as described below.
14 March 2012	Kariyarra Working Group Yamatji Marlpa Aboriginal Corporation (YMAC)	Presented an overview of the Project and the proposed Haul Road options through the Yandeyarra Reserve (which occurs within Kariyarra country). HPPL is also required to consult Mugarinya Community Association for matters involving Yandeyarra.	Meeting arranged on 27 March with Mugarinya Community Association Board of Directors.
27 March 2012	Mugarinya Community Association (MCA) Board meeting	Presented an overview of the Project and the proposed Haul Road through Yandeyarra. Initial comments from traditional owners advised that the options were unacceptable to the community on the basis that they affected grazing land and community meeting places. Mugarinya Community Association advised that the information needs to be presented to the full Council on country, in the Yandeyarra.	HPPL removed the proposed Haul Road through the Yandeyarra from the project definition. HPPL formally requested in writing a meeting with the full Council on country (26 April).
11 April 2012	Office of the Environmental Protection Authority (OEPA)	Presented an overview of the Project – scope – area of disturbance, life of mine – will define the level of assessment. OEPA recommended a briefing to other State departments that may be decision making authorities in the assessment process. OEPA recommended that HPPL also consult with the Federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).	Federal department briefing held via teleconference on 20 April. State government department briefing held on 27 April.
17 April 2012	Department of State Development (DSD) Department of Mines and Petroleum (DMP)	Discussion on the need for a variation to the Abydos-Woodstock protected area for the purposes of a haul road and stockpiles for the Project. DMP confirmed the Abydos-Woodstock excision is required prior to lodging a Miscellaneous Licence application for the haul road. HPPL confirmed that the Project is not part of a State Agreement.	HPPL commenced consultation on the variation to a protected area (i.e. excision process).
20 April 2012	DSEWPaC pre-referral scoping meeting	Presented an overview of the Project. At the referral stage, the Minister can only consider the adverse impacts not the positive outcomes of offsets. The level of assessment is based on the scope lodged with the referral. DSEWPaC is interested in a site visit to Mulga Downs.	HPPL has used this discussion to develop its referral document and define the scope of works for the biological surveys.
24 April 2012	DSD	Presented an overview of the Project. Abydos-Woodstock excision – requires a lead agency. Given this is not a State Agreement matter, DSD does not have lead agency role.	HPPL identified that the lead agency for Abydos-Woodstock excision in this instance is the Department of Indigenous Affairs (DIA)[4].

[4] Department of Indigenous Affairs existed at the time of consultation. The relevant agency is now Department of Aboriginal Affairs.

Date	Stakeholder	Topics Raised	Proponent Response
26 April 2012	MCA full council meeting plus technical advisers (on Country, in Yanderra Reserve)	Presented an overview of the Project and in particular the transport corridor. HPPL requested an access agreement with MCA for surveys of the transport corridor with a view to obtaining a miscellaneous licence in the near future. MCA Council advised that this matter needs to be presented to the full community and will advise next steps through Hammond Legal.	HPPL provided formal correspondence to MCA requesting an agreement to enter Yandeyarra for reconnaissance surveys.
27 April 2012	State agency briefing Department of Water (DoW) Pilbara Region DIA - Heritage North DEC- Environmental Management Branch (EMB) DEC- Industry Regulation DMP - Environment North DSD OEPA OEPA - Assessment and Compliance Division OEPA - Terrestrial Ecosystems Branch	Presented an overview of the Project. HPPL sought early stakeholder feedback to guide the project definition. Each agency provided comment on the information expected to be provided in approvals documentation.	HPPL actions arising from agency feedback: Meeting with OEPA to discuss scope of works for biological surveys. Meeting with DIA to confirm process for excision. Develop scope of works for engineers to address information requests from government departments. Develop stakeholder consultation schedule to meet each department separately.
7 May 2012	DIA	HPPL presented an overview of the Project and sought advice on the approvals pathway for the Abydos Woodstock excision. DIA advised that Regulation 10 permits are required to access Abydos-Woodstock for non-ground disturbing investigations. DIA advised that s 18 permits provide indemnity to HPPL from prosecution if sites are disturbed. DIA advised that the department is initiating a project to redefine the boundaries of Abydos-Woodstock Reserve. Any new infrastructure should be designed to 'stay close to existing infrastructure'. DIA advised that HPPL should provide the Minister with early notification of the proposal to vary the protected area status of a section of Abydos-Woodstock. DIA will provide information on the approvals pathway once HPPL defines the project scope to one preferred transport option.	HPPL provided formal notification to the then Minister for Indigenous Affairs of the Project.
8 May 2012	Department of Regional Development and Lands (DRDL)	HPPL presented an overview of the Mulga Downs Project HPPL seeking advice on obtaining access to conduct ground disturbing investigations prior to Miscellaneous licence being granted. DRDL advised that non-ground disturbing works can be completed with the consent of the landowner. A s 91 Land Administration Act licence is required for the geotechnical and water investigations.	Change of project scope – no longer require this investigation licence.

Date	Stakeholder	Topics Raised	Proponent Response
9 May 2012	Meeting with YMAC and Roe Legal (representatives of the Banjima People)	Presented an overview of the Project. HPPL requesting negotiations on a Mining Agreement. HPPL aiming to complete surveys by September to lodge s 18 applications to Aboriginal Cultural Material Committee by 26 October for the 15 December meeting (final meeting for the year). YMAC advised that a heritage team will need to be formed with appropriate members of the group before progressing on an agreement.	HPPL correspondence formally requesting a Heritage Team to be formed for the Project. Heritage Team meeting held on 21 June 2012.
18 May 2012	Shire of East Pilbara	Presented an overview of the Project. Shire of East Pilbara advised that no development applications or planning approval will be required, as the project does not affect the Shire. HPPL should provide photos and project updates to the Shire once the haul road is finalised.	HPPL provides periodic project updates to Shire of East Pilbara.
21 May 2012	Main Roads WA (MRWA)	Presented an overview of the Project and a discussion of the haul road options. MRWA advised that it prefers grade separated crossings of the Great Northern Highway. HPPL and MRWA can commence with an 'in principle agreement' for the road concept. HPPL to provide designs to MRWA engineers for review and comments.	HPPL correspondence to MRWA requesting an 'in principle' agreement from MRWA. MRWA in principle agreement letter received 11 July 2012.
21 May 2012	Town of Port Hedland	Presented an overview of the Project and the haul road options. Town of Port Hedland advised that it does not regulate private roads. HPPL needs to refer to MRWA for design and set-back distances. Town of Port Hedland Planning and Development Department can provide guidance on planning and building applications and requirements, if/where required.	HPPL consultation with Town of Port Hedland - Planning and Development Department.
22 May 2012	OEPA - Assessment and Compliance Division	Presented an overview of the Project and stakeholder consultation to date. OEPA advised that the s 38 referral will need to be lodged by late August or early September to ensure Level of Assessment decision by December 2012. OEPA recommended that HPPL check the data available in the public domain to ensure that cumulative impacts of the project can be assessed and the EPA can confidently make approval decisions and set conditions.	The Project scope was defined in August 2012. Additional environmental studies were completed to close out data gaps for the referral document.
23 May 2012	Yindjibarndi Aboriginal Corporation (YAC)	HPPL presented an overview of the Project to YAC and requested an access agreement for the purposes of the haul road. Yindjibarndi provided positive feedback on the HPPL approach of involving stakeholders early in the project definition work. Yindjibarndi proposes a land access agreement to cover both exploration activities and surveys for the private haul road.	HPPL returned draft land access and mineral exploration agreement to YAC on 29 May 2012.
20 June 2012	Hammond Legal (phone) as representative of MCA	HPPL clarification on intra-indigenous arrangements between the Kariyarra People and MCA for the Yandeyarra Reserve. Hammond Legal confirmed that Kariyarra People will complete the heritage (ethnographic and archaeological) surveys within Yandeyarra. Hammond Legal advised that MCA will allow access into the Yandeyarra Reserve for the purposes of heritage surveys only. MCA community members will be present on all other types of surveys (e.g. engineering, geotechnical, water source, borrow).	HPPL completed heritage surveys of haul road Option 12 within the Yandeyarra Reserve with Kariyarra People 23 July to 3 August.

Date	Stakeholder	Topics Raised	Proponent Response
21 June 2012	YMAC on behalf of Kariyarra	HPPL introduced the Project and the proposed haul road option 12 through Yandeyarra. YMAC confirmed that it will organise the Kariyarra heritage team. Additional survey scoping meeting held 5 July.	HPPL completed heritage surveys of haul road Option 12 within the Yandeyarra Reserve with Kariyarra People 23 July to 3 August.
21 June 2012	Banjima Heritage Team	Banjima heritage team members stated that they are the representatives of the land on which the Project (and pastoral station) occurs. Ethnographic and archaeological surveys for the purposes of the Project cannot be completed until a Mining Agreement has been executed with HPPL. HPPL and Banjima agreed to a reconnaissance survey to identify any show-stoppers for the proposed haul road.	Preliminary reconnaissance survey of the section of haul road Option 12 that occurs within Banjima country was completed 6-9 August 2012.
22 June 2012	Fortescue Metals Group (FMG)	FMG confirmed that the private haul road Option 12 will need to have a grade separated crossing of the Solomon Railway. FMG requested GIS shape files from HPPL to determine the best location for a cross-over. HPPL requested environment and heritage data of the Solomon project. Confidentiality Deed required prior to exchange of data.	GIS shapefile of Option 12 haul road emailed to FMG on 28 June 2012. A change in project scope in August 2012 resulted in Option 12 remove from the project definition. Fenceline Road requires an Access Agreement with FMG.
3 July 2012	Hammond Legal as representative of MCA	Meeting to discuss draft consent for non-ground disturbing surveys. HPPL and MCA will enter into a short-form agreement for non-ground disturbing surveys. Kariyarra will complete the heritage surveys. In the absence of heritage surveys, HPPL is required to have a Mugarinya representative accompany all other work in Yandeyarra. HPPL and Mugarinya will enter into a project access agreement once the location of the Miscellaneous Licence for the haul road is confirmed.	Access deed for non-ground disturbing surveys drafted by HPPL and returned to Hammond Legal for comment and execution. Change of project scope in August, no longer using Option 12. HPPL maintains ongoing dialogue with MCA and Hammond Legal on exploration projects.
5 July 2012	YMAC as representatives of the Kariyarra People	HPPL and YMAC held a heritage survey scoping meeting. The surveys for the haul road Option 12 through Yandeyarra will be completed using the conditions of the alternative heritage agreements.	Kariyarra ethnographic and archaeological survey of Option 12 completed 23 July to 3 August 2012.
19 July 2012	DMP	HPPL presented an overview of the Project and discussed the information/data requirements for a Mining Proposal. Mines Safety is primarily interested in the design stability of large infrastructure such as tailings dams, surface water diversion bunds and the location of critical infrastructure. DMP Environment Branch would like a preliminary closure plan that realistically addresses closure issues and demonstrates stakeholder consultation.	HPPL holding a separate meeting with Mines Safety on 26 July 2012. HPPL to engage a suitably qualified consultant to assist in the development of a mine closure plan.
23 July to 3 August 2012	Kariyarra archaeological and ethnographic survey of road option 12 within Kariyarra country	A significant number of archaeological sites identified in the southern portion of the road. Boundary of sites marked. Will require a further survey to records details.	Change of project scope in August, no longer using Option 12.

Date	Stakeholder	Topics Raised	Proponent Response
26 July 2012	DMP - Mine Safety	HPPL and Mines Safety discussion of the requirements for a Mining Proposal. Mines Safety advised to design to address the hazards and consequences of catastrophic failure of infrastructure. Use DMP Guidelines on the Safe Design and Operating Standards for Tailings Storage. Use guidelines from Australian National Committee on Large Dams. Mining Proposal needs to include actions for verification in the field of the stability of infrastructure as designed.	Comments noted and addressed in consultant scopes of works for the Mining Proposal and closure plan.
6-9 August 2012	Banjima Elders	Helicopter reconnaissance survey of haul road Option 12 within Banjima Country. One permanent watering hole identified and must be avoided. Requires on the ground archaeological survey.	Design of road and mining footprint avoids significant ethnographic and archaeological sites. s 18 AHA consents obtained for site disturbances. A change in project scope in August 2012 resulted in Option 12 remove from the project definition.
8 August 2012	Internal Proposal Meeting	HPPL internal project meeting confirmed the definition of the Project that will be taken through approvals and detailed design: • 5 Mtpa • AWT • Use of Fenceline Road to access Great Northern Highway (i.e. no-longer using Option 12) • Use of Great Northern Highway to access Roy Hill Infrastructure Railway within Abydos Woodstock excised area.	Project briefings to government departments and relevant Minister's offices.
16 August 2012	MRWA	HPPL presented the final project definition and advised of the intention to use licensed vehicles on Great Northern Highway. MRWA provided initial verbal "in principle" agreement for the transport concept and agreed to an initial two years concessional loading for use of Great Northern Highway. HPPL and MRWA will visit proposed intersection locations to confirm best turn-off point from Great Northern Highway to access the railway siding and stockpiles.	HPPL and MRWA site visit 24 October 2012.
28 August 2012	Office of the then Minister for Indigenous Affairs	HPPL presented an overview of the Project. Minister's Advisers recommended that HPPL consult with DIA on the process and information requirements for the variation to the Abydos-Woodstock protected area. Minister's Advisers recommended that HPPL provide a briefing note to the Minister as soon as possible.	HPPL provided a letter to the then Minister for Indigenous Affairs on 6 September 2012 providing an overview of the Mulga Downs Project and advising of the need for a variation to the Abydos-Woodstock protected area.
3 September 2012	DIA - Heritage North	HPPL presented an update on the scope of the Project, including the reduced area of impact on the Abydos-Woodstock protected area. DIA confirmed that the variation to protected area status must occur before the s 18 application for the construction of the road. DIA advised that a Regulation 10 permit will be required to enter Abydos-Woodstock for the purposes of preliminary investigations.	Letter to the then Minister for Indigenous Affairs dated 6 September 2012 Regulation 10 permit issued on 8 October 2012.

Date	Stakeholder	Topics Raised	Proponent Response
17 September 2012	MCA	HPPL presented the revised Project scope. MCA would like to understand the mining project process and how stakeholders are involved.	Correspondence to MCA via Hammond Legal on 9 October 2012 describing the stages of a mining project from exploration through to resource definition, and explaining MCA involvement in each stage of the process.
19 September 2012	DEC - EMB	HPPL presented the revised scope of the Project. HPPL requested confirmation of the environmental surveys and data required for the referral to EPA. EMB identified the key environmental management issues as: • surface water management • managing residual long term impacts	EMB comments were provided to the engineering studies and design teams; and the environmental impact assessment team.
20 September 2012	OEPA - Assessment and Compliance Division	HPPL presented an update on the Project with the revised scope and definition. OEPA advised that the referral needs to include an impact assessment of the project footprint relative to the cumulative regional impact and impact on the Fortescue Plain IBRA. OEPA also advised that HPPL needs to consider offsets as the last resort for impacts that cannot be avoided or mitigated.	OEPA comments provided to approvals, impact assessment and biological studies team.
20 September 2012	OEPA - Terrestrial Ecosystems Branch	HPPL presented the scope of the Project and requested confirmation on the scope of the environmental surveys and data required for the referral. Terrestrial Ecosystems Branch requested copies of survey scopes and the existing environmental reports on which the impact assessments will be completed.	HPPL provided all environmental reports and the scope of works for the vertebrate fauna surveys to Terrestrial Ecosystems Branch for review and comment. Terrestrial Ecosystems Branch confirmed via email 24 September 2012 and 5 October 2012 that information and scope of works is appropriate for use on Mulga Downs Project.
9 October 2012	Kariyarra Working Group YMAC	HPPL advised of the proposed excision from Abydos-Woodstock (variation to protected area status of the processed access road from Great Northern Highway to the railway siding). HPPL requested heritage surveys with Kariyarra in October 2012 to define the area and location of excision. YMAC advised that surveys cannot be completed without a project heritage agreement. HPPL provided a draft access agreement specifically for the purposes of the heritage surveys.	An Access and Heritage Agreement was developed specifically for heritage surveys in Abydos-Woodstock. Additional discussions held in late October 2012 and early 2013 (see below).
24 October 2012	MRWA	HPPL attended a site visit with MRWA to review the proposed access road intersections on Great Northern Highway. From the visual inspection, Coonarrie railway access road option has a better position for the intersection. From the visual inspection, there are no show stoppers at the intersection of the Mulga Downs access road onto the Great Northern Highway. MRWA provided an “application for access” form, for HPPL to complete and return. No issues identified that would prevent concessional loading from being granted.	These comments were provided to the engineering team to inform their design process.
24 October 2012	BHP Billiton	BHP Billiton sent an email to HPPL confirming that it will not object to an access road or construction and operation of the rail siding and stockyards within Roy Hill SRL for the purposes of the Mulga Downs Project.	Consultation ongoing.

Date	Stakeholder	Topics Raised	Proponent Response
31 October 2012	YMAC on behalf of the Kariyarra People	HPPL sent a draft Access and Heritage Agreement to YMAC. Agreement developed specifically for the purposes of completing heritage surveys within Abydos-Woodstock. Subsequent consultation on project agreement.	Surveys scheduled for early November 2012 were cancelled because the traditional owners who could speak for the land were not available as scheduled.
24 May 2012	Roy Hill Infrastructure Pty Ltd (RHI)	HPPL and RHI Infrastructure Access Agreement; HPPL use of RHI railway and port infrastructure.	Access Agreement executed on 24 May 2012
27 November 2012	DSEWPaC	HPPL presented an overview of the Project, the preliminary results of the vertebrate fauna surveys and discussed the environmental impact considerations under the *Environment Protection Biodiversity Conservation Act 1999*.	HPPL will review the likely significance of impacts on Matters of National Environmental Significance once the terrestrial survey report is completed.
28 November 2012	OEPA	HPPL presented an overview of the Project and the results of biological surveys completed since the earlier meeting on 20 September 2012. Key issues identified for further consideration relate to residual impacts on vegetation and subterranean fauna.	HPPL has addressed the subterranean fauna and vegetation impact assessment consistent with the EPA guidelines. These matters are addressed in Sections 11 and 13 respectively.
11 December 2012	MRWA	HPPL formally advises design intent of Mulga Downs Project and use of Great Northern Highway for access to the railway siding.	No action.
14 January 2013	Mulga Downs Station Manager	Discussion of the following matters • alternative watering points supplied if operations occur within 3 km of an existing watering point • avoid the use of overhead powerlines • management of water from dewatering • some pit voids may be kept to provide the station with a water storage facility • fenceline road to be retained and used by station for an alternative access road.	Ongoing consultation with Station Manager on operational and closure matters. Incorporate the matters discussed in engineering, operations and other technical studies.
18 January 2013	Karijini Development YMAC Roe Legal	HPPL notification to Banjima of pegging of mining lease as part of process of converting E47/1244.	This tenement will be included in the scope of the Project Agreement that is currently being drafted.
29 January 2013	Karijini Development YMAC Roe Legal	HPPL notification to Banjima of application for s 91 investigation licence for geotechnical investigations on L45/316.	This tenement will be included in the scope of the Project Agreement that is currently being drafted.
30 January 2013	DoW	Provide an overview of the project in particular, • Surface water impacts • Surface water management • Water balance – demand/supply The above water table project scope will have insignificant impacts on the local and regional catchments and can be managed under existing water licences.	Ongoing consultation and project updates. Apply for 5C water licences on completion of pump testing.

Date	Stakeholder	Topics Raised	Proponent Response
31 January 2013	Karijini Development YMAC Roe Legal	HPPL advised of intention to peg mining lease as part of process of converting E47/1244. Pegging to take place on Thursday 7 and Friday 8 February 2013.	This tenement will be included in the scope of the Project Agreement that is currently being drafted.
14 February 2013	DSEWPaC Lachlan Wilkinson	Notice to DSEWPaC of decision not to refer the Mulga Downs Project based on the outcomes of the test of significance - answers to questions of impact on MNES are "no" and "unlikely." Letter to Lachlan Wilkinson included supporting vertebrate fauna reports and EPBC test of significance report.	DSEWPaC returned letter on 21 February 2013 confirming receipt of assessment and acknowledging decision not to refer the project.
6 March 2013	HPPL and YMAC on behalf of Kariyarra People	Woodstock-Abydos Interim Survey Agreement is executed.	Heritage surveys scheduled to be completed in April.
19 March 2013	YMAC on behalf of Kariyarra People	Presented a budget estimate to HPPL for the costs associated with negotiating a project agreement with Kariyarra.	HPPL is developing a draft project agreement to be negotiated with YMAC and Kariyarra.
28 March 2013	HPPL and YMAC on behalf of Banjima People	HPPL tables the Murray's Hill Mining Agreement to YMAC, to present to the Banjima People.	Banjima People request a meeting with HPPL on 15 May to negotiate agreement.
2-4 April 2013	Ethnographic and Archaeological Survey of Mulga Downs Project Railway Access Road options through Abydos-Woodstock	YMAC, Kariyarra, Eureka and HPPL heritage survey. No ethnographic sites recorded within railway access road corridor. All archaeological sites recorded can be avoided.	All recommendations from survey taken into consideration in the engineering design process.
7 May 2013	OEPA	Meeting to provide an update and overview of the Mulga Downs Project since previous discussions. Key messages from the meeting included: • place location of the Project in the context of the Fortescue Marsh • ensure EPA draft Environmental Assessment Guideline for subterranean fauna is considered as part of the assessment of subterranean fauna • include any correspondence or communications with other agencies regarding the Project • referral document to provide an overview, with relevant technical reports attached.	The referral document provides an overview of the relevant environmental factors. Relevant technical reports are provided as Appendices. HPPL has specifically addressed the following in the referral document • subterranean fauna and consistent with the relevant EPA guidelines (Section 13) • the location of the Fortescue Marsh has been described in the context of the Project (Section 6.4) • consultation with other agencies is outlined in this table.

Date	Stakeholder	Topics Raised	Proponent Response
15 May 2013	Banjima Working Group HPPL YMAC Roe Legal	Initial negotiation meeting on Project Agreement with Banjima Working Group.	Ongoing discussions.
10 June 2013	Hon. Peter Collier, Minister for Education, Aboriginal Affairs, Electoral Affairs	Commenced discussion with Office of the Minister for Aboriginal Affairs and made a formal submission on being able to use Regulation 10 of the AH Act to temporarily construct and operate an access road within the Abydos Woodstock reserve for access to the RHI Rail Siding C.	Ongoing discussions
2013	FMG	Access Agreement for miscellaneous licence associated with the Fenceline Road.	HPPL and FMG are well progressed in negotiations with the aim of achieving an executed agreement in 2013.

4.2 Aboriginal heritage

HPPL has an active heritage management program integrated into the Native Title, stakeholder consultation and ground disturbance permit plans.

The objective of the heritage management program is to ensure, at a minimum, compliance with the *Aboriginal Heritage Act 1972* (AH Act) and the *Native Title Act 1993* as well as maintaining positive working relationships with the traditional owners of the land within which the Project is located.

The Project is located within two Native Title claim areas: Banjima WAD6096/1998 claim and Kariyarra Peoples' WAD6169/1998 claim.

HPPL has completed numerous consultation actions with the Banjima and the Kariyarra on the, such as:

- Banjima (WAD6096/1998)
  - HPPL has a long working history with the Banjima People, in particular the Martu Idja Banjima group, since the 1990s
  - HPPL has regularly conducted heritage surveys with the Banjima for exploration projects within the Banjima claim area
  - HPPL has conducted monthly heritage surveys – including recordings of sites to s 18 AH Act level of detail, with the Banjima within the mine site and Fenceline Road area.
  - HPPL maintains a strong working relationship and consultation with the Banjima people
  - a briefing of the Project was presented to the Banjima elders and their legal representatives in June 2012 (at this meeting, the group raised the need for a Project Agreement)
  - a draft Project Agreement was tabled on 15 April 2013 and a negotiation meeting held on 15 May 2013.
- Kariyarra (WAD6169/1998)
  - HPPL commenced its working relationship with Kariyarra during the development of the Roy Hill Infrastructure Railway
  - HPPL and the Kariyarra have partnered to complete two ethnographic and archaeological heritage surveys within the Project area; including one survey for the original haul road option 12 through the Yandeyarra (note: this option is no longer being used)
  - HPPL has provided several briefings in Port Hedland to the Kariyarra people and their legal representatives on the Project
  - Kariyarra traditional owners and stakeholders were briefed on the Project from its inception and have been provided with regular updates on any changes
  - An ethnographic and archaeological survey was conducted over the two railway access road options from 2-4 April 2013
  - HPPL is currently negotiating a Project Agreement for the transport of minerals through the Kariyarra claim area.

5. Regulatory framework and environmental approvals

5.1.1 Applicable legislation

The key environmental legislation applying to the Project includes, but is not limited to:

- *Environmental Protection Act 1986* (EP Act) (WA)
- *Conservation and Land Management Act 1984* (CALM Act) (WA)
- *Wildlife Conservation Act 1950* (WC Act) (WA)
- *Mining Act 1978* (Mining Act) (WA)
- *Aboriginal Heritage Act 1972* (AH Act) (WA)
- *Rights in Water and Irrigation Act 1914* (RIWI Act) (WA)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Commonwealth)
- *Native Title Act 1993*

5.1.2 Western Australian environmental impact assessment process

The EP Act is the primary legislation that governs environmental impact assessment and protection in Western Australia. This Project is being referred to the EPA under s 38(1) of the EP Act.

5.1.3 Other state environmental approvals

A clearing permit under Part V of the EP Act will be required if the Project is not assessed. DMP has delegated responsibility for the administration, assessment and approval of clearing permit applications relating to mineral and petroleum activities in Western Australia.

The Project will also be subject to Part V of the EP Act. A works approval will be required for construction of several items that qualify as 'prescribed premises' under the Environmental Protection Regulations 1987 and a licence will be required for operation. The Project is expected to be prescribed for the categories listed in Table 7.

Table 7 Prescribed premises categories

Category	Description
12	Crushing and screening
85	Sewage facility: premises on which sewage is treated (excluding septic tanks) or from which sewage is discharged to land or waters (more than 20 but less than 100 m^3/day)
89	Putrescible landfill site (More than 20 but less than 5000 tonnes per year)

HPPL will prepare and submit works approval and licence application(s) for assessment by DEC.

The Mining Act regulates mineral exploration and mining in Western Australia. A Mining Proposal and Mine Closure Plan will be submitted to DMP.

The RIWI Act provides the legislation for DoW to manage and allocate water resources in Western Australia. HPPL will submit applications for 26D and 5C licences under the provisions of the RIWI Act for construction of, and abstraction from, water supply bores for the potable and process water requirements for the Project.

The AH Act makes provision for the preservation of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants. HPPL will submit applications under s 18 of the AH Act for disturbance to Aboriginal heritage sites where required.

If an excision from the Abydos-Woodstock Protected Area 33 is required for access to the proposed Mulga Downs rail siding and Roy Hill Infrastructure Railway, the process will be led by DAA and the Minister for Aboriginal Affairs.

5.1.4 Australian Government environmental impact assessment process

While the states and territories have responsibility for environmental matters at a state and local level, the EPBC Act aims to focus the Australian Government interests on protecting Matters of National Environmental Significance (MNES).

The EPBC Act requires an assessment as to whether a proposed action is likely to have a significant effect on a MNES.

The most relevant matter of MNES is that which aims to protect threatened species and ecological communities. The EPBC Act lists flora and fauna species that are either extinct, extinct in the wild, critically endangered, endangered, vulnerable, or conservation dependent. Ecological communities are listed that are critically endangered, endangered or vulnerable. An assessment requires determining the presence (either confirmed or likely) of listed threatened species and communities in the project area and the likelihood of significant impacts that may be posed by the proposed action.

The Project has been assessed against the DSEWPaC 'Test of Significance' criteria and the Northern Quoll Impact Assessment Guidelines. As a result of discussions with DSEWPaC and the outcomes of this assessment, DSEWPaC was notified in January 2013 that HPPL did not intend to refer the Project under the EPBC Act. Based on the information provided, in February 2013 DSEWPaC concurred that the Project was unlikely to significantly affect identified MNES. Given this, there will be no further input from DSEWPaC in the approvals process for the stated Project scope.

6. Existing environment

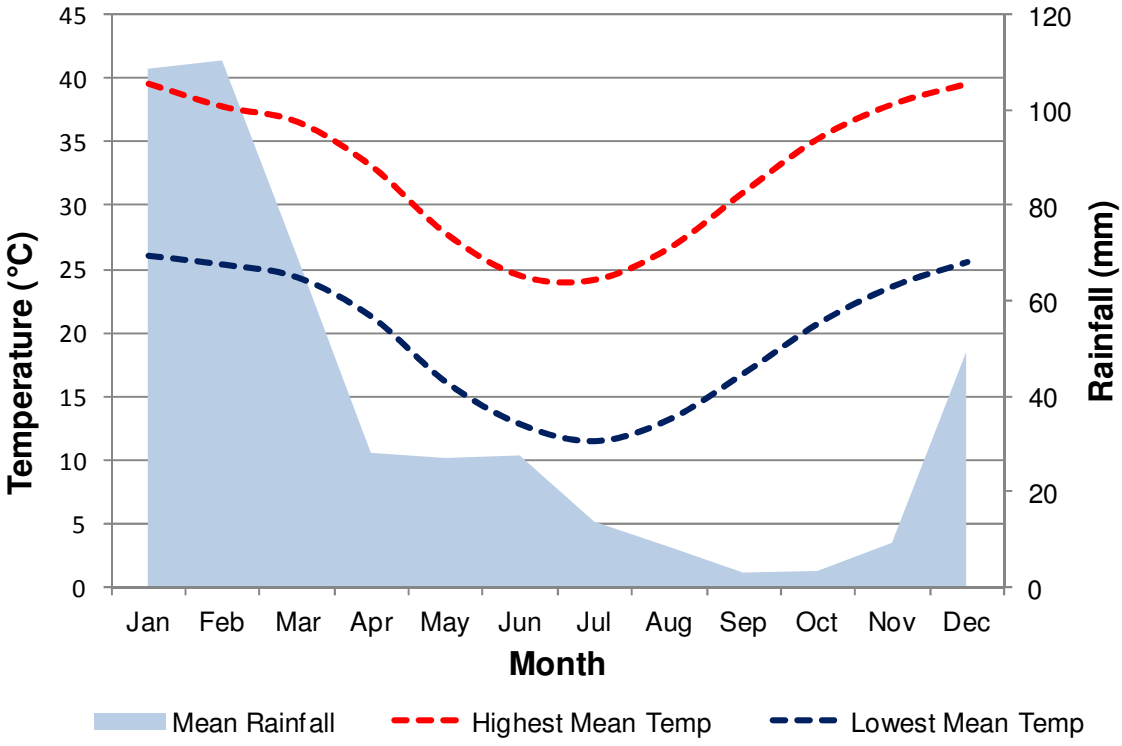
6.1 Climate

The Project is located within the Pilbara region of Western Australia. The climate is arid-tropical with two distinct seasons comprising a hot summer extending from October to April where maximum daily temperatures can exceed 35 degrees Celsius (°C) and a mild winter from May to September, with a temperature range of 7°C to 23°C (BOM 2012)

Rainfall in the Pilbara is predominantly from January to March but is largely unreliable and unpredictable and annual evaporation can exceed rainfall by up to 500 mm per year.

The closest recorded meteorological data from the project area is Wittenoom, approximately 20 km south-west of the Project area. At Wittenoom, temperatures can reach a mean maximum of about 39.0ºC in summer and a minimum of about 24.0ºC in winter (BOM 2012). The average annual rainfall is 460 mm. As is typical for the Pilbara, the distribution of rainfall across the year is bimodal. The majority of rainfall occurs in the summer period between December and March, followed by a smaller peak from April to June (BOM 2012). Average climate data from the weather station at Wittenoom (Station # 5026) is shown in Figure 4.

Figure 4 Mean monthly temperature and rainfall observations at Wittenoom (BOM 2012)



6.2 Geology

6.2.1 Regional geology

The Pilbara Region has undergone a long geological evolution over a period of about 3500 million years. Precambrian basement rocks, generated during phases of sedimentation, intrusion and volcanism, were deformed and metamorphosed due to movements in the Earth's crust. These rocks occupy most of the Pilbara and have been intersected by intrusive dykes and veins. Sea level changes and subsidence led to the deposition of large Phanerozoic sedimentary basins that overlie the western and eastern margin of the Pilbara. Erosion of the basement rocks and transportation by drainages has led to the deposition of Cainozoic superficial units, which now cover much of the basement rocks and the sedimentary basins (Van Vreeswyk et al. 2004).

The Project area is located within the Hamersley Iron Province covering an area of about 100 000 km^2. Within the main area of the Hamersley Province, the Marra Mamba Formation has been subdivided into three main horizons, the Nammuldi, MacLeod and Mount Newman. The lowermost Nammuldi member is predominantly comprised of a cherty Banded Iron Formation (BIF) interbedded with irregularly spaced thin shale bands. The middle horizon comprises the MacLeod, which displays interbedded BIF and shales while the lower Mount Newman is predominantly BIF with irregularly spaced shale bands (Coffey 2008, p. 5).

Alluvial and detrital of Cainozoic age overlie the sequence, within which iron rich detritals have been identified in the vicinity of other Marra Mamba and Brockman deposits. A weathered zone is typically developed over deposits characterised by the presence of silicified / aluminous / vitreous goethite and cavities (Coffey 2008, p. 5).

Multiple phases of deformation have occurred with folding identified at varying intensity and direction. As a result, the strata are often folded into a series of anticlinal and synclinal structures. Faults, low angle shears or thrusts further disrupt the sequences and are the other main structural elements often observed (Coffey 2008, p. 5).

Iron mineralisation of varying grade and quality usually occurs within the Mount Newman horizon and can be found within the MacLeod and Nammuldi horizons. The in-situ ore forming process is a combination of the pseudomorphic replacement of magnetite (resulting in martite), the replacement of BIF gangue minerals by hydrous iron oxides (goethite), often followed by extensive leaching which gives rise to limonite (ochreous goethite). Formation of the martite-goethite ores result in a reduction in the thickness of the stratigraphic units. The resultant iron enrichment contains varying amounts of martite (hematite), goethite and limonite interbedded with shales (Coffey 2008, p. 52).

6.2.2 Local geology

Murray's Hill mine and Fenceline Road

The Marra Mamba Formation has been identified with lowermost Nammuldi horizon dominant within the Murray's Hill mine area. This horizon outcrops as small rounded hills but elsewhere is buried below alluvial/colluvial and detrital cover. At Murray's Hill, iron mineralisation occurs within the upper part of this lowest horizon. The mineralisation does not extend through the entire Nammuldi Formation to the underlying Jeerinah Formation. The shales of Jeerinah Formation that underlie the Nammuldi Member are occasionally observed outcropping mostly in the lower slopes of the rounded hills (Coffey 2008, p. 6).

Within the overlying alluvial-colluvial and detrital sequence, iron rich horizons including pisolite; have been identified in the proximity to the underlying Marra Mamba formation. The relatively flat plain surrounding the low profiled Murray's Hill area typifies the presence of this alluvial-colluvial and detrital cover (Coffey 2008, p. 6).

A weathered horizon or hardcap is present at Murray's Hill, which is thin and exhibits elevated iron and occasionally manganese grades (Coffey 2008, p. 7).

Surface geology of the Project area is shown in Figure 5. The geological sequence of the Murray's Hill mine is described in Table 8 and shown in Figure 6.

Table 8 Summary of geological sequence

Sequence	Description
Alluvium	Quaternary deposits found in the Fortescue Valley
Detritals	Tertiary pisolites, rock fragments and clays
Nammuldi semi-hardcap	The semi-hardcap interval ranges in thickness from 2–11 m, although most commonly was between 2–3 m thick comprising hard, brown goethite
Nammuldi Member	Hematite/goethite comprising mineralised and non-mineralised deposits
Jeerinah Formation	Underlies the Marra Mamba Iron Formation comprising black graphitic shale, sometimes leached white with chert

Railway access road

The Chichester subregion has undulating Archaean granite and basalt plains including significant areas of basaltic ranges (DEC 2003, p. 89).

The railway access road options are located between the Yule River and Coonarrie Creek and in the vicinity of Two Camel Creek. The area is underlain by alluvium, and variably consolidated colluvium, derived from granitoid rocks. The underlying bedrock is pegmatite of the Yule Granitoid Complex, with possible areas of amphibolite containing abundant granitoid dykes and veins. The granitoid bedrock is bisected by a number of north-west/south-east trending regional fault, which is concealed by the superficial deposits (MWH 2012 p. 23).

6.2.3 Characterisation of waste rock and tailings

The Project will result in the generation of waste rock. Waste rock will consist primarily of banded iron formation and lesser amounts of shale. Geochemical characterisation of waste rock and ore has concluded that the materials are geochemically benign. The materials are non-acid forming and leachate concentrations of materials sampled are within Australian Drinking Water Guideline metrics. Based on the size distribution and physical characteristics of the waste materials, the waste dumps will be stable and relatively free draining.

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Mulga Downs Project
Figure 5
Mulga Downs Project surface geology

650000 660000 670000 680000

7560000

7550000

MAP A

MAP B

Railway Access Road Options

Map Area B

Map Area A

Hwy

Northern

Great

Mine and Fenceline Road

Port Hedland

Project Area

Newman

Kalgoorlie

Perth

Qrc

Agzc

Atp

Qa

Agi

Cza

Czk

Great Northern Highway

Two Camel Railway Access Road Option

Coonarrie Railway Access Road Option

155km

156km

157km

158km

Awfj

Achm

Czl

Czims

M 47/206

E 47/1244

E 47/339

L 45/316

FORTESCUE RIVER

RHI Railway Chainage
RHI Railway
Main Roads
River
Mulga Downs Tenement Boundaries
Claypan
Railway Access Road Options

RHI Railway Infrastructure Area

Geology

Achm, Marra Mamba Iron Formation
Awfj, Jeerinah Formation
Awft, Tumbiana Formation
Abfm, Maddina Formation
Czl, Ferruginous Duricrust

Qa, Alluvium
Qrc, Colluvium
Czims, Millstream Formation
Agi, Sisters Supersuite
Agzc, Cockeraga Leucogranite
Atp, Metamorphosed mafic rocks
Czk, Calcrete

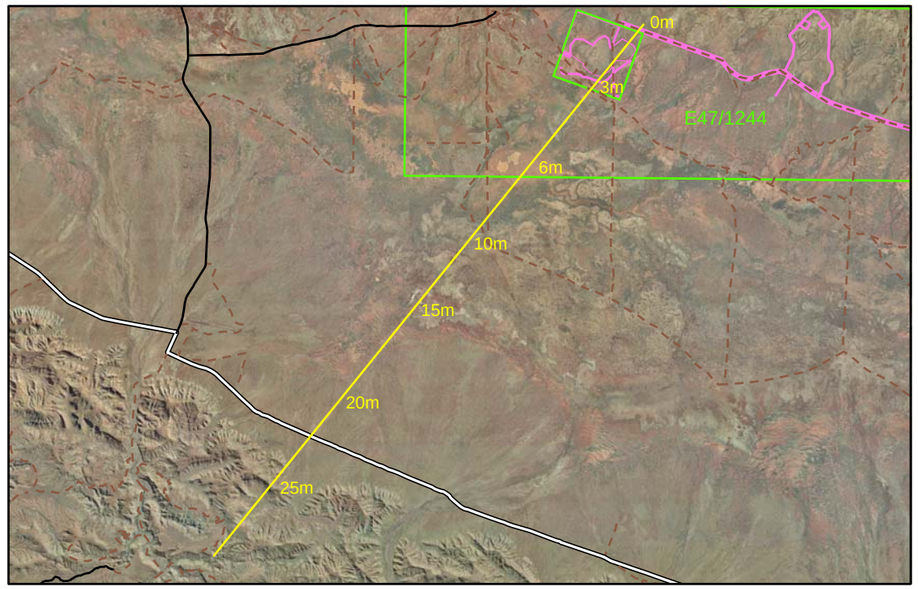
N

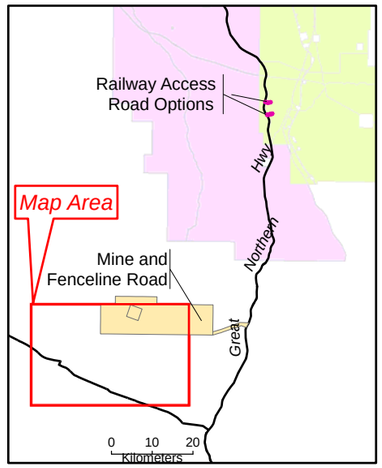
0 2 4

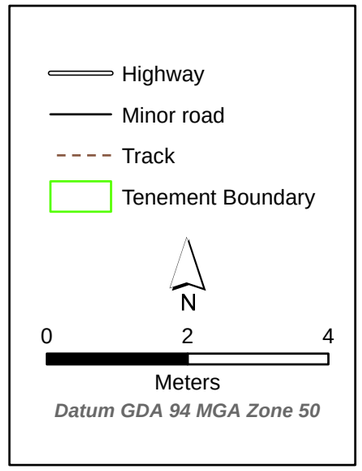
Kilometres

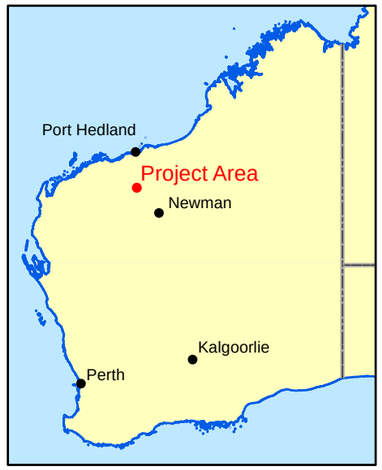
Datum GDA 94 MGA Zone 50

prepared by: vanessa donley

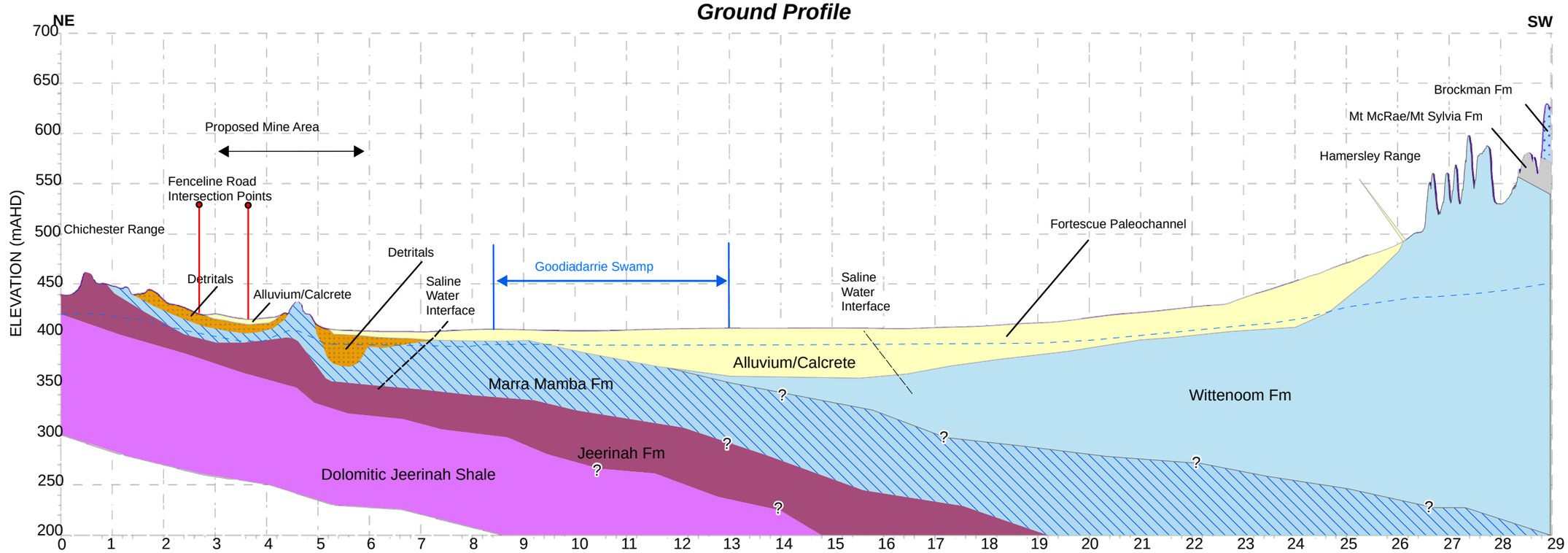








Ground Profile



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6.3 Biogeographic region

The project area is located in the Pilbara biogeographic region of the Interim Biogeographic Regionalisation for Australia (IBRA). The Pilbara bioregion is one of the largest bioregions with an area of 179 287 km^2, which is typical of bioregions situated in remote arid and semi-arid areas.

There are four subregions within the Pilbara biogeographic region — Chichester, Fortescue Plains, Hamersley and Roebourne. The Project area lies mostly (98.5%) in the Fortescue Plains subregion with a small section (1.5%) falling within the Chichester subregion (Maia 2012b, p. 3) (Figure 7). .

The Murray's Hill mine and Fenceline Road are located within the Fortescue Plains subregion, which is described as alluvial with river frontages, extensive salt marsh, mulga-bunch grass, and short grass communities on the plains in the east. River gum woodlands fringe the drainage lines. An extensive calcrete aquifer feeds numerous permanent springs in the central part of the Fortescue region, supporting large permanent wetlands with extensive stands of river gum and cajuput (DEC 2003, p. 89).

The Fortescue Plains sub-region occupies an area of 2.04 million ha, with the dominant uses being grazing of native pastures, conservation areas, Unallocated Crown Land, Crown reserves and Aboriginal land.

The Fortescue Marsh is located within the Fortescue Plains sub-region. The Fortescue Marsh is an episodically inundated samphire marsh covering an area of 1000 km^2 and is approximately 100 km long by 10 km wide. The marsh contains various wetland types, including riverine floodplains, river flats, flooded river basins, seasonally flooded grassland, savannah and palm savannah. The site also consists of seasonal or intermittent freshwater and floodplain lakes (Maia 2012, p. 13)

The Fortescue Marsh is an Environmentally Sensitive Area (ESA) and a section is also listed as a Priority 1 Priority Ecological Community (PEC). A portion of the Fortescue Marshes Environmentally Sensitive Area (ESA) and buffer occurs within the western extent of E47/1244. The ESA and buffer will not be directly affected by the Project. The edge of the buffer around the 'Priority 1' ecological community 'Fortescue Marsh' is approximately 42 km to the south-east from the centre of the E47/1244 (Figure 8).

The railway access road options are located within the Abydos-Woodstock Reserve in the Chichester subregion. The Chichester subregion comprises the northern section of the Pilbara Craton and contains undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges (Kendrick & McKenzie 2001, p. 547).

The Chichester subregion occupies an area of 9.04 million ha, with dominant land-uses including grazing of native pastures, conservation areas, Unallocated Crown Land, Crown reserves, Aboriginal land, and mining leases (Kendrick & McKenzie 2001, p. 547).

6.4 Land systems

Land systems as described by Van Vreeswyk et al. (2004) are areas with a recurring pattern of topography, soils and vegetation. The recurring patterns are visible from aerial photography and other remotely sensed images. Ten land systems are mapped within the Project area and surrounding region which are described in Table 9 and shown in Figure 9 (Maia 2012b, pp. 6-9).

Table 9 Land systems, land types and associated land forms of the Project area

Land system (LS)	Area mapped in WA (ha)	Area mapped in the Pilbara (ha)	Land Forms, Vegetation	Land Type
Boolgeeda	999 609	774 800	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	Land Type 8: Stony plains with Spinifex grasslands.
Brockman	74 108	73 500	Alluvial plains with cracking clay soils supporting tussock grasslands.	Land Type 14: Alluvial plains with tussock grasslands and grassy shrublands.
Calcrete	167 042	144 400	Low calcrete platforms and plains supporting shrubby hard Spinifex grasslands.	Land Type 18: Calcreted drainage plains with shrublands or Spinifex grasslands.
Coolibah	101 035	101 035	Flood plains with weakly gilgaied clay soils supporting coolabah woodlands with tussock grass understorey.	Land Type 17: River plains with grassy woodlands and shrublands, and tussock grasslands.
Hooley	59 081	59 000	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands.	Land Type 15: Alluvial plains with snakewood shrublands.
Jamindie	1 188 272	207 400	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	Land Type 12: Plain mosaic grassy shrubland.
Jurrawarrina	66 475	66 400	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.	Land Type 12: Wash plains on hard pan with groved mulga shrublands (sometimes with Spinifex understorey).
Macroy	1 333 614	1 309 500	Stony plains and occasional tor fields based on granite supporting hard or soft spinifex grasslands.	Land Type 8: Stony plains with Spinifex grasslands.
McKay	427 471	420 200	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	Land Type 1: Hills and ranges with Spinifex grasslands.
Newman	1 999 771	1 458 000	Rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands.	Land Type 1: Hills and ranges with spinifex grassland.

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Mulga Downs Project
Figure 7
Mulga Downs project biogeographic regions

650000 660000 670000 680000

7560000

MAP A

Chichester

M 47/206

E 47/1244

L 47/339

L 45/316

Great Northern Highway

FORTESCUE RIVER

Fortescue Plains

7550000

7540000

MAP B

Chichester

Great Northern Highway

Two Camel Railway Access Road

155km

156km

157km

Coonarrie Railway Access Road

158km

N

0 2.5 5

Kilometres

Datum GDA 94 MGA Zone 50

RHI Railway Chainage
Highway
RHI Railway
River
Mulga Downs Tenement Boundaries

Railway Access Road Options
Claypan
RHI SRL

Source: Biogeographic regions sourced from Maia 2012

Railway Access Road Options
Map Area B
Map Area A
Mine and Fenceline Road
Great Northern Hwy

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

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Mulga Downs Project
Figure 8
Fortescue Marsh

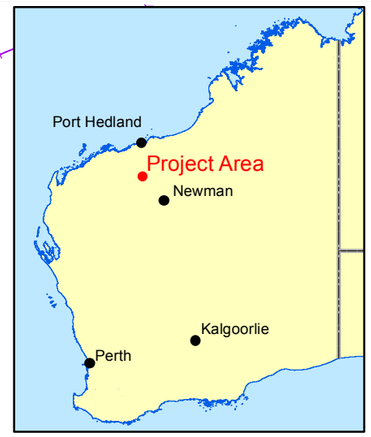
600000 650000 700000 750000 800000

7600000 7550000 7500000 7450000

Railway Access Road Options

M 47/206
E 47/1244
L 47/339
L 45/316

FORTESCUE RIVER



N

0 10 20

Kilometres

Datum GDA 94 MGA Zone 50

Roads
- Highway
- Minor road
- Track

Railway
- BHP
- FMG
- Hamersley Iron
- QR (Proposed)
- Roy Hill

Floodplain
- Floodplain

Pastoral relinquishments
- 2015 Fortescue Marsh Conservation Estate

HPPL Project
- HPPL tenements
- Fortescue Marsh Management Zone

Railway Access Road Options
- Railway Access Road Options

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MD0244_30

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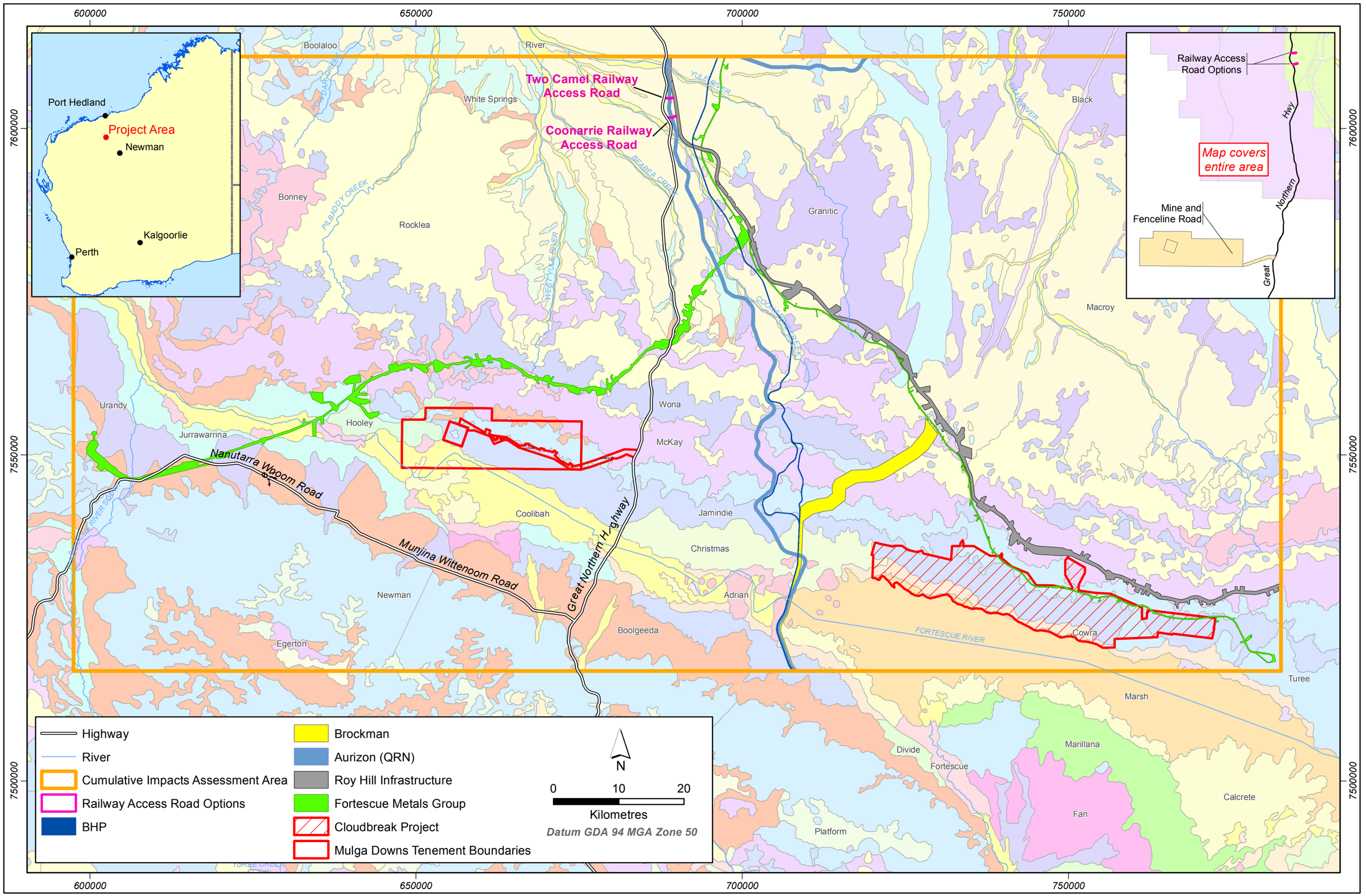
Mulga Downs Project
Figure 9
Land systems - cumulative impact assessment area



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prepared by: vanessa.donley

6.5 Soils

The Pilbara is characterised by red, shallow soils on hills, ranges and sandy plains. The soils are highly weathered due to the harsh environment of the region. The dominant soils throughout the region are extensive shallow red soils. Floodplain areas are made up of cracking and non-cracking clays, with duplex soils existing on saline alluvial plains (Van Vreeswyk et al. 2004).

Landloch (2009) undertook a soil and overburden assessment of the Murray's Hill mine area (Appendix 2). Landloch (2009, p. 23) identified two main soil associations:

- upland soils
- lowland soils.

Figure 10 shows the distribution of these soils in the mining lease.

Landloch (2009, p. 29) reported that soils across the tenement have similar properties but are differentiated by soil depth and the presence of rock outcrops. Soils occurring within the Fenceline Road alignment are expected to be similar to those found within the Murray's Hill mine area given its location at the break in slope between the Chichester Ranges and plains.

Soils were described by Landloch (2009, p. 29) as clay loams that are red in colour and with a clay content ranging from 30-50%. It has been inferred that the clay fraction is predominantly kaolinite, which comprises highly weathered clays that do not shrink and swell and are less prone to erosion. Additionally, the rocky nature of these materials is likely to result in elevated erosion resistance and reduced erosion potential.

Coarse fragments on the surface and within the soil profile are common in both upland and lowland soils; however, the abundance of these fragments is more variable in lowland soils. Areas with gradients greater than 30 % are typically dominated by rock outcrops (Landloch 2009, p. 30).

Soil depth varies from very shallow (<0.10 m) to deep (>1.0 m). Shallower soils are generally found in upland soils, with lowland areas exhibiting deeper soils where depths can exceed 3.0 m (Landloch 2009, p. 30).

6.5.1 Railway access road

The railway access road options are located within the Abydos Plain. Soils within the Abydos Plain are described as stony plains (with some hills) on granitic rocks of the Pilbara Craton with red deep sandy duplexes and red shallow loams with stony soils, red sandy earth and red loamy earths (Maia 2011, p. 10).

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Mulga Downs Project
Figure 10
Soils of Murray's Hill Project Area

654000 656000 658000

7554000

7552000

Railway Access Road Options

Hwy

Northern

Great

Map Area

Mine and Fenceline Road

E 47/1244

M 47/206

410 420 430

Port Hedland

Project Area

Newman

Kalgoorlie

Perth

Contours

Index contour

Intermediate contour

HPPL Tenure

Murrays Hill Tenement Boundary

Murray's Hill Soils

Upland Soils

Lowland Soils

N

0 250 500

Metres

Datum GDA 94 MGA Zone 50

Source: Soil data sourced from Landloch 2009

prepared by: vanessa donley

MD0244_11

6.6 Topography

The Murray's Hill mine is located on the southern side of the Chichester Ranges and to the north of the Fortescue River. The Chichester Ranges forms a watershed between the numerous rivers flowing north to the coast and to the Fortescue River in the south. The Chichester Range displays an average elevation of between 400 m to 500 mAHD. Elevations drop to approximately 400 mAHD along the Fortescue River and Goodiadarrie Swamp to the south (MWH 2012, p. 6).

Murray's Hill is a distinct topographical feature within the mine site area with a maximum elevation of 440 mAHD surrounded by elevations of 410 m to 420 mAHD. The Fenceline Road follows the alignment of the existing road with an average elevation of 436 mAHD. Both the Murray's Hill mine and the Fenceline Road are positioned at the break in the slope between the Chichester Ranges and the flat outwash plains of the Goodiadarrie Swamp (MWH 2012, p. 6).

The access road to the proposed accommodation camp is located approximately 6 km from the mine, off Fenceline Road (Figure 2). The camp sits at an elevation of approximately 450 mAHD (MWH 2012, p. 6).

The Two Camel railway access road option follows a low-rise ridge that forms a watershed between several minor drainage lines and rises from approximately 244 mAHD at the intersection with Great Northern Highway to approximately 248 mAHD where it intersects within the Roy Hill Infrastructure Corridor. The Coonarrie railway access road option falls away from the Great Northern Highway, from approximately 257 mAHD to 248 mAHD. The alignment crosses Two Camel Creek approximately 1 km east of the highway (MWH 2012, p. 6).

6.7 Surface water

6.7.1 Regional catchments

The project is located within two regional drainage basins shown in Figure 11:

- Fortescue River Basin
- Port Hedland Coast Basin (MWH 2012, p. 6).

Murray's Hill mine and Fenceline Road

The Murray's Hill mine and Fenceline Road are located in the Fortescue River Basin, which covers a total area of 49 750 km^2 and is defined to the north by the Chichester Ranges and to the south by the Hamersley Ranges (see Figure 11). The basin is divided into two regional catchments (MWH 2012, p. 6):

- Upper Fortescue Catchment
- Lower Fortescue River Catchment.

The Upper Fortescue Catchment is internally draining and feeds into the Fortescue Marsh, which is recognised as a wetland of national significance in the Directory of Important Wetlands in Australia. The Marsh extends approximately 100 km east of the Goodiadarrie Hills. This catchment area is approximately 29 750 km^2 (MWH 2012, p. 7).

The Goodiadarrie Hills form the divide between the Upper Fortescue River Catchment and the Lower Fortescue River catchment. The Goodiadarrie Swamp is located in the upper reaches of the Lower Fortescue River catchment and sits within an internally draining sub-catchment. Flows from the surrounding Hamersley Ranges and Chichester Ranges drain through the outwash plains and into the Goodiadarrie Swamp. Goodiadarrie Swamp is not believed to be hydraulically connected to the Upper Fortescue River Catchment or the Lower Fortescue River Catchment and is considered a separate hydrological system to the Fortescue Marsh. The Goodiadarrie Swamp is also recognised as a wetland of national significance in the Directory of Important Wetlands in Australia (MWH 2012, p. 7).

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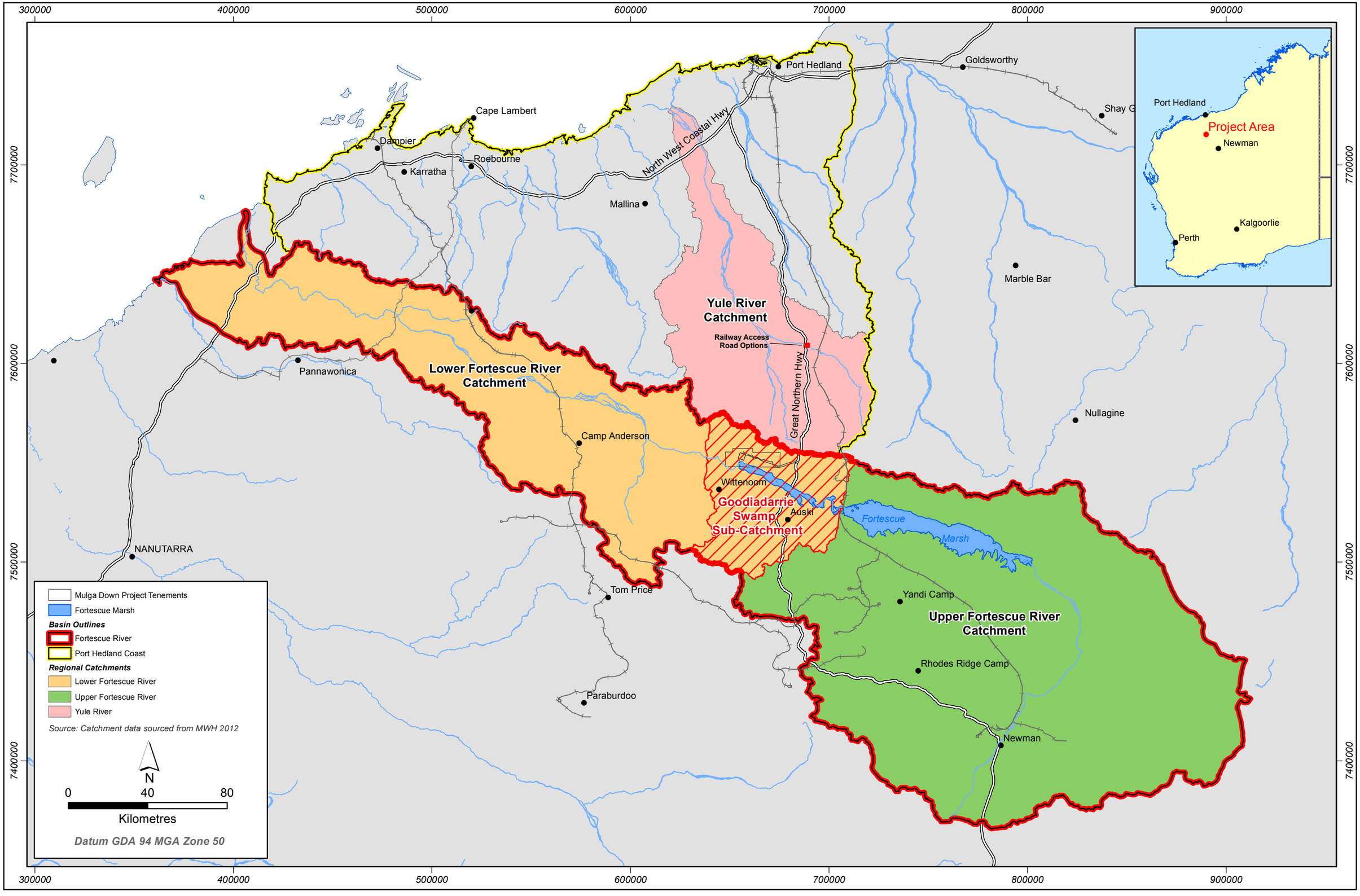
Mulga Downs Project
Figure 11
Regional catchments



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The Lower Fortescue River catchment drains into the Fortescue River, which presents as a fresh water system. It extends from the divide of the Goodiadarrie Swamp catchment and flows approximately 300 km in a northwest direction to the coast. The total area of this catchment is approximately 19 890 km^2. The water quality exhibited in this catchment is generally fresh supporting the position that the sub-catchments are not hydraulically connected (MWH 2012, p. 7).

Railway access road

The railway access road options are located within the Port Hedland Coast basin, which is made up of six major rivers: Maitland, Harding, George, Sherlock, Yule and Turner Rivers (Figure 11). The Yule River is the largest and longest river in the drainage basin and is bounded by the Mungaroona and Chichester Ranges. The major tributaries of the Yule are: Beabea Creek, Coonarrie Creek and Cockeraga River. Coonarrie Creek is in close proximity to the two proposed railway siding access roads; however, neither options cross this creek (MWH 2012 p. 7).

6.7.2 Local surface water catchments

Murray's Hill mine

There are three catchments surrounding the proposed Murray's Hill mine that are described in Table 10 and shown in Figure 12. There are no significant creeks within these sub-catchments. Drainage on Murray's Hill is primarily radial with sheet flows emanating downstream of the mining lease (47/206) as flows move towards the flat sandy plains and outwash areas of the Goodiadarrie Swamp (MWH 2012, p. 9).

Table 10 Local catchments

Catchment	Area (km^2)
West Sub-catchment	17.9
Central Sub-catchment	20.7
East Sub-catchment	6.3

Fenceline Road

A total of 68 catchments of varying size occur along the alignment of Fenceline Road, generally flowing in a north to south direction (Figure 13) (MWH 2012, p. 9).

Fenceline Road follows the break in slope between the Chichester Range and the sandy plains of the Goodiadarrie Swamp. Upstream flows are expected to predominantly present in defined drainage lines with sheet flow characteristics commencing downstream of the road alignment (MWH 2012, p. 9).

Accommodation camp

Figure 14 shows the local catchments associated with the accommodation camp. The proposed camp is located within a small catchment of approximately 0.63 km^2. There will be minimal upstream surface water flow and minimal flows through the area occupied by the camp (MWH 2012, p. 9).

Railway access road

Figure 15 depicts the local catchments for the two proposed railway access road options: Coonarrie and Two Camel.

The Two Camel railway access road option is located north of a natural watershed between two minor drainage lines feeding into Two Camel Creek. The proposed alignment sits north of a local watershed and intersects seven small sub-catchments varying in size from 0.002 km^2 to 0.1 km^2 (MWH 2012, p. 9).

The Coonarrie railway access road option is aligned east from the Great Northern Highway to Two Camel Creek, continuing to the Roy Hill Infrastructure Corridor. The alignment crosses Two Camel Creek and intersects three small sub-catchments occupying areas of 0.03 km^2 to 0.16 km^2.

6.7.3 Surface water quality

Surface water quality in the Pilbara tends to be dominated by high sediment loads caused by the large runoff events generated by significant rainfall events and cyclones. The primary water quality parameters measured in the Pilbara are salinity and turbidity (MWH 2012, p. 14).

As the flow rate within rivers increases during significant rainfall events, turbidity generally increases. Turbidity levels are extremely high during flood events. Conversely, during low flows, salinity levels can be high compared with high flow events as a result of evaporative and groundwater inputs to stream flows (MWH 2012, p. 14).

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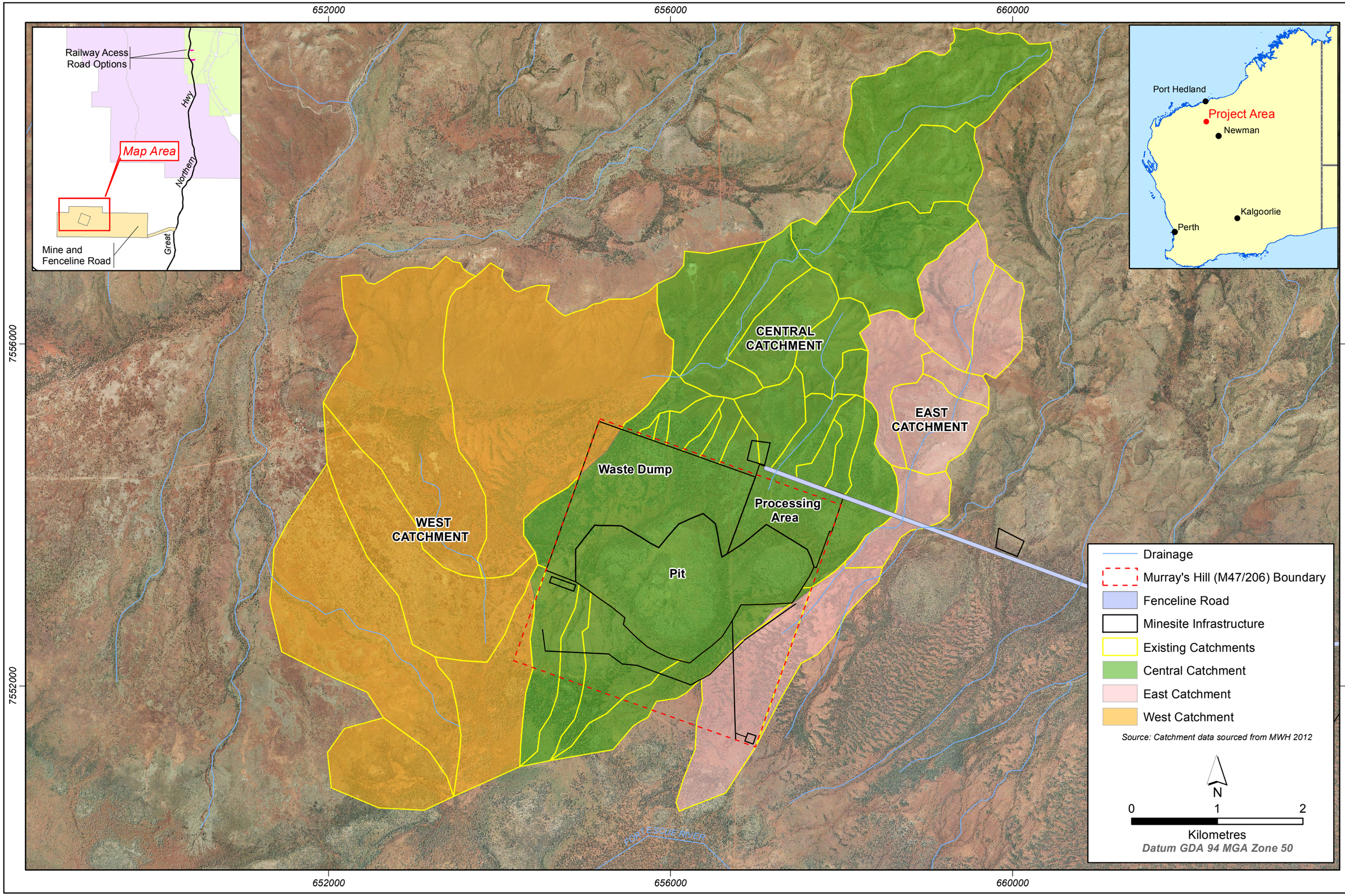
Mulga Downs Project
Figure 12
Local surface water catchments - Murray's Hill mine



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Mulga Downs Project
Figure 13
Local surface water catchments - Fenceline Road

655000 660000 665000 670000 675000 680000 685000

7560000
7555000
7550000
7545000

M 47/206
L 47/339
E 47/1244
L 45/316
Great Northern Highway
FORTESCUE RIVER

Highway
Drainage
Existing Catchments
HPPL Tenements
Fenceline Road
Minesite Infrastructure

Source: Catchment data sourced from MWH 2012

N

0 2 4
Kilometres

Datum GDA 94 MGA Zone 50

Railway Access Road Options
Hwy
Map Area
Mine and Fenceline Road
Northern
Great

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

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Mulga Downs Project
Figure 14
Local surface water catchment - Camp location

664000 665000 666000 667000 668000

7557000

7556000

7555000

CL1 WEST CATCHMENT

CL1 EAST CATCHMENT

CL2 CATCHMENT

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

Railway Access Road Options
Hwy
Northern
Great
Map Area
Mine and Fenceline Road

Drainage Line
Subcatchments
Proposed Camp
Access Tracks

Source: Catchment data sourced from MWH 2012

N

0 0.25 0.5
Kilometres

Datum GDA 94 MGA Zone 50

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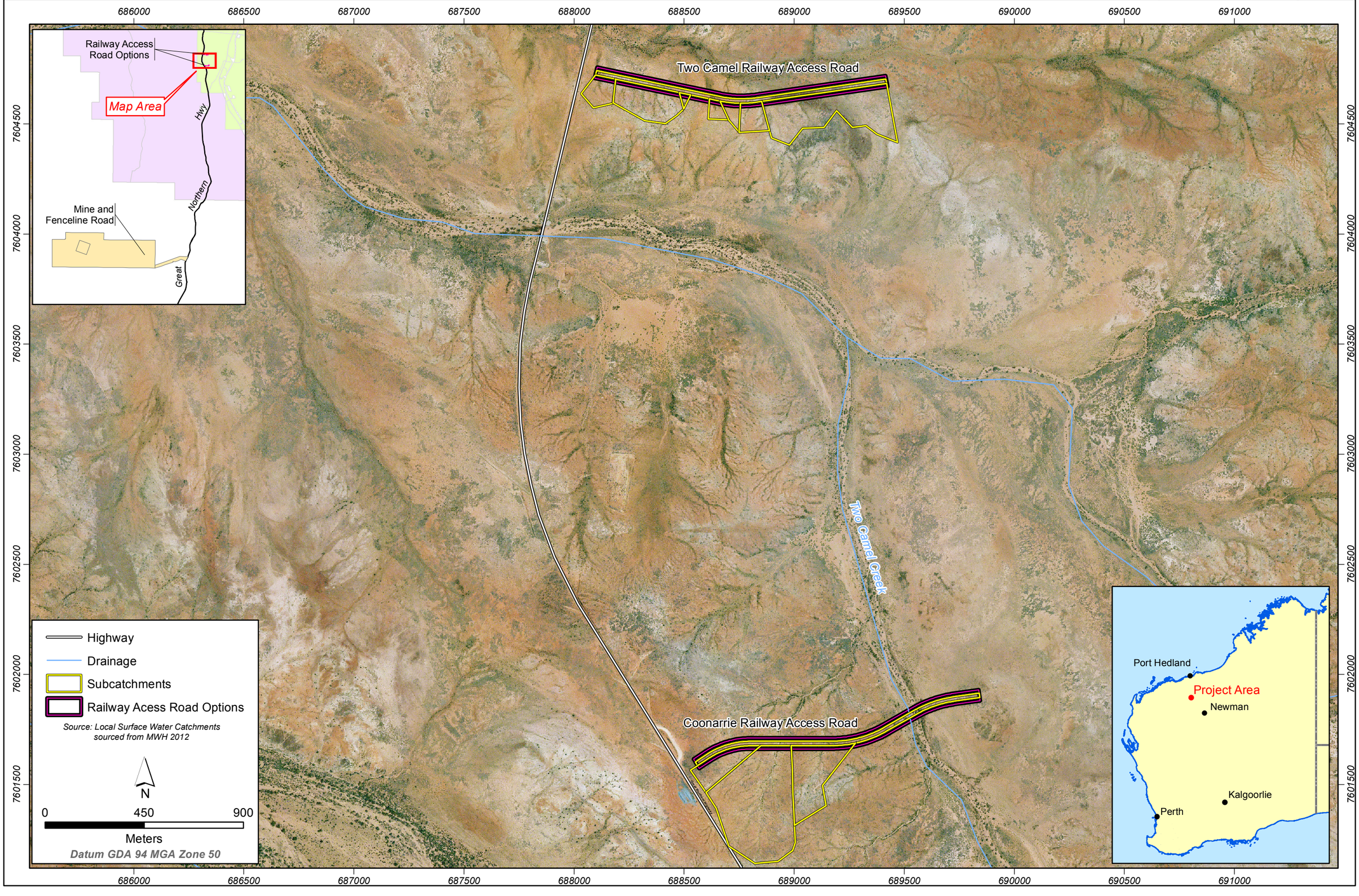
Mulga Downs Project
Figure 15
Local surface water catchments - Railway Access Road Options



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6.8 Groundwater

Regional hydrogeology of the area is closely related to the underlying geology. The Murray's Hill mine and Fenceline Road is in the Central Pilbara Iron Ore geological province and the railway access road options are in the Fractured Zone geological province (MWH 2012, p. 14).

6.8.1 Murray's Hill mine and Fenceline Road

The Murray's Hill mine and Fenceline Road lie along the northern flank of the Fortescue Valley, approximately midway between the Chichester Range and the internally draining Goodiadarrie Swamp to the south (Figure 12). The Goodiadarrie Hills form a major surface water and potential groundwater divide between the Fortescue Marsh and Goodiadarrie Swamp as shown by brackish to saline shallow groundwater as compared with fresh water in the lower portion of the Fortescue River (MWH 2012, p. 14).

Figure 16 presents a schematic of the regional hydrogeology based on available data. Alluvial deposits occur on the lower slopes at the mine site and their thickness generally increases in a south-westerly direction towards the Goodiadarrie Swamp. Tertiary calcrete outcrops to the south of the mining tenement area, where it is deposited widely along major drainage lines and on the fringes of the Goodiadarrie Swamp. The calcrete is considered to represent a zone of chemical precipitation of carbonates and silica in proximity to an historical watertable and is generally highly permeable. The detrital deposits, which appear to be the primary water-bearing unit within the sequence, comprise colluvial and alluvial sediments and include mineralised geothitic materials with hematite and magnetite pisoliths (MWH 2012, p. 15).

Dolomite of the Wittenoom Formation is inferred to exist in the south of the mining tenement area, and in the Goodiadarrie Swamp, where it is overlain by the Mt Sylvia Formation and Mt McRae Shale (MWH 2012, p. 15).

Regionally, the Marra Mamba Iron Formation consists of the Nammuldi, MacLeod and Mount Newman Members. The basal unit of the Marra Mamba Iron Formation, the Nammuldi Member, outcrops along the southern edge of the Chichester Range. The remaining members, Macleod and Mount Newman, are inferred to either be in sub crop below the Quaternary and Cainozoic sedimentary sequence that occupies the palaeochannel of the Fortescue River, or have been removed by erosion (MWH 2012, p. 15).

The Roy Hill Shale is the uppermost unit of the Jeerinah Formation. The Roy Hill Shale generally has low permeability, although some zones of relatively enhanced hydraulic conductivities associated with weathering and fracturing may be present. These permeable zones are typically associated with chert-dominated horizons. The Roy Hill Shale overlies the Warrie Member of the Jeerinah Formation, and conformably overlies the dolomitic upper part of the Warrie Member. The Warrie Member consists of shale, chert, mudstone, and dolomite, all of which are usually described as thin-bedded. This unit is typically weathered white on exposure, and characteristically dark grey or black in unweathered sections (MWH 2012, p. 17).

Groundwater quality

Based on sampling in 2009, shallow groundwater within the saturated alluvium, detritals, and upper mineralised Marra Mamba Formation is fresh (<1000 mg/L TDS [Total Dissolved Solids]) to brackish (1000–2000 mg/L), with the higher concentrations recorded at the southern edge of the mine area. Groundwater is pH-neutral (7–7.5) (MWH 2012, p. 20).

Salinity generally increases south towards the Goodiadarrie Swamp, and generally increases with depth at the southern extent of the mining tenement area (MWH 2012, p. 20).

Groundwater recharge

Over the mining tenement area, aquifers within the alluvium/colluviums, detritals and Marra Mamba Formation units are recharged through infiltration during rainfall events although high evapotranspiration (ET) rates limit regional infiltration. Indirect recharge to the Marra Mamba Formation also occurs via leakage from the overlying alluvium and detrital deposits (MWH 2012, p. 20).

Estimates of recharge from rainfall in the Pilbara region range from 1 to 3% of mean annual precipitation. As such, recharge from rainfall infiltration in the general area is expected to be in the range of 3 – 10 mm/a. Substantial groundwater recharge occurs from large cyclonic events (MWH 2012, p. 20).

Groundwater levels

Shallow groundwater in the vicinity of the mining tenement area mimics topography with flows generally south away from the Chichester Range toward the Goodiadarrie Swamp area (Figure 17). Depth to groundwater varies from 35–40 m below ground level (mbgl) near the base of the Chichester Range, to 3–10 mbgl at the southern reaches of the mine area (MWH 2012, p. 20).

Groundwater levels are subject to significant seasonal fluctuations with rapid watertable response to cyclonic events and groundwater recession during prolonged dry periods (MWH 2012, p. 20).

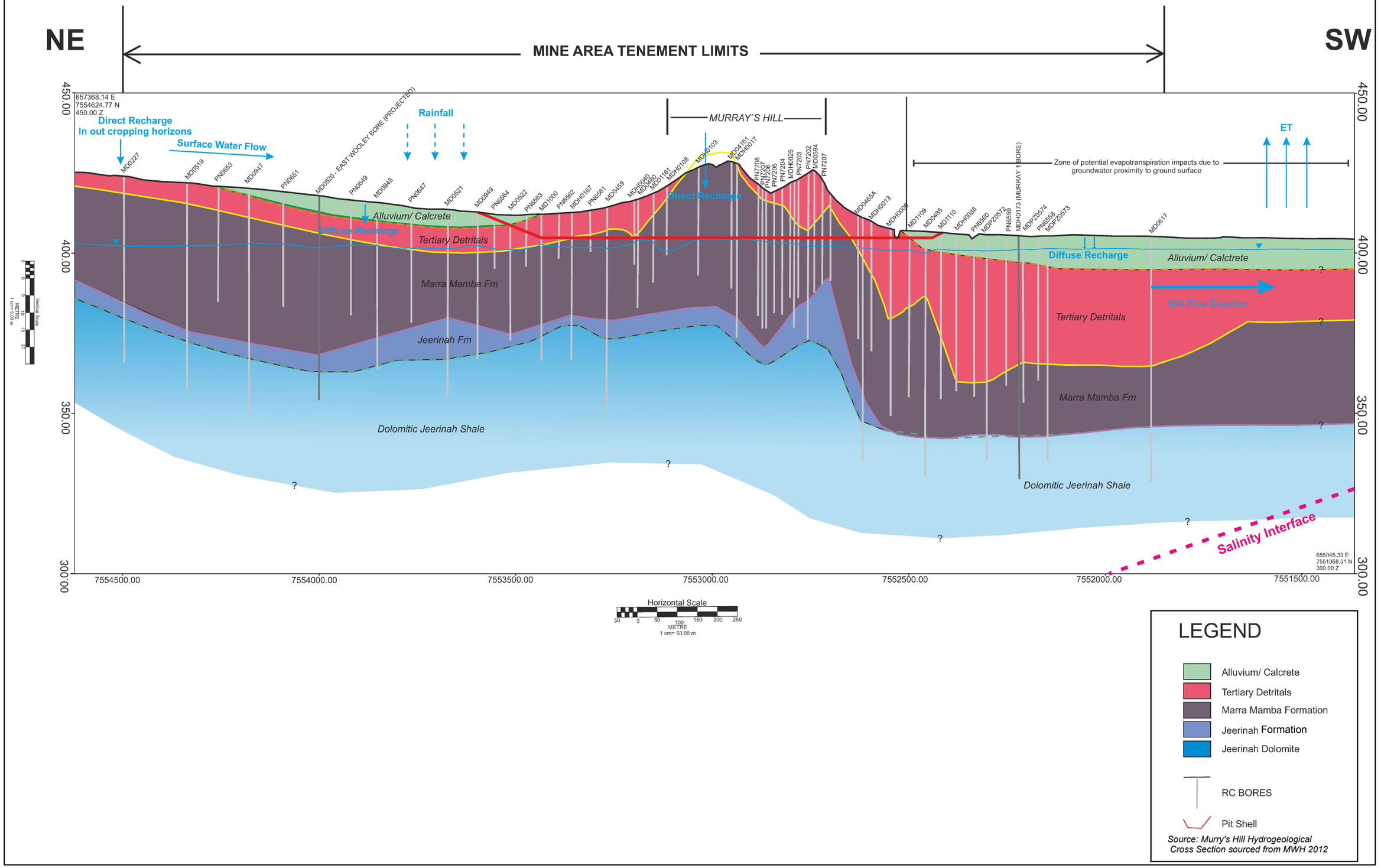
Storage and throughflow

The mineralised detrital and mineralised Nammuldi Member aquifers are expected to have the greatest groundwater storage capacity. Where saturated, the alluvium is also expected to contain low to moderate storage capacity (MWH 2012, p. 21).

The majority of throughflow is considered to take place within the mineralised detritals and upper Marra Mamba Formation aquifers with the majority of recharge occurring from direct precipitation particularly in upland regions along the Chichester Range, and vertical leakage from the overlying alluvium (MWH 2012, p. 21).

Hydraulic connectivity

The connection between recent alluvial deposits, the underlying mineralised detritals and upper mineralised Marra Mamba Formation is potentially significant given the rise in groundwater levels following cyclonic storm events. Ongoing field investigations will provide additional data for evaluation of hydraulic connectivity between these units (MWH 2012, p. 21).



prepared by: paul.rowe

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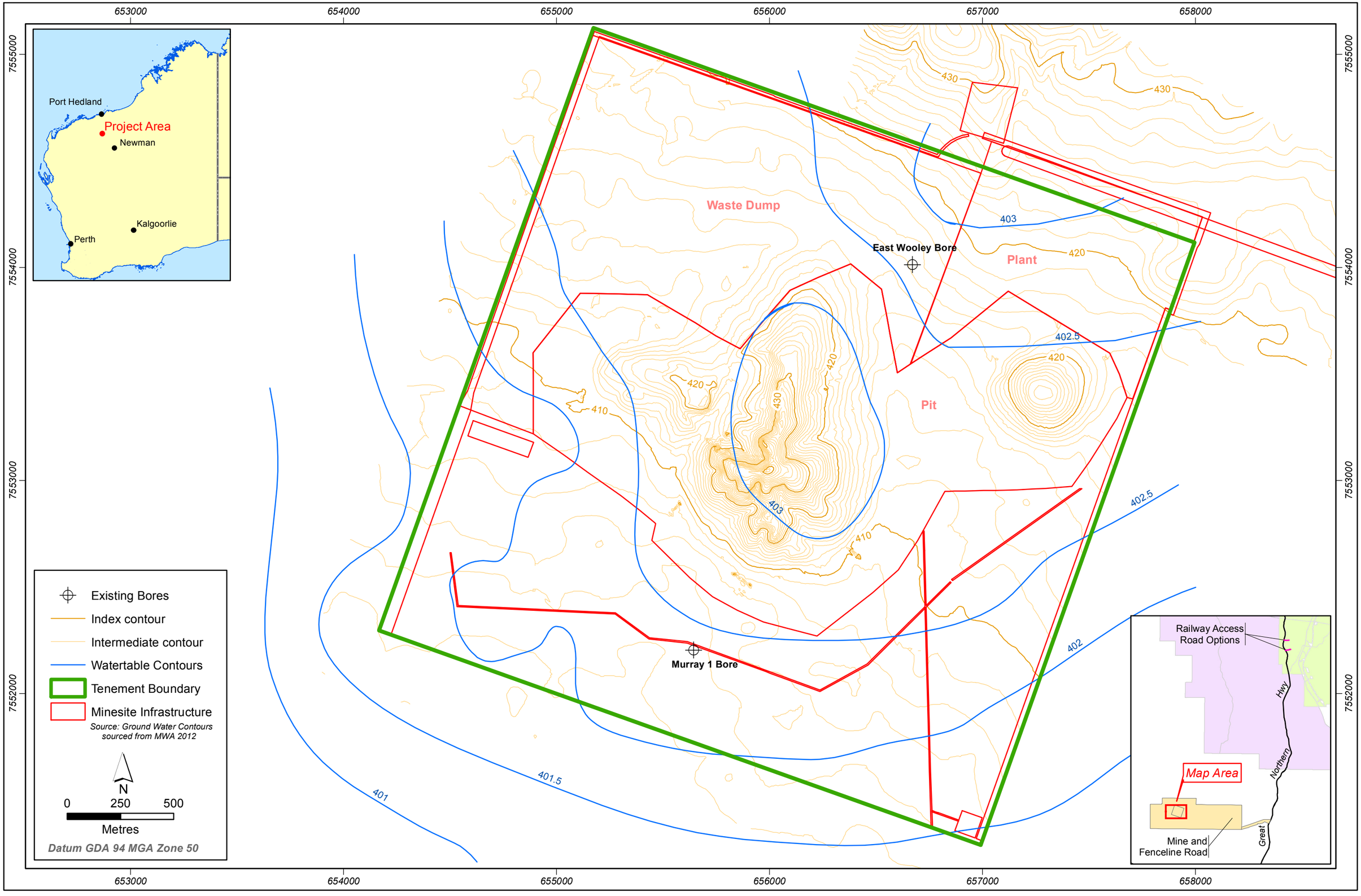
Mulga Downs Project
Figure 17
Murray's Hill Mine ground water contours



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Discharge

No springs or surface expressions of groundwater occur within the mining area (MWH 2012, p. 23).

Given the shallow groundwater depth at the southern extent of the mining tenement area, potential exists for groundwater discharge via evapotranspiration (ET) processes. However, studies carried out at the Cloudbreak mine to the south-east of the Murray's Hill mine area indicate that vegetation types occurring in the area are not expected to contribute significantly to ET losses (MWH 2012, p. 23).

Potential also exists for groundwater discharge at the freshwater/saline water interface along the fringes of playa lakes in the Goodiadarrie Swamp, particularly during prolonged wet periods when fresh water ponds on the surface of the swamp, and groundwater approaches ground surface. However, discharge through this mechanism is likely to be a small component of the regional groundwater discharge (MWH 2012, p. 23).

6.8.2 Railway access road

Exploration drilling for water supply indicates the area of the railway access road options are underlain by pockets of superficial alluvium comprising sand, silt and clay floodplain deposits, saprolitic clays, with sand and gravel alluvial channel deposits. These deposits, along with the upper weathered section of the underlying granitoid complex, form the primary water bearing aquifer in the area and are underlain by relatively low permeability granitoid bedrock. The watertable is relatively shallow at 3–9 mbgl (MWH 2012, p. 23).

Recharge

Groundwater recharge over the area of the railway access road options is spatially 'diffuse' from precipitation events and also 'focused' from creeks following cyclonic events. Significant recharge of aquifers within the alluvial deposits is likely from direct recharge from the creek beds following cyclonic events; however, ET rates and moderate precipitation limit regional recharge from rainfall (MWH 2012, p. 23).

Recharge from rainfall infiltration in the area is expected to be in the range of 3–10 mm/a, with substantial recharge occurring as a result of large cyclonic events (MWH 2012, p. 23).

Groundwater levels

Groundwater elevation data from production bores suggests a northward flow gradient. Local flow patterns are likely to mimic the easterly surface water flow direction (MWH 2012, p. 23).

Storage and throughflow

The superficial alluvium, sand and gravel alluvial channel deposit aquifers are expected to contain the greatest groundwater storage capacity with the saprolitic clays exhibiting low to modest storage. Where significantly weathered, the upper surface of the granitoid bedrock is expected to have significant storage capacity (MWH 2012, p. 24).

The majority of throughflow is expected to occur within the sand and gravel alluvial channel deposit aquifers. Most of the recharge to these aquifers is considered to be via vertical leakage from the overlying alluvium and via direct infiltration for outcropping areas (MWH 2012, p. 24).

Hydraulic connectivity

Limited data are available to characterise hydraulic connectivity between adjacent hydrogeological units in this area. However, based on drilling and test pumping data investigations to date, the connection between the superficial alluvium and underlying sand and gravel alluvial channel deposits is likely to be significant (MWH 2012, p. 24).

Discharge

No springs or surface expressions of groundwater have been observed within the area (MWH 2012, p. 24).

As with the mine site, given the shallow nature of the watertable within the area, potential exists for groundwater discharge via ET; however, such losses are not expected to be significant (MWH 2012, p. 24).

Water quality

Preliminary hydrochemistry data from bores in the area indicates that the quality of shallow groundwater within the area is variable, ranging from fresh (560 mg/L TDS) to brackish (8400 mg/L TDS). The water is slightly basic, with pH in the range of 8–8.4 (MWH 2012, p. 24).

6.9 Vegetation and fauna

6.9.1 Vegetation

Murray's Hill mine and Fenceline Road

The Murray's Hill mine and Fenceline Road lies in the Fortescue Plains subregion. The Fortescue Plains subregion is dominated by alluvial plains and river frontage and in the east extensive salt marshes, mulga-bunch grass and short grass communities are dominant on the plains. River gum woodlands fringe drainage lines and an extensive calcrete aquifer feeds numerous permanent springs that support large wetlands (Maia 2012a, p. 3).

Five broad floristic vegetation categories occur over the Murray's Hill mine and Fenceline Road area. These include:

- *Triodia* hummock grassland, shrubland and open low woodlands on hills and undulating plains
- *Acacia* shrublands and tussock grasslands on habitats associated with minor drainage
- *Acacia* low woodlands and tall shrublands on plains
- *Eucalyptus* low woodlands and mixed shrublands associated with rivers and related habitats
- Tussock grasslands on freshwater claypans.

The condition of the vegetation occurring in this area of the Project ranges from completely degraded to excellent (Maia 2012b).

Flora and vegetation values within the Project area are described in Section 11.

Railway access road

The railway access road options occur within the Chichester subregion. Vegetation on the Chichester subregion is dominated by *Acacia pyrifolia* over *Triodia pungens* hummock grasslands on plains and *Eucalyptus leucophloia* on ranges. The subregion has high species diversity in hummock grassland, as well as the cracking clay communities of the Chichester and Mungaroona ranges (Maia 2012a, p. 3).

Three broad floristic vegetation categories occur in the area over which the railway access road options are located. These include:

- *Acacia* shrublands with open hummock grasslands on plains
- Tall mixed shrublands with open grasslands on habitats associated with minor drainage
- Hummock grassland, shrubland and open low woodlands on hills and undulating plains.

The condition of the majority of vegetation as reported by Maia (2011) during surveys within the Roy Hill Infrastructure Corridor was Very Good. Evidence of grazing was apparent; however, vegetation structure was generally intact with few weeds (Maia 2011, p. 3).

Flora and vegetation values within the Project area are described in Section 11.

6.9.2 Fauna

The Project area supports a reptile and small mammal assemblage that contains less species and few individuals than generally found elsewhere in similar habitat in the Pilbara. The avian assemblage is considered comparable to that found in similar habitats in the region.

A habitat assessment has been undertaken based on species likely to be present in each land system occurring within the fauna survey boundary area. Habitats present in the Project area are similar to those in adjacent areas and similar fauna assemblages can be expected outside the Project development envelopes.

Terrestrial Ecosystems (2013) reported that 395 species have the potential to be present within the Murray's Hill mine and Fenceline Road area, comprising 197 birds, 135 reptiles, 52 mammals and 11 amphibians. Field surveys of the Murray's Hill mine and Fenceline Road recorded the presence of 115 native vertebrate species and one introduced species (Terrestrial Ecosystems 2013). An additional 17 species were recorded by Ecologia (2009). Earlier surveys of the railway access road area recorded 136 species (Terrestrial Ecosystems 2011a).

Six conservation significant species of birds (two considered infrequent visitors), five species of mammals and three species of reptiles are considered likely to occur in the Murray's Hill mine and Fenceline Road area (Table 30). A total of 30 conservation significant species comprising 11 mammals, 12 birds, six reptiles and one fish have the potential to occur in the area of the railway access road options (Terrestrial Ecosystems 2011, p. 23).

Surveys of the Project area did not confirm the presence of any short-range endemic (SRE) species. There are no known, likely or potential SRE fauna recorded from, or within the vicinity of, the Project. The Project will not directly affect habitat that may be suitable for SRE invertebrate fauna (Biologic 2012, p. 40).

Terrestrial fauna values within the Project area are described in Section 12.

Given that mining will occur above the watertable, the Project is not expected to affect stygofauna.

A local troglofauna community exists at Murray's Hill that occurs across a mix of geologies and is low in abundance. The majority of species were found from both impact and reference survey sites. The distribution of species provides strong evidence of biological connection between the different geologies. Six species were recorded only from within the disturbance area; however, these species are considered likely to have a range that extends beyond the disturbance area. Subterranean fauna is discussed in Section 13.

7. Socio-economic setting

The Project is located within the Mulga Downs pastoral lease within the Pilbara Region of Western Australia. HPPL owns the lease and manages the pastoral station. The Mulga Downs Project is located approximately 185 km and 230 km from the nearest regional centres of Newman and Port Hedland respectively and is approximately 40 km to the west of the Great Northern Highway. While the majority of the Project lies within the Shire of Ashburton, sections are located within the Town of Port Hedland.

The surrounding land uses include pastoral leases, Aboriginal reserves, conservation reserves and unallocated crown land, and the major land uses include grazing and mining. Pastoral leases account for 60% of the land area within the Pilbara.

The Mulga Downs Homestead is located approximately 3.5 km west of the Murray's Hill mining lease (M47/206). An existing exploration camp is located on E47/1244 approximately 0.5 km north of the mining lease (M47/206).

The Project is located within two Native Title claim areas. The mine site, mining infrastructure (including accommodation camp) and Fenceline Road are located within the Combined Banjima WAD6096/1998 Native Title claim. Both railway access road options from the Great Northern Highway into the railway siding are located within the Kariyarra People's WAD6169/1998 claim.

There are a number of other mines and/or proposed development in proximity to the Project, including:

- Roy Hill Infrastructure and Fortescue Metals Group granted SRL corridors
- 100 m wide corridor for BHP Billiton Iron Ore Port Hedland to Newman rail corridor and Chichester Deviation
- 500 m wide corridor for a notional rail line to be developed by Aurizon (formerly QR National)
- Brockman Iron Pty Ltd Railway Infrastructure Project
- Cloudbreak Iron Ore Mine and Proposed Expansion Proposal area.

8. Framework for environmental impact assessment

8.1 Relevant factors

The environmental factors considered relevant to the Project are:

- groundwater
- surface water
- vegetation and flora
- fauna, including subterranean fauna and short range endemics (SRE).

Other relevant environmental factors have been identified as requiring less detailed assessment as they can be readily managed through standard operating procedures and adherence to regulations. These include:

- Aboriginal heritage
- dust
- noise
- hydrocarbons and hazardous materials management
- solid and liquid waste management
- mine closure and rehabilitation.

Cumulative impacts of the Project with other developments in the region are addressed separately in Section 14.

8.2 Relevant EPA policies and guidance

The following table provides an overview of the key EPA policies and guidance for the Project and outlines how these have been considered and/or addressed.

Table 11 EPA Guidance and Position Statements for relevant factors

EPA policy/guidance	How addressed
Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012	HPPL has considered the principles and practices outlined in these procedures.
Environmental Assessment Guideline No. 1 – *Defining the Key Characteristics of a Proposal*.	A description of the Project is provided in Section 2.
EPA Position Statement No. 2, *Environmental Protection of Native Vegetation in Western Australia* (EPA 2000)	Unless otherwise identified, flora and vegetation surveys adhered to the requirements of Position Statement No. 2.
EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002)	Unless otherwise identified, flora and vegetation surveys and fauna surveys were undertaken in accordance with Position Statement No. 3.
EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004)	Unless otherwise identified, flora and vegetation surveys were undertaken in accordance with Guidance Statement 51.
EPA Guidance Statement No. 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b)	Unless otherwise identified, fauna surveys conducted for the Project were in accordance with Guidance Statement No. 56.

EPA policy/guidance	How addressed
EPA Guidance Statement No. 54, *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia* (EPA 2003)	Unless otherwise identified, subterranean fauna studies were undertaken in accordance with Guidance Statement 54 and 54a.
Draft EPA Guidance Statement No. 54a *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (EPA 2007b)	
EPA Guidance Statement No. 20, *Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA 2009)	Unless otherwise identified, survey design, methodology and report-writing aspects adhered to Guidance Statement No.20.
Draft Environmental Assessment Guideline for Consideration of subterranean fauna in environmental impact assessment in Western Australia	The principles of this draft guideline have been considered in addressing the effects of the Project on subterranean fauna.
EPA Guidance Statement No. 41 *Aboriginal Heritage* (EPA 2004c)	HPPL will address Guidance Statement No. 41 through implementation of management measures, relevant project agreements and implementation of an Aboriginal Heritage Management Plan. Where disturbance to a site of heritage significance cannot be avoided, applications would be made under s 18 of the AH Act.
EPA Guidance Statement No. 19 – *Environmental Offsets* (GS 19) Environmental Protection Bulletin No. 1 – *Environmental Offsets – Biodiversity* (EPB 1).	GS 19 and EPB 1 define what offsets are and the criteria and guiding principles for proponents to consider and follow when developing an offsets package. The key principles of 'avoiding and minimising' impact have been addressed in Section 3 through the consideration of options and alternatives in the design of the Project. Further management and mitigation measures designed to avoid and/or minimise the effects of the Project are addressed under each environmental factor.
EPA Draft Guidance Statement No. 8 *Environmental Noise*	This document was considered in the assessment and evaluation of the potential noise impacts associated with the Project.
Guidance Statement No. 55 *Implementing best practice in proposals submitted to the environmental impact assessment process*	The Project has been designed to minimise potential effects to flora, vegetation, fauna and surface water and groundwater and the generation of waste.
EPA Guidance Statement No. 6 – *Rehabilitation of Terrestrial Ecosystems.* (GS 6) DMP/EPA *Guidelines for Preparing Mine Closure Plans.*	Rehabilitation and closure will be addressed through detailed rehabilitation and closure planning to be undertaken as part of the Mining Proposal required under the *Mining Act 1978.*

8.3 Consistency with environmental principles

In 2003, the EP Act was amended to include a core set of principles that are applied by the EPA in assessing proposals. These environmental protection principles listed in s 4A of the EP Act are:

- precautionary principle
- principle of intergenerational equity
- principle of the conservation of biological diversity and ecological integrity
- principle relating to improved valuation, pricing and incentive mechanisms
- principle of waste minimisation.

HPPL has considered these principles in its design and will continue to do so during implementation of the Project (Table 12).

Table 12 Principles of environmental protection

Principle	Consideration	Relevant section
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.	A number of biological and technical studies have been undertaken to ensure that the potential effects of the Project have been appropriately identified and assessed. The results of these studies have been used to in early design and planning to ensure that appropriate management measures have been adopted to avoid, where practicable, and/or minimise potential effects. The current understanding of potential impacts and proposed management of the Project has been outlined in this supporting document. Precautionary principles have been applied to environmental impacts related to the Project with the intention of identifying issues early in the process to enable planning to avoid, prevent or manage effects. The Project has been designed to minimise potential effects to flora, vegetation, fauna and surface water and groundwater.	Sections 9; 10; 11; 12; 13; 15
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 Project has been designed to minimise potential effects to flora, vegetation, fauna and surface water and groundwater and will ensure that the health, diversity and productivity of the environment is maintained and/or enhanced for the benefit of future generations. A Mine Closure Plan will be prepared and reviewed regularly to ensure that closure planning is an integral aspect throughout the planning, development and life of the Project. The Project area will be returned to a pastoral station.	Sections 9; 10; 11; 12; 13; 15
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 the HPPL approach to environmental management and is a major environmental consideration for the Project. Biological investigations have been undertaken early in the project planning process to identify values of environmental conservation significance required to be protected from disturbance. The Project has been designed to minimise potential impacts to the key environmental values of the surrounding environment. The Project does not impact on areas of significant environmental features in the area and vegetation clearing will be kept to a minimum through the use of previously cleared areas and the use of existing infrastructure. HPPL is committed to restoring disturbed environments upon decommissioning, creating safe, stable, non-polluting landforms.	Sections 9; 10; 11; 12; 13; 15
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.	HPPL acknowledges the need for 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 and waste rock landform locations • HPPL will put in place procedures that will ensure that emissions and discharges are minimised as far as practicable • the cost of rehabilitation and closure requirements will be provided for in production costs throughout the life of the Project. Closure costing will also be addressed in the Mine Closure Plan submitted to DMP.	Section 15.2

Principle	Consideration	Relevant section
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	The HPPL approach to waste management is consistent with the hierarchy of waste minimisation, that is: • avoid and reduce at source • reuse and recycle • treat and/or dispose. HPPL will operate an appropriately licensed landfill for the disposal of general domestic solid wastes and recycles scrap metal, rubber, waste oil and batteries. HPPL will continue to investigate other waste management opportunities with the aim of minimising waste generation and disposal requirements.	Section 15

9. Groundwater

9.1 Relevant environmental objectives, policies, guidelines, standards and procedures

9.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals 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.

9.2 Findings of surveys and investigations

The Project is for mining above the watertable and dewatering is not required. Groundwater resources in the area will be utilised to support construction and mining operations such as dust suppression, road construction and maintenance, and camp domestic water supplies. Groundwater will also be abstracted from up to three existing bores along the proposed Roy Hill Infrastructure Railway alignment to support dust suppression activities at the chosen railway access road option.

9.2.1 Murray's Hill mine and Fenceline Road

Preliminary investigations have been undertaken to characterise the quantity and quality of the groundwater resources within the mining tenement (Appendix 3). Hydraulic parameters from these investigations are presented in Table 13.

Minimal drawdown was observed in the pumped aquifers during the tests (0.1 m drawdown in Murray 1 test bore) at discharge rates of 10 Litres per second (L/s). More comprehensive test pumping of the planned hydrogeological test bores is being undertaken to define acceptable long-term abstraction rates (MWH 2012, p. 42).

Table 13 Summary of hydraulic parameters from investigations in the mine area

Bore ID	Formation/Unit	T (m^3/day)	K (m/d)	Storativity	Specific yield
East Wooley	Alluvium	433	8.4	0.012	0.03-0.1
	Mineralised Detritals				
	Mineralised Nammuldi (?)				
Murray 1	Mineralised Detritals	982	17.9	0.012	0.01-0.28
	Mineralised Nammuldi				

K = hydraulic conductivity T = transmissivity m/d = metres per day

Based on similarities in preliminary drilling data and hydrostratigraphy, hydraulic characteristics of the stratigraphic sequence along Fenceline Road are expected to approximate those of the mine area (MWH 2012, pp. 42–43).

Investigations of aquifer parameters are ongoing, including identification of a water source for the proposed camp (MWH 2012, pp. 43).

9.2.2 Railway access road

Previous investigations have been undertaken to characterise the quantity and quality of the groundwater resources in the vicinity of the proposed Mulga Downs rail siding area. Three bores are likely to be used as water supply at this location: PB155/23-1; PB161/24-1; and P161/24-2 and for construction of the chosen railway access road option. A summary of key hydraulic parameters derived from test pumping at these bores is presented in Table 14 (MWH 2012, p. 43).

Table 14 Summary of hydraulic parameters from railway siding area bores

Bore ID	Chainage (Km)	Static Water Level (mbgl)	Transmissivity (m^3/day)	Recommended pumping rate (L/s)
PB155/23-1	155	3.17	3.95	1.5
PB161/24-1	160	9.95	27.9	2.0
P161/24-2	161	9.16	38.0	7.0

9.3 Project water demand

Water demand estimates for the construction and operations phases of the Project are shown in Figure 18.

The total projected water demand for construction activities at the proposed mine is approximately 252 ML/a, inclusive of a 20% uncertainty factor. Water demand associated with construction and operation is described below:

1. Construction of Fenceline Road and camp facilities will require approximately 462 ML/a over the duration sourced from bores along Fenceline Road or potential future potable water supply bores.
2. Water use (252 ML/a) for construction of infrastructure within the Murray's Hill mine will be abstracted from bores at the southern edge of the mining area. The highest projected water demand is associated with operations at the mine (594 ML/a) where water will be sourced from bores at the southern end of the mine area.
3. Potable water demand for the camp will be 61.2 ML/a based on 350 L/person/day for a 400 room camp running at 80% occupancy.
4. Water demand at the proposed Mulga Downs rail siding is projected to be 168 ML/a for construction activities and 60 ML/a for long-term operations from one or two of the existing bores (MWH 2012, pp. 43-46).

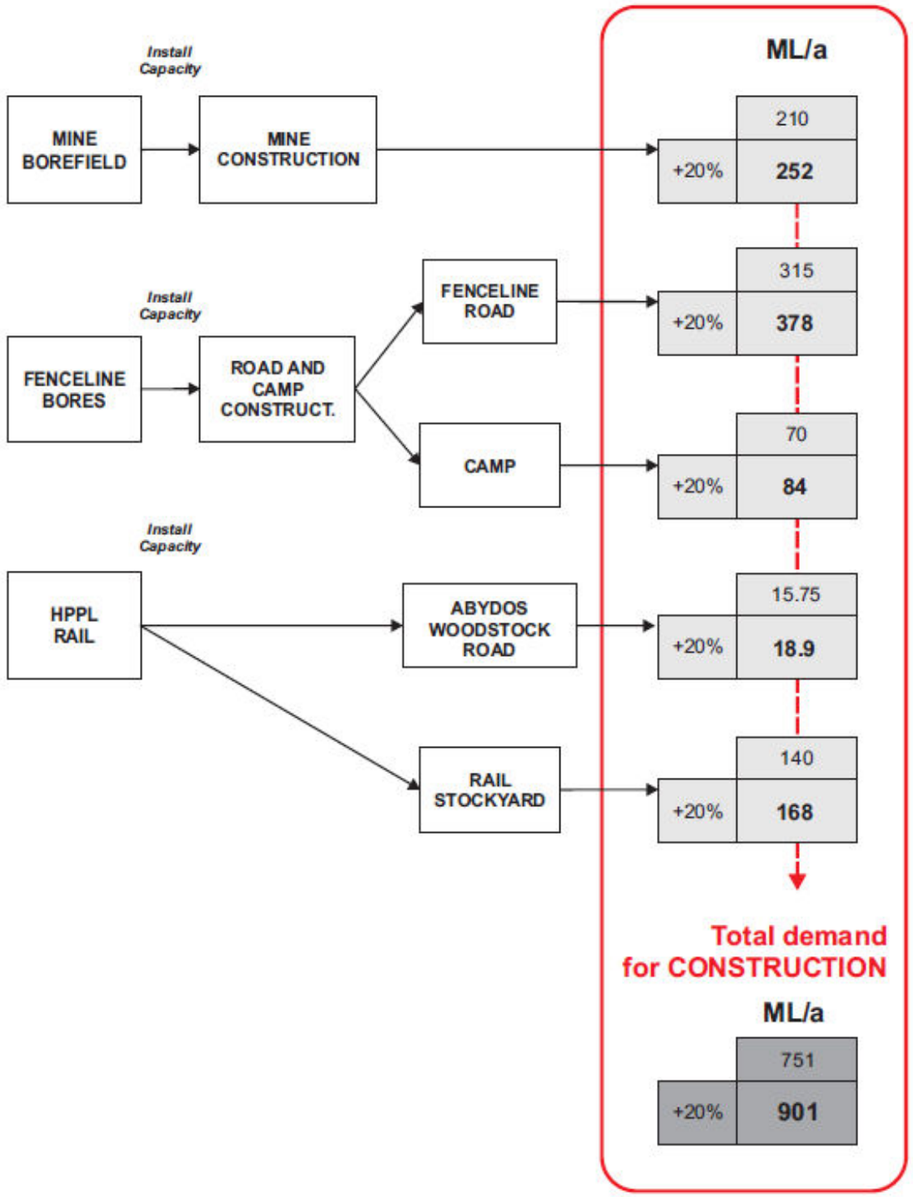
9.4 Drawdown response to proposed abstraction

9.4.1 Murray's Hill mine and Fenceline Road

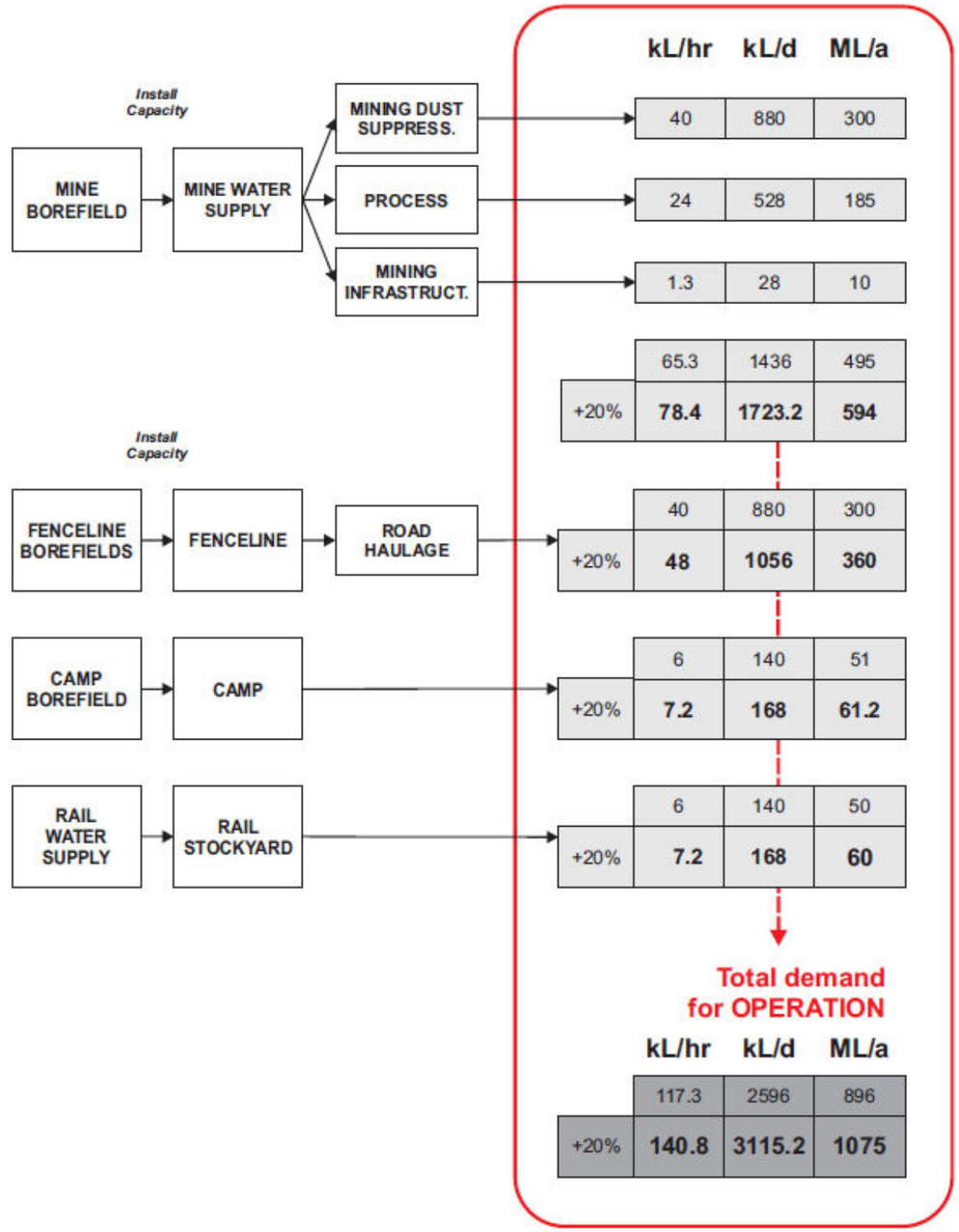
Drawdown from the proposed abstraction within the mining tenement area will be defined once test pumping has been completed.

Based on the projected water demand, anticipated abstraction rates required to meet the water demand for both the Murray's Hill mine and Fenceline Road will result in minimal drawdown of the watertable. Test pumping of the water supply bore for the camp will be undertaken to determine the potential effects to the water balance and surrounding groundwater levels (MWH 2012, p. 46)

Project Water Demand - CONSTRUCTION



Project Water Demand - OPERATION



Source: Water demand diagrams sourced from MWH 2012

9.4.2 Railway access road

Water supply for construction of the railway access road is proposed from up to three bores within a 6 km stretch of the proposed Roy Hill Infrastructure Railway (MWH 2012, p. 46). MWH has undertaken a combined assessment of projected water demand for construction of the railway access road and construction and operational activities at the proposed Mulga Downs railway siding and stockyards. Data from test pumping indicates that abstraction from the three bores will meet the required water demand for the Mulga Downs railway siding and stockyards. Approximately 18.9 ML will be required for construction of the chosen railway access road.

9.5 Potential sources of impact

The Project has the potential to affect groundwater through:

- **changes to groundwater levels** (drawdown) from abstraction for water supply
- **contamination of groundwater** from use of hydrocarbons and chemicals.

9.6 Assessment of likely direct and indirect impacts

9.6.1 Changes to groundwater levels

Murray's Hill mine and Fenceline Road

Groundwater abstraction is proposed from up to two bores at the southern edge of the mine area and from up to three bores along Fenceline Road (Figure 19). Based on projected water demand, abstraction rates to meet the demand for the mine and Fenceline Road will result in minimal drawdown of the watertable. Groundwater throughflow in the mine area is conservatively estimated to be in the order of 900 ML/a, which exceeds the total annual water demand. As such, no change to the natural groundwater flow regime or water balance is anticipated (MWH 2012, p. 48).

Once a supply bore for the camp has been identified, test pumping will be undertaken to determine the potential effects to the water balance and surrounding groundwater levels (MWH 2012, p. 48).

Railway access road

Groundwater abstraction for construction of the railway access road and the proposed Mulga Downs railway siding and stockyards will be from three supply bores within the proposed Roy Hill Infrastructure Railway alignment (Figure 20). Test pumping indicates that abstraction from two bores will meet projected water demand for construction and operations. Water requirements for construction of the railway access road forms a minor component (11%) of the total projected water requirements for construction activities associated with the Project at this location. Drawdown of groundwater associated with the construction of the chosen railway access road is not expected to be significant.

Appropriate abstraction management will be implemented to prevent over-abstraction and excessive drawdown in the bores. Such management strategies will include continuous monitoring of water levels to inform adjustment of pumping rates (MWH 2012, p. 48).

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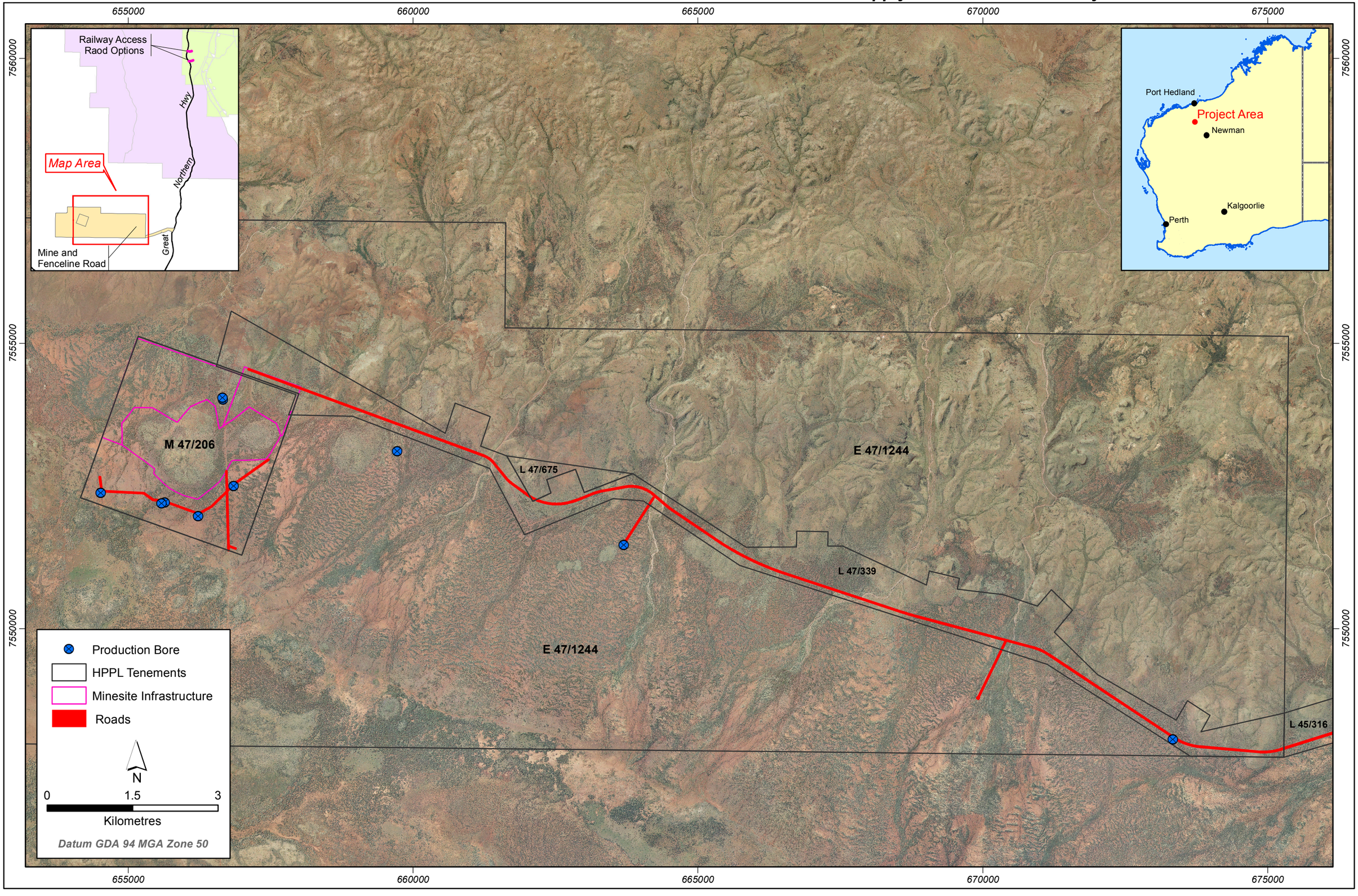
Mulga Downs Project
Figure 19
Water supply bore locations - Murray's Hill Mine and Fenceline Road



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Mulga Downs Project
Figure 20
Water supply bore locations - Railway Access Road Options

685000 690000 695000 700000

7610000 7605000 7600000

Railway Access Road Options
Map Area
Hwy
Mine and Fenceline Road
Northern
Great

Great Northern Highway

149km 151km 152km 153km 154km

YULE RIVER

Two Camel Railway Access Road

43A

PB155/23-1

157km W23 158km 159km

Coonarrie Railway Access Road

COONARRIE CREEK

PB161/24-1

161km W24 162km 163km

PB161/24-2

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

Production Bores
BHP Rail
FMG Rail
RHI Railway
Highway
Proposed Sliding
Railway Access Road Options
Proposed Stockyard
Water Area
RHI Railway Infrastructure Area

Source: Water supply bore locations sourced from MWH2012

N

0 1.5 3
Kilometres

Datum GDA 94 MGA Zone 50

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9.6.2 Contamination of groundwater

The proposed mine void will be above the watertable, reducing the potential for contamination and eliminating the need for dewatering (MWH 2012, p. 47).

The potential for chemicals and/or hydrocarbons to enter the groundwater system is low, and HPPL will adopt appropriate management practices to mitigate any effects (MWH 2012, p. 48).

No effects on water quality are predicted as potentially resulting from the proposed abstraction activities. However, data from planned comprehensive pumping tests in the mining tenement area will provide projections of groundwater quality, particularly with regard to potential for up-coning of any saline groundwater (MWH 2012, p. 48).

9.7 Management measures and performance standards

A water resources management operating strategy for the Project will be submitted to the DoW as part of a water abstraction licence application (5C licence). The operating strategy will address the following:

- identifying and managing impacts
- operating rules for abstraction
- monitoring and reporting
- contingency and trigger levels (MWH 2012, p. 49).

HPPL will adopt appropriate management practices to minimise the risk of spills and potential groundwater contamination. Abstraction from water supply bores will be managed to minimise drawdown, which may affect other beneficial uses in the area. Management will include continuous water level monitoring and ongoing adjustment of pumping rates to eliminate the potential for over-abstraction (MWH 2012, p. 49).

Field investigations are also ongoing and include drilling and installation of hydrogeological test bores, test pumping, and collection of water samples for hydro-chemical assessment. These investigations are designed to provide additional data for a detailed evaluation of the hydrogeological system and groundwater regime in the area and will aid in further evaluation of the effect of abstraction on the water balance, groundwater quality and groundwater levels. Existing piezometers will be used to enhance the groundwater monitoring network (MWH 2012, p. 49).

Field investigations will also be undertaken to identify a suitable water source for the accommodation camp.

9.8 Predicted environmental outcomes

In considering the above assessment, the following conclusions have been reached:

1. The open pit will not extend below the watertable eliminating the need for dewatering.
2. Water abstraction for the purpose of water supply will have minimal effect on groundwater levels and will be managed through the development and implementation of a water resources management operating strategy.
3. All necessary approvals will be obtained from DoW.
4. The Environmental Management Plan (EMP) will contain specific measures relating to the use and management and of hydrocarbons and chemicals within the mine area to limit any potential for contamination of groundwater.
5. Overall, the quantity and quality of groundwater will be maintained so that environmental values are protected and statutory requirements and acceptable standards are achieved.

The effect of the Project on groundwater will be insignificant and; therefore, the EPA objectives are expected to be achieved.

10. Surface water

10.1 Relevant environmental objectives, policies, guidelines, standards and procedures

10.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals that may affect surface water, water quality and the ecology that surface water supports:

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.

10.2 Findings of surveys and investigations

Hydrological modelling was undertaken by MWH (2012) for the mining lease area to determine catchment response during rainfall events for the existing environment and that following implementation of the Project (Appendix 3). The modelling was undertaken based on the conceptual disturbance footprint. The location and extent of the mine pit, waste dump and processing area within M47/206 are unlikely to significantly change through the final Project design. Given the linear nature and maximum width of Fenceline Road and the railway access road options, effects on surface water flows are not expected to alter significantly regardless of the final alignment within the respective development envelopes.

10.2.1 Murray's Hill mine

A rainfall runoff model (RORB) was applied to the three sub-catchments which define the main surface water flows through and around the proposed mine area and to understand how the surface water flow processes will be affected by the proposed mining activities and associated infrastructure. The results of the modelling are shown in Figure 21 (MWH 2012, p. 28).

Table 15 provides a summary of the RORB output flows for the existing scenario (i.e. base case) and the likely operational scenario based on the conceptual disturbance footprint layout. The reduction in catchment area is reflected by a 36 m^3/s reduction in flood flows for the 5-yr Average Recurrence Interval (ARI) event with flows also reduced for all other events (MWH 2012, p. 29).

Flows that were previously flowing towards Goodiadarrie Swamp through the Central Catchment will be intercepted upstream of the mining area and diverted to the East and West Catchments. This will increase the catchment area and contribute to the outflows of the East and West Catchment and decrease those of the Central Catchment (MWH 2012, p. 29).

Table 15 Comparison of RORB output flows for existing and operational scenarios

Catchment	Scenario	Area (km^2)	5-Year		10-Year		50-Year		100-Year	
			Flow (m/s)	hrs	Flow (m/s)	hrs	Flow (m/s)	hrs	Flow (m/s)	hrs
West	Existing	17.9	57	12	83	12	150	6	213	6
	Operational	26.8	61	12	89	12	483	12	242	6
Central	Existing	20.7	54	12	79	12	150	12	206	6
	Operations	3.1	13	12	20	12	30	1	46	1
East	Existing	6.3	8	2	11	12	29	12	40	12
	Operational	9.2	9	12	14	12	40	12	54	12
Total	**Existing**	**44.9**	**119**		**173**		**329**		**458**	
	Operational	**39.1**	**83**		**123**		**253**		**342**	
Difference in total (operational minus existing)		-5.8	-36		-50		-76		-116	

Overall, the three runoff catchment areas will be reduced by approximately 5.8 km^2. The Goodiadarrie Swamp catchment has a total area of 4138 km^2 and the total runoff area will be reduced by 0.14% as a result of the Project.

Given the RORB model is primarily a catchment rainfall-runoff model, rainfall losses were also quantified through volumetric calculations. The footprint occupied by the mine pit (2.86 km^2) will no longer contribute to catchment areas that flow into the Goodiadarrie Swamp. Rain falling on this area will be collected in the pit and will not reach Goodiadarrie Swamp, unless pumped out or discharged when of a suitable quality standard. The total volume of runoff that reaches the Goodiadarrie Swamp will remain relatively unchanged direct rainfall lost within the pit equates of 0.07% of the total catchment (MWH 2012, p. 31).

Further losses may occur via evaporation and infiltration from the sedimentation ponds designed to collect runoff from the waste rock dump and ore processing areas. These areas equate to a small percentage of the total catchment area (MWH 2012, p. 29-31).

10.2.2 Fenceline Road

The Fenceline Road alignment will intercept the surface water flow regime into the Goodiadarrie Swamp. A total of 68 catchments have been identified that cross Fenceline Road (refer to Figure 13) and been categorised according to size:

- 55 small catchments – area less than 2 km^2
- six medium catchments – area greater than 2 km^2 but less than 15 km^2
- seven large catchments greater than 15 km^2 (MWH 2012, p. 33).

Fenceline Road will be positioned at the break of the slope and the escarpment is likely to induce primarily channel flows upstream of drainage structures in the road. Sheet flow will become the primary form of surface runoff downstream of the road alignment as flows move into the sandy outwash plains of the Goodiadarrie Swamp (MWH 2012, p. 33).

10.2.3 Accommodation camp and access road

The accommodation camp is located within a small sub catchment area of 0.16 km^2 (refer to Figure 14). The footprint for the camp is 0.09 km^2 resulting in a small upstream catchment area. Minimal diversion of surface flows will be necessary to protect the camp (MWH 2012, p. 33).

10.2.4 Railway access road

The Two Camel railway access road option intersects seven sub-catchments all of catchment sizes less than 0.1 km^2. The Coonarrie railway access road option crosses Two Camel Creek and intersects three sub-catchments, all of which are less 0.16 km^2 in extent. Due to the location and nature of these catchments, it is not expected that sheet flow will be a predominant form of runoff for these catchments (MWH 2012, p. 33).

10.3 Potential sources of impact

The Project has the potential to affect surface water through:

- **alterations to surface water flows** a result of placement and design of new infrastructure
- **increased sediment runoff and scour** due to the construction of infrastructure
- **contamination of surface water** from the use of hydrocarbons and chemicals.

10.4 Assessment of likely direct and indirect impacts

In order to determine the effects of mining on the local and regional surface water regime, the percentage disturbance that the Project will affect within the local and regional catchments has been determined. Table 16 outlines the percentage of the total catchment areas that are to be occupied by the various components of the Project (MWH 2012, pp. 34).

Table 16 Percentage disturbance within regional catchments and sub-catchments (adapted from MWH 2012)

Regional catchment	Catchment area (km^2)	Project component/development envelope boundary	Area/footprint (km^2)	% Disturbance
Conceptual disturbance footprint				
Goodiadarrie Swamp	4138	Mine operations area (pit, waste dump and infrastructure)	5.8	0.14
		Fenceline Road (including borrow pits)	1.95	0.05
		Accommodation camp	0.2	0.005
Catchment total			**7.95**	**0.2**
Yule River	8860	Railway access road (either option)	0.08	0.0009
Catchment total			**0.08**	**0.0009**

The percentage of the total catchment area of the Goodiadarrie Swamp catchment that the Project components will occupy is 0.2% using the conceptual disturbance footprint. Impacts are considered to be a small percentage of the total Goodiadarrie Swamp catchment area of 4138 km^2. Any alteration to the surface water regime is; therefore, expected to only be noticed at a local level and will not significantly affect the catchment.

Alterations to catchment hydrology resulting from either railway access road option will be insignificant (MWH 2012, p. 34).

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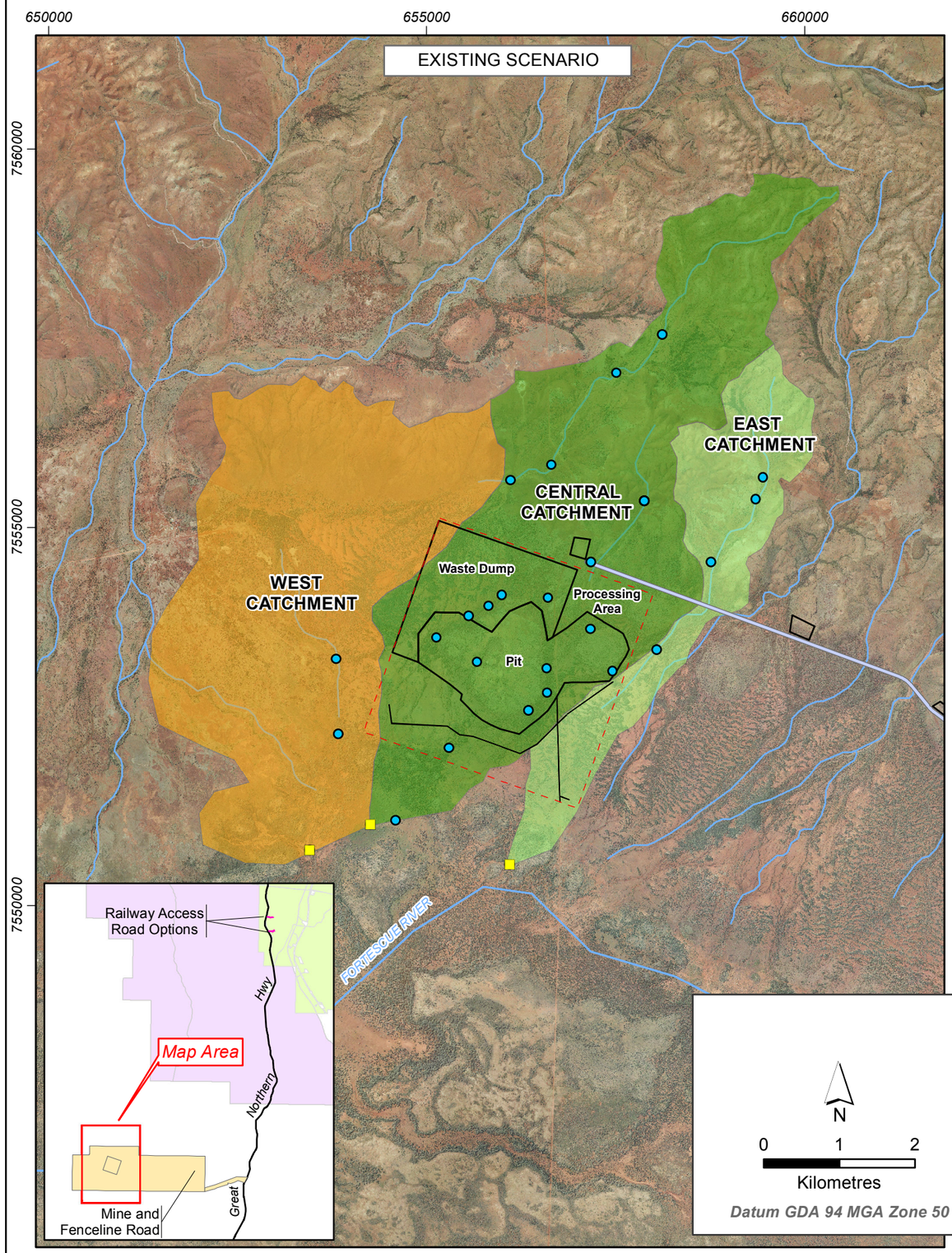
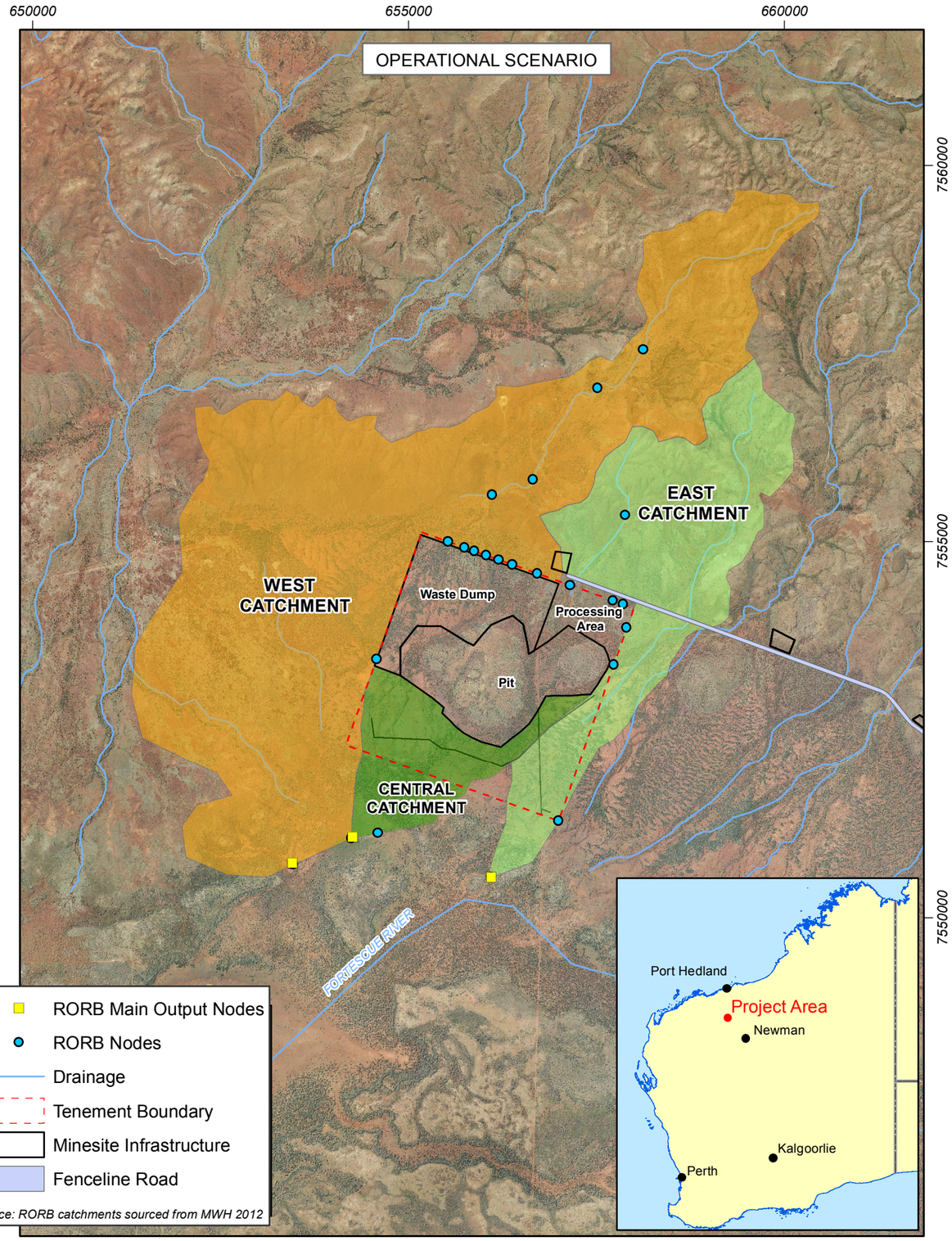
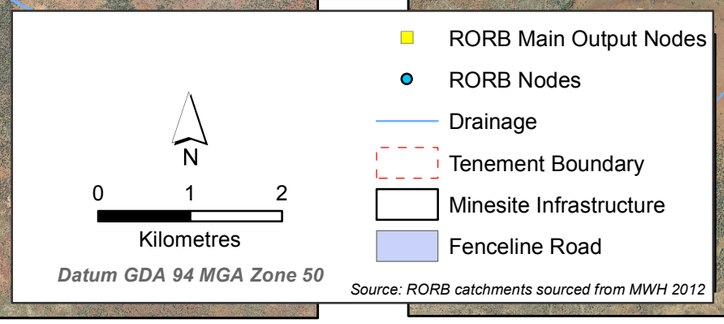
Mulga Downs Project
Figure 21
Pre and post mining RORB catchments - mine site area







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10.4.1 Alterations to surface water flows

Murray's Hill mine

The proposed mining operations will interrupt and modify natural drainage lines and capture rainfall within pit area. The overall effect of this diversion is not considered significant as most flows are diverted around infrastructure and will enter the receiving Goodiadarrie Swamp. Only small volumes will be captured in the mine pit (MWH 2012, p. 35).

The occurrence of sheet flow in the mine area is limited and ponding upstream is consequently not expected (MWH 2012, p. 35).

Diversion of flows from the East and West Catchments will have the effect of reducing flows in the Central Catchment, creating a shadow effect for the remaining portion of the Central Catchment. However, total runoff within the catchment will be reduced by 0.14% and effects to flows within the Goodiadarrie Swamp catchment will consequently be insignificant (MWH 2012, p. 35).

Fenceline road

Sheet flow is not a primary runoff characteristic within the majority of catchments within which Fenceline Road alignment traverses. The effect of any potential ponding and drainage shadow is expected to be small and localised given the presence of the existing Fenceline Road and the use of the floodways and causeways in the construction of the road upgrade (MWH 2012, p. 36).

Further investigations will be undertaken to identify catchments along the alignment that display sheet flow characteristics and manage surface water flows to minimise adverse effects upstream or downstream of the road alignment through engineering design.

Camp location and access roads

The accommodation camp is located within a small catchment with limited through-flow of surface water. Minimal surface water diversion will be necessary and effects on the modifications of flows are insignificant (MWH 2012, p. 35).

There will be no upstream ponding or downstream shadowing from the proposed accommodation camp as minimal surface water diversion will be necessary (MWH 2012, p. 36). The camp access road will be constructed at grade. The camp access road will be constructed at grade and will not significantly interrupt or modify any existing drainage patterns (MWH 2012, p. 35).

Railway access road

The Two Camel access road intersects a greater number of catchments than the Coonarrie railway access road and runs across the local topography. Sheet flow is more likely along the alignment of Two Camel railway access road option than the Coonarrie access road option due to the gently undulating topography around the Two Camel Creek access road option (MWH 2012, p. 35).

Overall, the effect of either access road option on modifications or interruptions to surface water flows will be negligible (MWH 2012, p. 35).

10.4.2 Increased sediment runoff and scour

Murray's Hill mine and camp locations

An increase in sediment runoff and scour may occur as a result of ground disturbance and vegetation removal. Surface water quality in the Pilbara tends to be dominated by high sediment loads caused by the large runoff events generated by significant rainfall events and cyclones. Diversion of flows into defined channels (diversion channels) has the potential to concentrate flood flows and increase flood velocities, thereby increasing the potential for scour. The extent of these effects will be minimised through the engineering design of the diversion channels (MWH 2012, p. 36).

The waste rock dump will be susceptible to erosion and is therefore a potential source of sediments during high rainfall events. The extent of these effects will be minimised through the presence of a downstream sedimentation pond (MWH 2012, p. 36).

Any effects to the water quality as a result of the mining operations will be insignificant due to:

- the small percentage of total area occupied by the Project
- engineering design
- management of stormwater run-off through adherence to engineering design standards (MWH 2012, p. 36).

Fenceline Road

Upgrade to Fenceline Road is not expected to significantly increase the potential for erosion and scouring of channels and banks of natural surface drainage lines. Existing drainage lines that intersect the road alignment are well defined and flows during significant rainfall events will be typically of high velocity and short duration. Potential effects will however be managed through construction of floodways and causeways (MWH 2012, p. 37).

Railway access road

The catchment areas associated with the Two Camel railway access road option are small and the gradient is such that flow volumes will be relatively small and of low velocity (MWH 2012, p. 37).

The potential for erosion and scouring along the Coonarrie railway access road alignment is greater as the alignment cuts across the contours and will channel water directly towards Two Camel Creek. Roadside drainage channels will be appropriately designed to avoid the generation of new drainage channels along the boundary of the new roadway (MWH 2012, p. 37).

Potential effects of the Project at this location can be managed through construction of floodways and causeways and consequently are expected to be insignificant.

10.4.3 Contamination of surface water

There is limited potential for chemicals and/or hydrocarbons to enter the groundwater system, and HPPL will adopt appropriate management practices to minimise the risk of contamination and mitigate any effects (MWH 2012, p. 48).

10.5 Management measures and performance standards

Impacts of the Project on surface water will be managed through engineering design and adherence to engineering design standards. A stormwater management strategy will be developed for the Project focussing on:

- minimising the risk of flood to the mining operations to ensure the safety of personnel and efficiency of mining
- minimising potential impacts to the receiving downstream environment.

To achieve this, mitigation measures will be implemented to ensure flood flows are safely diverted around the operations and best practices will be adhered to ensure the minimisation of any potential environmental impacts (MWH 2012, p. 38).

10.6 Predicted environmental outcomes

Taking into the account the abovementioned mitigation and management measures, the following conclusions have been made in relation to the effects of the Project on surface water:

1. There will be no significant effects on the surface water regime within the Goodiadarrie Swamp catchment.
2. There will be no significant effects on the surface water regime within the Yule River catchment.
3. The Project will not result in significant effects to the quality and quantity of surface water.
4. Engineering and design measures will be implemented to reinstate surface water flows immediately downstream of the Project.

The impacts of the Project on surface water regimes will be insignificant and; therefore, the EPA objectives for this factor will be achieved.

11. Vegetation and flora

11.1 Relevant environmental objectives, policies, guidelines, standards and procedures

11.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals that may affect flora and vegetation:

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.

11.2 Findings of surveys and investigations

11.2.1 Previous studies undertaken

A number of flora and vegetation surveys have been undertaken for the Project area and surrounds since 2008, and include regional, site-specific and targeted rare and threatened flora surveys. Studies relevant to the Project area are described in Table 17.

Table 17 Flora and vegetation surveys relevant to the Project area

Title reference	Outline of survey
Ecologia (2008) Murray's Hill (M47/0206)	This survey consisted of a database search and single phase (Level 1) botanical survey of the Murray's Hill Mining Lease (M47/206) conducted between 4th and 8th June 2008. Survey methods were developed to meet EPA Guidance Statement 51 and Position Statement 3.
G & G Environmental (2009) Murray's Hill (E47/1244)	Report of a baseline flora and vegetation survey of a proposed transport corridor and associated borrow pits within pending miscellaneous licences 46/339 and 46/340 at Murray's Hill. The study included database searches and an on-ground survey conducted in August 2009.
Maia Environmental Consultancy (2010) HPPL Regional Drilling Programme, 23 August 2010	This document describes the vegetation and flora recorded during targeted surveys of drill lines and tracks at the following tenements: E47/1307, E47/1313, E47/1308, E47/1244 (west of M47/206), E46/586, E47/1326, E47/1324, E47/1325, E47/1327, E47/1609, E47/1610, and E46/685 – 688. The survey was conducted between 12th and 20th May 2010 of drill pads and along drill lines within the above tenements.
Maia (2011) RHI Rail Corridor Abydos-Woodstock Section: Detailed Flora and Vegetation Assessment	Maia undertook a detailed flora and vegetation assessment of the Roy Hill Infrastructure Railway corridor from west of Gillam Siding to the southern end of the Abydos-Woodstock Reserve in March / April 2011 which overlaps the majority of the proposed access road within the Abydos-Woodstock Reserve.

Title reference	Outline of survey
Maia Environmental Consultancy (2012a) HPPL Mulga Downs Project Preliminary Vegetation and Flora Impact Assessment	A preliminary vegetation impact assessment relevant to tenements M47/206 and E47/1244 covering a 94 km by 185 km area around the Project area was used as the base area in which to search for available literature, mapping data and to conduct database searches. Relevant databases and available literature were searched. Land systems and Beard vegetation association data files were used to indicate cumulative impacts to vegetation and habitats of the Mulga Downs study area. The report was based on an earlier conceptual mine footprint which had a significantly larger impact area. The impact assessment provided in this report is therefore not current to this Project.

11.2.2 Recent studies undertaken

In June–August 2012, Maia (2012b) undertook a literature and database search and detailed (Level 2) flora and vegetation assessment of those areas not previously surveyed (i.e. areas around and excluding M47/206[5] but within E47/1244 and L45/316). The survey was undertaken in accordance with EPA Guidance Statement 51 (EPA 2004) and Position Statement 3 (EPA 2000). The survey report is provided as Appendix 4.

11.2.3 Land systems

Ten IBRA land systems occur within the Maia (2012b) flora and vegetation survey area (Boolgeeda, Brockman, Calcrete, Coolibah, Hooley, Jamindie, Jurrawarrina, Macroy, McKay and Newman) which have been described in Table 9. Of these land systems, most comprise less than 10% of the survey area (i.e. Boolgeeda, Brockman, Calcrete, Hooley, Jurrawarrina, Macroy and McKay). Coolibah covers 15% of the survey area, Jamindie 33% and Newman 27%. The extent of each of these land systems in the survey area, relative to the mapped extent in the Pilbara, is small. Most land systems range between 0.003–0.64%, while three (Coolibah, Hooley and Jamindie) have 3.36%, 3.53% and 3.66% respectively of their Pilbara extent in the survey area. The local significance of the Coolibah, Hooley and Jamindie land systems are rated by Maia as Moderate, while the remaining land systems are rated as having low local significance (Maia 2012b, p. 85).

11.2.4 Beard (1975) vegetation mapping

According to broad mapping by Beard (1975), five broad structural vegetation associations occur in the Maia (2012b) survey area and surrounding region, which are described in Table 18 and mapped in Figure 22.

The current and pre-European extents of these vegetation associations in the Pilbara IBRA region are also compared in Table 18 with each estimated to have more than 99% of their pre-European extent remaining.

[5] Although Maia (2012) did not survey M47/206, available survey information was used to incorporate flora and vegetation within the tenement in the vegetation and flora mapping, discussion of results and impact assessment.

Table 18 Vegetation associations mapped by Beard (1975) in the survey area

Beard Code	Mining lease/area	Vegetation Association Code (DAFWA 2012)	Physiographic Region	Broad Description	Pre-European Extent (ha) by Pilbara IBRA Bioregion and Vegetation Association	Current Extent (ha) by Pilbara IBRA Bioregion and Vegetation Association	Remaining (%)	Current extent protection for Conservation of pre-European extent (%)
a1Lp	E47/1244 M47/206 L47/675 L45/316	29	Fortescue Valley	Sparse Low Woodland; mulga, discontinuous in scattered groups.	1,133,219.76	1,132,939.21	99.98	1.91
a2Sr t1Hi	Coonarrie railway access road	93	Abydos Plain	Hummock grasslands, shrub steppe; kanji over soft spinifex	3,042,114.08	3,038,471.63	99.88	0.42
a2Sr t1,3Hi	E47/1244	173	Chichester Plateau	Hummock grasslands, shrub steppe; kanji over soft spinifex and *Triodia wiseana* on basalt	1,752,520.89	1,747,677.63	99.72	7.49
xGc	E47/1244	175	Chichester Plateau and Fortescue Valley	Short bunch grassland – savanna/grass plain (Pilbara)	507,032.56	506,625.99	99.92	4.38
a1Li/e16Lr t3Hi	E47/1244 L47/339 L47/675 L45/316	562	Fortescue Valley	Mosaic: Low woodland; mulga in valleys / hummock grasslands, open low tree steppe; snappy gum over *Triodia wiseana*.	103,606.82	103,606.82	100.00	0.00

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Mulga Downs Project
Figure 22
Associations mapped by Beard (1975) in the project area

650000 655000 660000 665000 670000 675000 680000 685000

7560000 7555000 7550000 7545000 7540000

MAP A

MAP B

175 173 562 29 619 93

M 47/206

E 47/1244

L 47/339

L 45/316

Great Northern Highway

Two Camel Railway Access Road Option

Coonarrie Railway Access Road Option

RHI SRL

155km 156km 157km 158km

FORTESCUE RIVER

RHI Railway Chainage
Highway
RHI Railway
River
Mulga Downs Tenement Boundaries
Railway Access Road Options
Claypan

CHICHESTER PLATEAU-173
CHICHESTER PLATEAU-175
FORTESCUE VALLEY-111
FORTESCUE VALLEY-175
FORTESCUE VALLEY-29
FORTESCUE VALLEY-562
ABYDOS PLAIN-CHICHESTER-619
ABYDOS PLAIN-CHICHESTER-93

N

0 2 4
Kilometres

Datum GDA 94 MGA Zone 50

Railway Access Road Options
Map B Area
Map A Area
Mine and Fenceline Road
Great Northern Hwy

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

prepared by: vanessa.donley

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11.2.5 Vegetation communities

Maia (2012b, pp. 31-32) undertook pattern analysis using the combined data from its survey with the mapping undertaken by Ecologia (2008) over M47/206 to collectively describe the vegetation communities occurring over tenements E47/1244, M47/206, L45/316, L47/339 and L47/675. Vegetation associations occurring within the railway access road alignment options were previously mapped for the Roy Hill Infrastructure Railway (Maia 2011).

Murray's Hill mine and Fenceline Road

Based on the results of the statistical analysis (Maia 2012b), field observations and previous mapping, 14 vegetation associations occur within the Murray's Hill mine and Fenceline Road survey area. Vegetation communities are comprised of: three occurring on hills and undulating plains, three within habitats associated with minor drainage, three on plains, four on river and related habitats and one associated with freshwater claypans.

The vegetation associations occurring over the Maia (2012b) survey area are shown in Figure 23 and described in Table 19.

Table 19 Vegetation associations (Maia 2012b)

Community code	Description	Area mapped within survey area (ha)	% Cover
Associations mainly occurring on hills and undulating plains			
H1 - *Triodia* Hummock Grassland	Hummock Grassland of *Triodia* aff. *basedowii* +/- *Triodia brizoides* with a Sparse Tall Shrubland of mixed *Acacia* species (*A. atkinsiana*, *A. ancistrocarpa*, *A. bivenosa* and *A. spondylophylla*) with Isolated Low Trees of *Eucalyptus leucophloia* subsp. *Leucophloia* +/- *Corymbia hamersleyana*.	6418.18	28.28
H2 - *Triodia* Hummock Grassland	Hummock Grassland of *Triodia* aff. *basedowii* and or *T. epactia* with a Sparse Shrubland of *Acacia* species (*A. aneura*, *A. aptaneura* and *A. incurvaneura*) and Isolated Low Trees of *Eucalyptus leucophloia* subsp. *Leucophloia* and/or *A. pruinocarpa*.	822.22	3.59
H3 - *Triodia* Hummock Grassland	Hummock Grassland of *Triodia brizoides* with an Open Low Woodland of *Eucalyptus leucophloia* subsp. *Leucophloia* with Isolated Low Shrubs of *Ptilotus obovatus*.	71.46	0.31
Associations on habitats associated with minor drainage			
D1 - Mixed Tall Shrubland	Tall mixed Shrubland (*Petalostylis labicheoides*, *Acacia marramamba* and *Grevillea wickhamii*) with an Open Hummock Grassland of *Triodia epactia*.	58.10	0.25
D2 - *Acacia* Tall Shrubland	Tall Shrubland of *Acacia tumida* and *A. pyrifolia* with a Sparse Tussock Grassland of *Themeda triandra* and Isolated Low Trees of *Corymbia hamersleyana* and/or *Eucalyptus victrix*.	1261.91	5.51
D3 - *Eragrostis* Tussock Grassland	Tussock Grassland of *Eragrostis xerophila* with a Sparse Tall Shrubland of *Acacia coriacea* subsp. *pendens* and *A. tetragonophylla* with a Sparse Low Shrubland of *Pluchea rubelliflora* and *Pterocaulon sphacelatum*.	272.69	1.19

Community code	Description	Area mapped within survey area (ha)	% Cover
Associations on plains			
P1 - *Acacia* Low Woodland or Tall Shrubland	Low Woodland/Tall Shrubland to Isolated Low Trees/Shrubs of *Acacia aneura* (complex) with a mixed Sparse Low Shrubland (*Dodonaea petiolaris*, *Eremophila forrestii* and *Abutilon otocarpum*) and Isolated Low Trees of *A. pruinocarpa*.	6225.36	27.16
P2 - *Acacia* Sparse Tall Shrubland	Sparse Tall Shrubland of *Acacia aneura* and *A. xiphophylla* with a Sparse Low Shrubland of *Eremophila cuneifolia* and a Sparse Hummock Grassland of *Triodia epactia* and/or *T.* aff. *basedowii*.	1018.41	4.44
P3 - *Acacia* Tall Shrubland	Sparse Tall Shrubland of *Acacia xiphophylla* and/or *A. synchronicia* with a mixed Sparse Chenopod Shrubland (*Sclerolaena tetragona*, *S. bicornis*, *S. densiflora*) and a Sparse Tussock Grassland of *Eragrostis xerophila*.	2945.99	12.85
Associations on river and related habitats			
R1 - *Eucalyptus* Open Low Woodland	R1: Open Low Woodland to Low Woodland of *Eucalyptus victrix* with a Mid Shrubland of *Muehlenbeckia florulenta*.	506.32	2.21
R2 - *Eucalyptus* Open Low Woodland	R2: Open Low Woodland to Low Woodland of *Eucalyptus victrix* and *Acacia distans* with a mixed Sparse Mid Shrubland of *A. tetragonophylla*, *Melaleuca glomerata* and *Muehlenbeckia florulenta*.	1703.64	7.43
R1/R2 mosaic - *Eucalyptus* Open Low Woodland	Mosaic of R1 and R2	415.24	1.81
R3 - Mixed Mid Shrubland	Sparse mixed Mid Shrubland (*Melaleuca glomerata*, *Eremophila longifolia* and *Acacia synchronicia*) with either a Hummock Grassland of *Triodia epactia* or a Tussock Grassland of annual *Eragrostis pergracilis* and Isolated Trees of *Eucalyptus victrix*	663.29	2.89
Associations on freshwater claypans			
CP1 - *Eriachne* Tussock Grassland	Tussock Grassland of *Eriachne flaccida* and *E. benthamii* with Isolated Trees of *Eucalyptus victrix*	287.65	1.26
Cleared		184.57	0.81
Total		22 918	100

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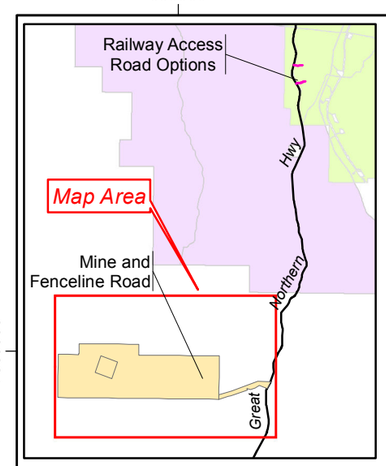
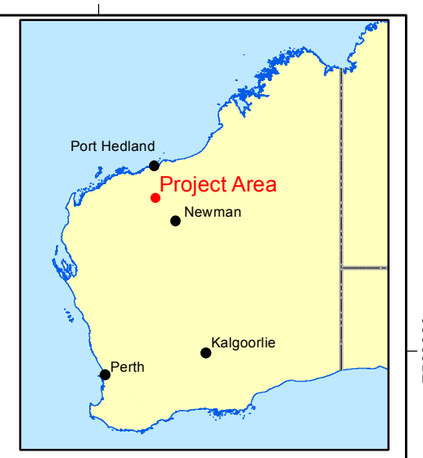
Mulga Downs Project
Figure 23
Vegetation mapping - Murray's Hill Mine and Fenceline Road

650000 660000 670000 680000

7560000

7550000





M 47/206

E 47/1244

L 47/339

L 45/316

FORTESCUE RIVER

Great Northern Highway

N

0 2 4
Kilometres

Datum GDA 94 MGA Zone 50

River
Highway
Mulga Downs Tenements

Cleared Area
CP1, *Eriachne* Tussock Grassland
D1, Mixed Tall Shrubland
D2, *Acacia* Tall Shrubland
D3, *Eragrostis* Tussock Grassland

H1, *Triodia* Hummock Grassland
H2, *Triodia* Hummock Grassland
H3, *Triodia* Hummock Grassland
P1, *Acacia* Low Woodland or Tall Shrubland
P2, *Acacia* Sparse Tall Shrubland

P3, *Acacia* Tall Shrubland
R1, *Eucalyptus* Open Low Woodland
R1/R2, Mosaic of R1 and R2.
R2, *Eucalyptus* Open Low Woodland
R3, Mixed Mid Shrubland

Source: Vegetation data sourced from Maia 2012

650000 660000 670000 680000

prepared by: vanessa.donley

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Railway access road

Based on the results of vegetation mapping undertaken by Maia (2011) for the Roy Hill Infrastructure Railway, nine vegetation associations occur within the area of the railway access road options. Three vegetation communities were associated with plains, three associated with minor drainage and three associated with hills and undulating plains.

The vegetation associations are shown in Table 24 and Table 25.

Table 20 Vegetation associations - railway access road options

Community code	Description	Total area mapped (ha)- RHI Environmental Approval Corridor	Two Camel railway access road development envelope (ha)	Coonarrie railway access road development envelope (ha)
Associations occurring on plains				
P2	Open Hummock Grassland of *Triodia longiceps* with a Low Sparse Shrubland of *Acacia bivenosa* and *Pluchea ferinandi-muelleri* on flood plains and depressions	2594	4.33	8.72
P4	Low Open Shrubland of *Acacia stellaticeps* and +/- *Pluchea ferdinandi-muelleri* with an Open Hummock Grassland of *Triodia lanigera* and *T. epactia* on floodplains and minor depressions	1605	-	3.56
P8	Hummock Grassland of *Triodia angusta* with Low Isolates Shrubs of *Senna notabilis* and *Acacia bivenosa* on undulating plains and floodplains	50	4.47	-
Associations occurring on minor drainage				
D1	Tall mixed Shrubland (*Petalostylis labicheoides*, *Acacia marramamba* and *Grevillea wickhamii*) with an Open Hummock Grassland of *Triodia epactia*.	789	-	3.2
D2	Tall open Shrubland of *Acacia trachycarpa* and *A. ampliceps* with an Open Hummock Grassland of *Triodia epactia* and a Sparse Tussock Grassland of **Cenchrus ciliaris* and *Themeda triandra* on minor creeks	637	0.05	-
D4	Tall Open Shrubland on *Acacia trachycarpa* and/or *A. tumida var. pilbarensis* with an Open Grassland of **Cenchrus ciliaris* and *Themeda triandra* on minor creeks	69	-	8.78
Associations occurring mainly on hills and undulating plains				
H1	Hummock Grassland of *Triodia lanigera* with a Sparse Low Shrubland of *Acacia bivenosa* and isolated Low Trees of *Corymbia hamersleyana* on rolling quartz hills	1283	30.58	-

Community code	Description	Total area mapped (ha)- RHI Environmental Approval Corridor	Two Camel railway access road development envelope (ha)	Coonarrie railway access road development envelope (ha)
H4	Mid Open Shrubland of *Acacia orthocarpa* and *A. inaequilatera* with an Open Hummock Grassland of *Triodia epactia* and *T. wiseana* on hill slopes and rolling hills	682	-	1.65
H4/D3	Mid Open Shrubland of *Acacia orthocarpa* and *A. inaequilatera* with an Open Hummock Grassland of *Triodia epactia* and *T. wiseana* on hill sloped and rolling hills/Open Hummock Grassland of *Triodia epactia* with an Open Tall Shrubland of *Grevillea wickhamii* and *Acacia tumida var. pilbarensis* and a Low Open Woodland of *Corymbia hamersleyana* on minor drainage channels	3427	-	18.07
Previously cleared			0.41	0.41
Unmapped			18.68	12.65

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Mulga Downs Project
Figure 24
Vegetation mapping - Railway Access Road Options

685000 690000 695000

7605000

7600000

150km 151km 152km 153km 154km 155km 156km 157km 158km 159km 160km

YULE RIVER

Highway

Northern

Great

Two Camel Railway Access Road

Coonarrie Railway Access Road

COONARRIE CREEK

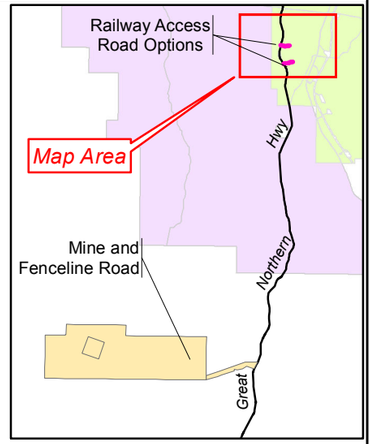
Chainage 1km
River
Highway
Railway Access Road Options
RHI SRL - 4SA
Development Envelope
D1, Eucalyptus Open Woodland
D2, Acacia Tall Open Shrubland
D3,Triodia Hummock Grassland
D4, Acacia Tall Open Shrubland
H1, Triodia Hummock Grassland
H3, Triodia Hummock Grassland
H4, Acacia Mid Shrubland
H4/D3, Mosaic
P1, Triodia Hummock Grassland
P2, Triodia Hummock Grassland
P3, Acacia Mid Sparse Shrubland
P4, Acacia Low Open Shrubland
P7, Triodia Hummock Grassland
P8, Triodia Hummock Grassland

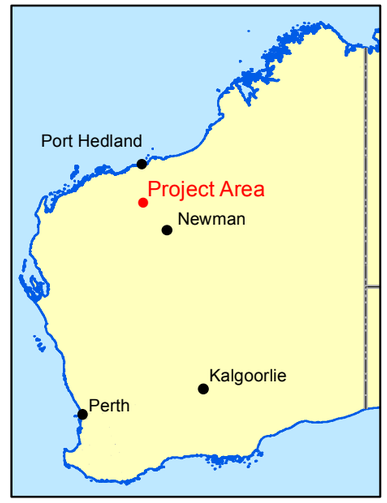
Source: Vegetation data sourced from Maia 2011

N

0 1 2
Kilometres

Datum GDA 94 MGA Zone 50





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11.2.6 Vegetation condition

Vegetation condition over the Project area was mapped by Ecologia (2008), Maia (2012b) and Maia (2011).

Vegetation condition within E47/1244 as mapped by Maia (2012b, p. 77) as excellent (32.47%), excellent/very good (11.43%), completely degraded (0.08%) with the majority of the vegetation considered to be in very good condition (41.27%). Figure 25 shows vegetation condition mapping within tenements the Murray's Hill mine and Fenceline Road area.

Vegetation condition mapped within the area of the railway access road options ranged from Good to Excellent/very good with vegetation associated with plains showing the greatest signs of disturbance (Maia 2012, p. 92).

Disturbances noted during surveys included cattle grazing and soil compaction, weeds and clearing for exploration activities and access tracks.

11.2.7 Threatened and Priority Ecological Communities

No Threatened Ecological Communities (TEC) are present in the Project area (Maia 2012b, p. 93). Threatened and Priority Ecological Communities and associated buffers in the vicinity of the Project are shown in Figure 26.

The Maia (2012b) survey area occurs within the 40 km buffer surrounding the Priority Ecological Community (PEC) 'Four plant assemblages of the Wona Land System'. One claypan of the PEC 'Freshwater claypans of the Fortescue Valley' also occurs within the area surveyed by Maia. The Project will not directly affect these two PECs (Maia 2012b, p. 95).

11.2.8 Environmentally Sensitive Areas, Conservation Estates, Schedule One Areas, EPA Redbook Areas and Reserves

There are no Conservation Estates, Schedule One Areas or EPA Redbook Areas located within the survey area (Maia 2012b, p. 40).

The nearest Environmentally Sensitive Area (ESA) is the Fortescue River and Marsh. Exploration lease 47/1244 lies over a section of the western extent of the Fortescue Marshes ESA and its associated buffer (Maia 2012b, p. 41). There will be no direct disturbance to the ESA or its buffer.

A small area (8 ha) may require excision from the Abydos-Woodstock Protected Area 33 for access from the Great Northern Highway to the Roy Hill Infrastructure Railway. This process will be led by DAA and the Minister for Aboriginal Affairs.

11.2.9 Other significant vegetation communities

Mulga

Mulga occurs in the Chichester, Fortescue Plains and Hamersley subregions of the Pilbara and grows on a range of landforms, including rocky hillslopes, at the base of hills and rock outcrops and in swales. The low stony hills of the Chichester Range are recognised as the northern-most extent of mulga in the Pilbara and are therefore considered to be locally significant (Maia 2012b, p. 11).

Regionally, the mulga woodlands of the Chichester footslopes cover 1641 km^2 of the mulga dominated land systems. Banded vegetation of intergrove areas and other broad plains are mainly distributed over the Boolgeeda, Brockman, Elimunna, Jamindie, Washplain and Turee land systems. Mulga woodlands are often organised into sequences of alternating mulga groves and intergroves ('banded' woodlands) in lower lying areas (Maia 2012b, p. 11).

Mulga is considered to be generally shallow-rooted (less than 3 m depth) and it is currently accepted that mulga communities are strongly reliant on recharge of surface soils from sheet flow. These communities are; therefore, susceptible to changes in surface flows (Maia 2012b, p. 11).

No mulga associations occur within the area affected by the railway access road options. Maia (2012b, p. 94) reported two mulga associations (P1 and P2) within the Murray's Hill mine flora survey area associated with the Jamindie and Newman land systems (refer to Figure 23).

Groundwater dependent ecosystems

The mine pit will be above the watertable, eliminating the need for dewatering.

Vegetation that depends to differing degrees on groundwater during its lifecycle is known as phreatophytic vegetation. Some phreatophytes can be wholly dependent on groundwater for survival while others have a facultative dependence. The National Groundwater Dependent Ecosystems (GDE) Atlas was used by Maia (2012) to determine the likelihood of GDEs occurring in the project area.

Five of the vegetation associations mapped within the flora survey area (refer to Figure 23) include *Eucalyptus victrix* - R1, R2, R3, CP1 and D2. *E. victrix* is considered to be a facultative phreatophyte that uses groundwater opportunistically when surface water is limited. Some of the shrub species growing with *E. victrix* are possibly also facultative phreatophytes. Phreatophytes can be affected by changes in the physical characteristics and level of groundwater in an area (Maia 2012, p. 16).

11.2.10 Flora of conservation significance

No Threatened species pursuant to the EPBC Act or plant taxa gazetted as Declared Rare Flora (DRF) pursuant to the WC Act were located within the Project area (Maia 2012b, p. 45).

Maia (2012b) undertook a database and literature search of the Project area and surrounds. A total of 29 Priority species listed by the DEC have been recorded in the vicinity of the Project. Three confirmed and three potential Priority species have been located in the survey area (Table 21; Figure 27) (Maia 2012b, p. 95).

Figure 28 shows the location of Priority flora recorded in the Project area and surrounds.

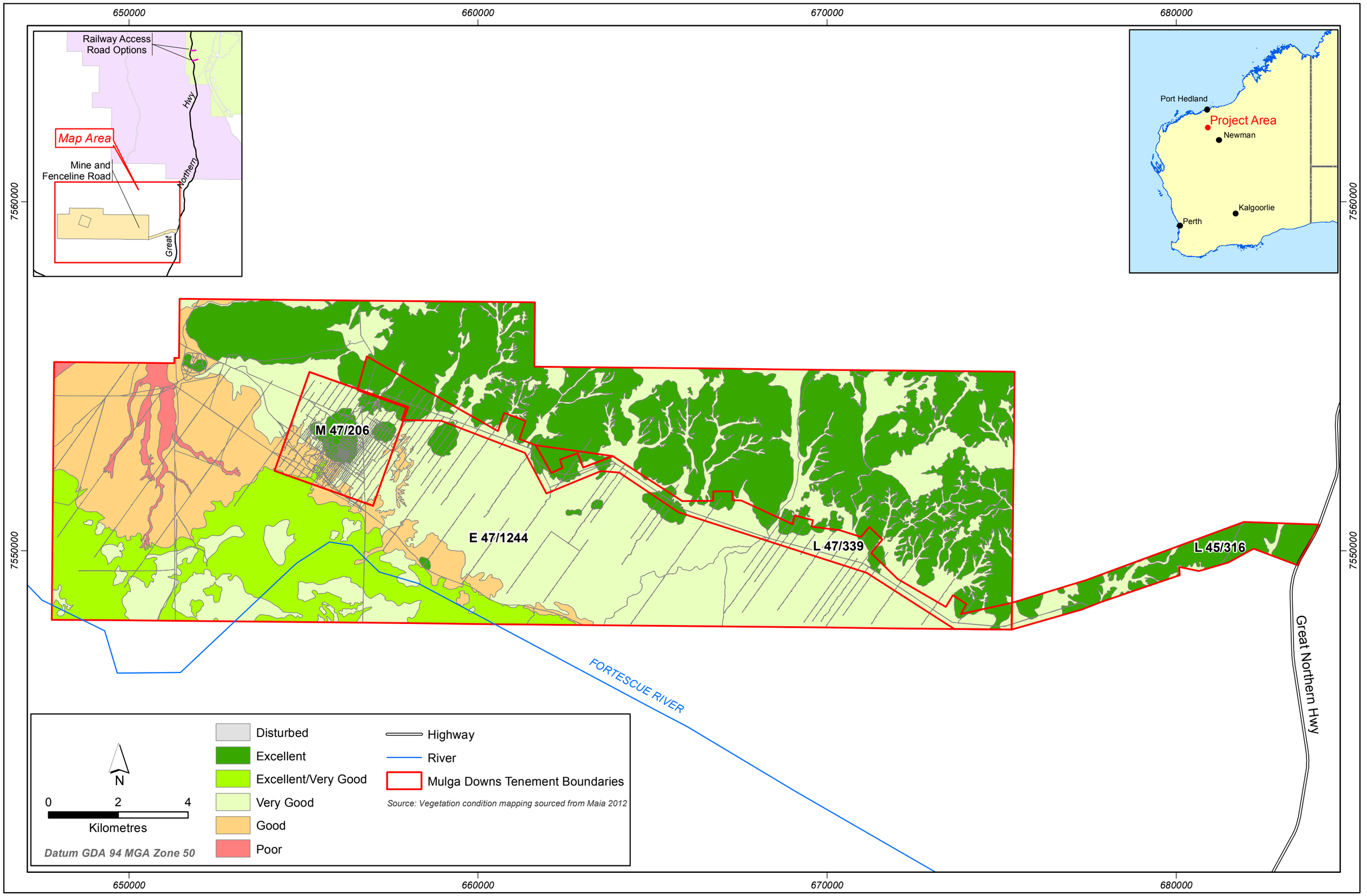
Table 21 Conservation significant flora recorded in the Project area

Species	Conservation status
Teucrium pilbaranum	P1
Rostellularia adscendens var. *latifolia*	P3
Goodenia nuda	P4
Aristida ?jerichoensis subsp. *subspinulifera*	Potential P3
Rhagodia ? sp. Hamersley	Potential P3
Goodenia ?lyrata	Potential P3

P1 (Priority 1); P3 (Priority 3); P4 (Priority 4)

HANCOCK PROSPECTING PTY LTD

Mulga Downs Project
Figure 25
Vegetation condition mapping - Murray's Hill Mine and Fenceline Road



prepared by: vanessa.donley

HANCOCK PROSPECTING PTY LTD

Mulga Downs Project
Figure 26
Threatened and priority ecological communities and associated buffers

600000 650000 700000 750000

7600000

7550000

7500000

Two Camel Railway Access Road

Coonarrie Railway Access Road

Great Northern Highway

Munjina Wittenoom Road

FORTESCUE RIVER

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

Highway
Cumulative Impacts Assessment Area
Mulga Downs Tenement Boundaries
Railway Access Road Options
Floodplain
Wona Land System

BHP
Brockman
Aurizon (QRN)
Roy Hill Infrastructure
Fortescue Metals Group
Cloudbreak Project

Themeda grasslands (TEC)
Fortescue Marsh (PEC P1)
Freshwater claypans of the Fortescue Valley (PEC P1)
Wona Land System (PEC P1)
Fortescue Valley Sand Dunes (PEC P3)

N
0 10 20
Kilometres

Datum GDA 94 MGA Zone 50

prepared by: vanessa.donley

MD0244_26

HANCOCK PROSPECTING PTY LTD

Mulga Downs Project
Figure 27
Priority flora recorded in project area and surrounds

600000 650000 700000 750000 800000

7600000

7550000

7500000

Port Hedland
Project Area
Newman
Kalgoorlie
Perth

Two Camel Railway Access Road
Coonarrie Railway Access Road
Great Northern Highway
Nanutarra Wittenoom Road
Munjina Wittenoom Road
Marble Bar Road

- Lepidium catapycnon, T
- Arisitda jerichoensis subsp. subspinulifera, P1
- Calotis squamigera, P1
- Cochlospermum sp. Pilbara, P1
- Eremophila spongiocarpa, P1
- Josephinia sp. Marandoo, P1
- Nicotiana heterantha, P1
- Teucrium pilbaranum, P1
- Adiantum capillus-veneris, P2
- Dicladanthera glabra, P2
- Gompholobium karijini, P2
- Paspalidium retiglume, P2
- Stylidium weeliwolli, P2
- Acacia glaucocaesia, P3
- Acacia levata, P3
- Elatine macrocalyx, P3
- Euphorbia stevenii, P3
- Glycine falcata, P3
- Goodenia sp. East Pilbara, P3
- Gymnanthera cunninghamii, P3
- Indigofera gilesii subsp. gilesii, P3
- Nicotiana umbratica, P3
- Oldenlandia sp. Hamersley Station, P3
- Olearia mucronata, P3
- Rhagodia ?sp. Hamersley, ?P3
- Rostellularia adscendens var. latifolia, P3
- Themeda sp. Hamersley Station, P3
- Bulbostylis burbidgeae, P4
- Eremophila magnifica subsp. magnifica, P4
- Eremophila youngii subsp. lepidota, P4
- Goodenia nuda, P4

N

0 10 20
Kilometres

Source: Flora data sourced from Maia 2012

Datum GDA 94 MGA Zone 50

prepared by: vanessa.donley

MD0244_28A

HANCOCK PROSPECTING PTY LTD

Mulga Downs Project
Figure 28
Priority flora and species of interest recorded in Mulga Downs

650000 660000 670000 680000

7560000

7550000

7540000

- Aristida ?jerichoensis var. subspinulifera, Potential P1
- Teucrium pilbaranum, P1
- Goodenia ?lyrata, Potential P3
- Goodenia nuda, P4
- Goodenia aff. muelleriana, SOI
- Hibiscus sp. ?nov., SOI
- Claypan
- Fortescue Marsh

N

0 2 4
Kilometres

Source: Flora data sourced from Maia 2012

Datum GDA 94 MGA Zone 50

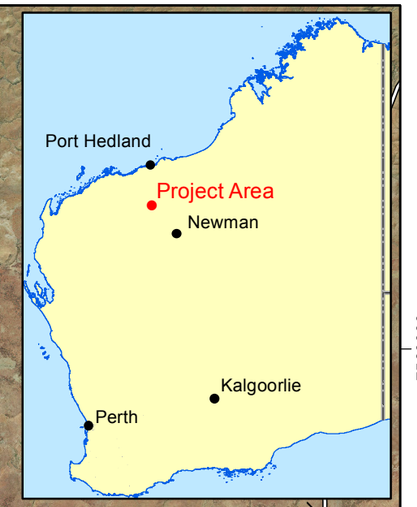
M 47/206

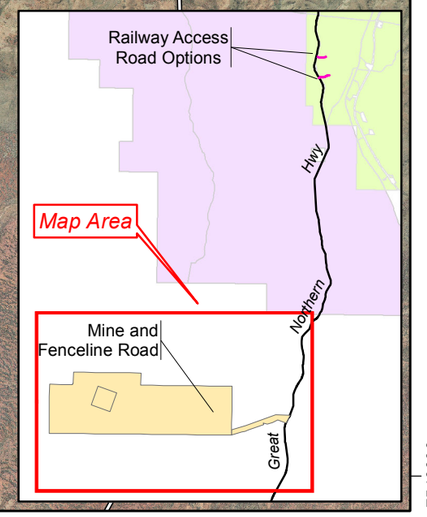
E 47/1244

L 47/339

L 45/316

Great Northern Highway





prepared by: vanessa donley

MD0244_28B

11.2.11 Other species of interest

Two species of interest were also located in the Maia (2012b) survey area:

- *Goodenia aff. muelleriana*
- *Hibiscus* ?sp. *nov*.

Species have a typical range that is indicated by their known distribution records. Species recorded in areas where they have not been previously found are described as range extensions. Identification of flora species range extensions is common in the Pilbara bioregion and reflects the increased knowledge of Western Australian flora that arises as comprehensive ground surveys are conducted in greenfield areas.

Six range extensions were collected from the area surveyed by Maia (2012b, p. 79):

- *Eragrostis exigua*
- *Eremophila forrestii* subsp. *Hastieana*
- *Eriochola pseudoacrotricha*
- *Maireana aphylla*
- *Wahlenbergia queenslandica*
- *Eleocharis pallens*.

11.2.12 Introduced flora and weed species

A total of 15 environmental weed species have been recorded in the areas surveyed (Table 22). Two additional species were located during earlier surveys in the area of the Project (Maia 2012b, p. 105).

Table 22 Weeds recorded in the Project area

Species	Common name
Acetosa vesicaria	Ruby Dock
Aerva javanica	Kapok Bush
Bidens bipinnata	Bipinnate Beggartick
Cenchrus ciliaris	Buffel Grass
Cenchrus setiger	Birdwood Grass
Cucumis melo	Ulcardo Melon
Cucumis melo subsp. agrestis	Ulcardo Melon
Echinochloa colona	Awnless Barnyard Grass
Flaveria trinervis	Speedy Weed
Malvastrum americanum	Spiked Malvastrum
Medicago polymorpha	Burr Medic
Portulaca oleracea	Purslane
Setaria verticillata	Whorled Pigeon Grass
Sonchus oleraceus	Common Sowthistle
Vachellia farnesiana	Mimosa Bush
Tribulus terrestris	Caltrop
Citrullus colocynthis	Bitter apple

No nationally listed weeds or declared plants have been recorded. One weed species is targeted for biological control (*Tribulus terrestris*); four are rated as high environmental impact weeds in Western Australia (*Aerva javanica, Cenchrus ciliaris, C. setiger* and *Vachellia farnesiana*); one is a weed not listed as having a high rating but requiring control in the Pilbara — *Acetosa vesicaria* (Maia 2012b, p. 105).

11.3 Potential sources of impact

The Project may affect flora and vegetation values through:

- **clearing of vegetation** for the mine pit, waste rock dumps, access roads and associated mine infrastructure will directly reduce the extent of vegetation communities, and may disturb conservation significant flora species
- **changes to groundwater levels** (lowering) from abstraction for construction and operational water demand has the potential to affect vegetation communities
- **alterations to surface water flows** and disruption of sheet flows from the presence of mine pit, waste rock dumps, access roads and associated mine infrastructure has the potential to have an effect on downstream vegetation communities
- **increased sediment load** from ground disturbance has the potential to cause infilling of pools and smothering of vegetation in downstream catchments
- **dust generation** due to earthworks, mining, processing and vehicle movements during construction and operation has the potential to smother vegetation.
- **introduction and spread of weeds** from vehicle movements and earthworks
- **increased incidence/frequency of fire** from on-site ignition sources may favour the establishment of weeds and prevent the regeneration of native vegetation, particularly fire-sensitive species, such as mulga.

11.4 Assessment of likely direct and indirect impacts

11.4.1 Clearing of vegetation

Vegetation will be progressively removed during construction of the mine and associated infrastructure and during mining. Up to 890 ha of vegetation will be disturbed as a result of the Project.

A development envelope approach uses the assumption that disturbance could occur anywhere within the development envelope boundary. The impact assessment has been carried out using a worst-case scenario, supported by measures to minimise, avoid and mitigate the impacts.

The actual areas cleared will be significantly less that those presented. Only those units that will be directly affected by the Project are included in the tables.

Vegetation associations – Murray's Hill mine and Fenceline Road

Maia (2012b) reported 14 vegetation associations within the flora survey area. Of these, nine associations occur within the development envelope and eight within the conceptual disturbance footprint. The indicative disturbance of each vegetation community (Table 23) has been calculated as a percentage using the total area mapped by Maia (2012) and the total area of each vegetation association within the:

- development envelope
- conceptual disturbance footprint.

Table 23 Worst case and indicative disturbance to vegetation associations

Vegetation unit	Total area mapped in the survey area (Maia 2012) (ha)	Maximum area of disturbance within development envelope (ha)	Maximum development envelope disturbance %	Area of disturbance – conceptual disturbance footprint (ha)	Area of disturbance – conceptual disturbance footprint (%)
H1 - *Triodia* Hummock Grassland	6481.18	756.15	11.6	73.17	1.13
H2 - *Triodia* Hummock Grassland	822.22	494.36	60.1	241.67	29.39
H3 - *Triodia* Hummock Grassland	71.46	71.46	100	1.66	2.32
D1 – Mixed Tall Shrubland	58.1	2.34	4.03	-	0.0
D2 - *Acacia* Tall Shrubland	1261.91	199.97	15.8	33.58	2.66
P1 - *Acacia* Low Woodland or Tall Shrubland	6225.36	1 178.76	18.9	367.66	5.91
P2 - *Acacia* Sparse Tall Shrubland	1018.41	20.59	2.02	10.76	1.06
P3 - *Acacia* Tall Shrubland	2945.99	174.32	2.5	36.45	1.24
R2 - *Eucalyptus* Open Low Woodland	1703.64	18.58	1.1	0.55	0.03
Previously cleared	184.57	99.42	53.9	64.16	34.76

All nine of the vegetation types mapped by Maia (2012) within the development envelope are likely to extend beyond the area surveyed and the impacts to these vegetation communities are expected to be less than shown in Table 23.

Assuming a worst case scenario that all vegetation within the development envelope will be cleared, impacts are less than 20%, with the exception of H2 (*Triodia* hummock grassland) and H3 (*Triodia* hummock grassland) at 60.1% and 99% respectively.

Vegetation association H2 (*Triodia* Hummock Grassland) has a mapped area of 822.22 ha. Disturbance to this community is predominantly associated with clearing within the portion of the development envelope associated with the upgrade to Fenceline Road. The current known extent of community H3 (71.46 ha) occurs within tenement L45/316 and has the potential to be affected by the construction of a new section at the eastern extent of the Fenceline Road alignment (Figure 23).

The upgrade to Fenceline Road is linear in nature and is based on a 50 m wide disturbance corridor. This width is conservative with an actual road width likely to be 20 m. Based on the conceptual disturbance footprint (Figure 23), impacts to community H2 and H3 are 29.39% and 2.3%.

Community H2 is rated as moderately significant; however, this vegetation association is found within the Boolgeeda, Coolibah, Jamindie, McKay and Newman land systems. Based on aerial photography, this association appears to occur to the west and east of the survey area in the mulga-spinifex interface zone (Maia 2012, p. 90).

Community H3 was identified by Maia (2012, p. 90) as having moderate conservation significance due to the small area mapped and does not display any attributes that would increase its conservation value. The alignment of Fenceline Road at this location is highly unlikely to alter significantly from the conceptual disturbance footprint based on other environmental (mapped Northern Quoll habitat) and engineering constraints. However, using a worst-case road alignment, the impact to this community is approximately 6.5%.

Impacts to communities H2 and H3 will be minimised as far as possible through final detailed design of the Fenceline Road and the location of borrow pits.

Clearing associated with the Project is not expected to significantly affect the abundance or diversity of flora or vegetation at a local or regional level.

Vegetation associations –railway access road

According to Maia (2011; 2012b) six associations may be disturbed as a result of the Coonarrie railway access road and four as a result of the Two Camel railway access road option.

The indicative disturbance of each vegetation community previously mapped by Maia (2011) for each railway access road option (Table 24 and Table 25) has been calculated as a percentage using the area mapped and the total area of each vegetation association within the:

- development envelope
- conceptual disturbance footprint.

Table 24 Indicative disturbance to vegetation communities - Coonarrie railway access road option

Vegetation type	Total Area Mapped (ha)	Maximum area of disturbance within development envelope (ha)	Maximum development envelope disturbance %	Area of disturbance – conceptual disturbance footprint (ha)	Area of disturbance – conceptual disturbance footprint (%)
P2 – Open Hummock Grassland of *Triodia lanigera*	2594	8.72	0.34	1.10	0.04
P4- Low Open Shrubland of *Acacia stellaticeps*	1605	3.56	0.22	0.39	0.02
D1 – Open Low Woodland of *Eucalyptus camaldulensis* subsp. *obtusa*	789	3.2	0.41	0.45	0.06
D4 – *Acacia* tall open shrubland	69	8.78	12.72	0.82	1.19
H4 – *Acacia* Mid Open Shrubland	682	1.65	0.24	0.48	0.07
H4/D3	3427	18.07	0.53	2.25	0.07
Previously cleared areas	-	0.41	-	0.05	-
Unmapped portion	-	12.65	-	1.58	-

Assuming the entire area within the development envelope is to be cleared, disturbances to five of the six vegetation communities associated with the Coonarrie railway access road are less than 0.53%, with association D4 (*Acacia* tall open shrubland) estimated at 12.72%. Based on the conceptual disturbance footprint, impact to this community is low at 1.19%. Given the linear nature and maximum width of the railway access road, the conceptual disturbance footprint is considered to be more reflective of actual disturbance associated with the Coonarrie railway access road.

The overall disturbance to vegetation associations associated with the Coonarrie railway access road option is not considered significant.

Table 25 Indicative disturbance to vegetation communities - Two Camel railway access road option

Vegetation type	Total Area Mapped (ha)	Maximum area of disturbance within development envelope (ha)	Maximum development envelope disturbance %	Proposed area of disturbance (ha)	% disturbance of mapped community
P2 - *Acacia* Sparse Tall Shrubland	2594	4.33	0.17	1.54	0.06
P8 – *Triodia* hummock grasslands	50	4.47	8.9	0.22	0.44
H1 - *Triodia* Hummock Grassland	1283	30.58	2.4	3.10	0.24
D2	637	0.05	0.007	-	-
Previously cleared areas	-	0.41		0.05	
Unmapped portion		19.96	-	2.22	-

Assuming the entire area within the development envelope is to be cleared, disturbances to three of the four vegetation communities associated with the Two Camel railway access road are less than 2.4%, with association P8 (*Triodia* hummock grassland) estimated at 8.9%. Based on the conceptual disturbance footprint, impact to all communities are less than 0.5%. Given the linear nature and maximum width of the railway access road, the conceptual disturbance footprint is considered to be more reflective of actual disturbance associated with the Two Camel railway access road.

The overall disturbance to vegetation associations associated with the Two Camel railway access road option is not considered significant.

Regional impacts

Disturbances to land systems and Beard (1975) vegetation associations have been assessed using the total area mapped within the development envelope and the total area in the Pilbara bioregion (Table 26). Only those associations that will be directly affected by the Project have been included in the assessment.

Table 26 Regional Impact Assessment – Land systems and Beard (1975) vegetation association

.	Total area mapped in Pilbara (ha)	% Remaining in Pilbara	% Extent protected	Extent in Maia (2012b) survey area (ha)	Extent in development envelope (ha)[6]	Maximum disturbance to total mapped Beard vegetation associations/land systems Impact (%)	Impact from other nearby projects[7] (ha)	Cumulative impact (ha)	Cumulative impact (%)
Beard vegetation associations									
29	1 132 939.21	99.98	1.91	12 844.8	2 365.66	0.208	33 183	35 548.66	3.1
562	103 606.82	100.00	0	7838.8	652.35	0.629	9861	10 513.35	10.1
93	3 038 471	99.88	0.42	14.4	58.53	0.002	13 455	13 513.53	0.4
Land systems									
Boolgeeda	774 800.00			1450.9	8.3	0.000	2404	2412.3	0.3
Coolibah	101 035.00			3393.7	5.6	0.005	327	332.6	0.3
Jamindie	207 400.00			7539.3	1899.72	0.916	22 557	24 456.7	11.8
McKay	420 200.00			1441.8	367.17	0.087	9239	9606.17	2.3
Newman	1 458 000.00			6120.6	737.27	0.050	5962	6699.27	0.46
Macroy	1 309 500.00			14.4	58.53	0.004	9215	9273.53	0.70

Source: adapted from Maia 2012b, p. 101.

[6] Includes railway access road. Two Camel option has been chosen to represent maximum impacts.

[7] Other projects include: include: BHP rail corridor and the Chichester Development, Brockman Resources Development, FMG railways from Port Hedland to Solomon and Cloudbreak, a notional rail line to be developed by Aurizon (formerly QR National), Roy Hill Infrastructure Railway

As shown in Table 26, the expected impacts of the Project on land systems and Beard (1975) vegetation associations are low.

Six of the 10 land systems identified within the flora survey area and the area of the railway access road options are affected by the Project (Boolgeeda, Jamindie, McKay, Coolibah, Newman and Macroy). However, the impacts are considered low, being less than 1% of the total area mapped.

The regional significance of the Coolibah land system is rated by Maia (2012b, p. 82) as high and the Jamindie land systems is rated as moderate. The remaining land systems affected are rated as having low regional significance (Maia 2012b, pp. 82-83). A maximum of 5.6 ha of the Coolibah land system (0.005%) will be affected as a result of the Project. The majority of the Project is located within the Jamindie land system; however, the maximum percentage impact to this land system is low at 0.9%.

The EPA Position Statement 2 (EPA 2000) outlines several key criteria that should be applied to clearing of remnant vegetation, particularly in agricultural areas:

1. 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.
2. A level of 10% of the original extent is regarded as being a level representing "endangered".
3. Clearing which would put the threat level into the class above should be avoided.

Three Beard vegetation associations occur within the Project area (562, 29 and 93). The Project will result in the removal of 0.6%, 0.2% and 0.002% of the pre-European extent of these vegetation associations respectively and as such, the remaining extent will not be significantly affected. No Beard vegetation association will have more than 1% of its remaining extent removed and the Project will not significantly affect the abundance or diversity of flora or vegetation at a local or regional level.

Environmentally Sensitive Areas, Threatened and Priority Ecological Communities

The Fortescue Marshes ESA, its buffer, the Priority 1 PEC 'Freshwater Claypans of the Fortescue Valley' and its buffer will not be directly disturbed by the Project.

Based on the development envelope, the estimated disturbance to the buffer around the 'Priority 1' PEC 'Four plant assemblages of the Wona Land System' is 1%. Disturbance resulting from the conceptual footprint is 0.09%. Although the Project area occurs within the Wona PEC buffer, it does not lie within the Wona Land System itself. The Wona Land System is located approximately 5 km north of the development envelope associated with the upgrade to Fenceline Road at its closest point. The PEC itself will; therefore, not be affected.

Impacts to significant flora

Two Priority flora species have been identified within the development envelope for the Project (Figure 28). Both Priority flora species occur within the section of the development envelope associated with Fenceline Road. Given the known locations and the linear nature of the Fenceline Road, impacts to these species can be avoided or minimised. Borrow pits will also be positioned to avoid known locations.

None of the other conservation significant flora species recorded during the Level 2 flora and vegetation assessment or during earlier surveys will be directly affected by clearing.

Impacts to mulga associations

No mulga associations occur within the area affected by the railway access road options. However, Maia (2012b, p. 94) reported two mulga associations (P1 and P2) mapped within E47/1244, M47/206, E47/339, L47/675 andL45/316 (Figure 23). Both associations were rated as highly conservation significant.

The total area of these associations surveyed by Maia (2012b) is 6225.36 ha and 822.22 ha respectively. In the context of the development envelope, the maximum impacts to these associations are 18.9% and 0.34% respectively.

Association P2 is known to occur outside of the survey area (Maia 2012, p. 90).

Based on the conceptual disturbance footprint (Figure 23), impacts to community P1 are low at 5.91%. Impacts to this community will be minimised as far as possible through final detailed design, particularly along the Fenceline Road alignment. The community is also associated with the Jamindie land system that extends east from the survey area to the Roy Hill Station. This association will extend beyond the Project area (Maia 2012b, pp. 94, 95, 105).

11.4.2 Changes to groundwater levels

The Project relates to mining above the watertable and dewatering is not required. Groundwater resources in the area will be utilised to support construction and mining operations such as dust suppression, road construction and maintenance, and camp domestic water supplies.

Minimal drawdown at the Murray's Hill mine was observed in the pumped aquifers during the tests (0.1 m drawdown in Murray 1 test bore) at discharge rates of 10 L/s (315 ML/a) which is more than adequate to meet projected water demand for mine construction activities (252 ML/a). Long-term abstraction impacts on the local groundwater regime will be evaluated following installation and comprehensive test pumping of the planned testing bores.

Maia (2012b, p. 94) identified one facultative phreatophyte: *Eucalyptus victrix* located within the creekline drainage vegetation mapping area south of the mining lease towards the Fortescue Marsh ESA and buffer. *E. Victrix* is considered to be a facultative phreatophyte which uses groundwater opportunistically.

Based on projected water demand and information available to date, abstraction rates to meet the demand for both the mine and Fenceline Road will result in minimal drawdown of the watertable (refer to Section 9). Groundwater throughflow in the mine area is conservatively estimated to be in the order of 900 ML/a, which exceeds the total annual water demand. As such, no change to the natural groundwater flow regime or water balance is anticipated (MWH 2012, p. 48). Given this, and the facultative nature of *E. Victrix,* this species is not expected to be adversely affected by the Project. However, drawdown from the proposed abstraction within the mining tenement area will be defined once test pumping has been completed at the testing bores.

The EMP will include specific measures to monitor and manage the effects of the Project on vegetation resulting from groundwater abstraction.

11.4.3 Alteration to surface water flows

The presence of mine pits, waste landforms and linear infrastructure (such as Fenceline Road) has the potential to change surface water runoff patterns and can affect downstream vegetation communities. Alteration of surface water flows from the presence of the mine and associated infrastructure are described in Section 10.

Murray's Hill mine

The diversion of flows around the mine area will have the effect of reducing volumes within the central catchment and creating a drainage shadow downstream of the mine, potentially affecting surface water dependent flora and vegetation in the area. Conservation significant vegetation at risk includes:

- mulga communities (dependent on sheet flow)
- vegetation communities associated within the Fortescue Marsh ESA.

Sheet flow within and upstream of the mining lease boundary is limited by topography and sheet flows are expected to emanate downstream of the mining lease boundary as flows move towards the sandy plains and outwash areas of the Goodiadarrie Swamp (MWH 2012, p. 9). Significant alterations to sheet flows downstream of the Murray's Hill mine as a result of the Project are; therefore, not expected.

Surface water diverted from the mine site area will be re-directed to the nearest existing drainage lines through the use of drainage controls to spread and slow runoff of surface water and reinstate natural drainage patterns within a short distance downstream of the mine and associated infrastructure.

Fenceline Road

Sheet flows are expected to emanate downstream from the Fenceline Road alignment as flows move towards the sandy plains and outwash areas of the Goodiadarrie Swamp (MWH 2012, p 33).

Further investigations will be undertaken to identify any catchments that display sheet flow characteristics and surface water flows will be managed to minimise adverse effects upstream or downstream of the road alignment through appropriate engineering design.

Accommodation camp and access road

The accommodation camp occupies 0.09 km^2 within is a small catchment of 0.16 km^2. There will a very small upstream catchment for the camp and minimal diversion of surface flows will be required (MWH 2012, p. 33)

Railway access road

Due to the location and nature of the catchments within which railway access roads are located, sheetflow is not expected to be a predominant form of runoff for these catchments (MWH, p 33).

Further investigations will be undertaken to identify any catchments that display sheet flow characteristics and surface water flows will be managed to minimise adverse effects upstream or downstream of the road alignment through appropriate engineering design.

11.4.4 Increased sediment load

The proposed mining operations will create ground disturbances that have the potential increase the sediment loads transported in rainfall runoff. These increased sediment loads may cause infilling of pools and smothering of vegetation in the downstream channels, floodplains and other sensitive ecological areas. Surface water quality in the Pilbara tends to be naturally dominated by high sediment loads during significant rainfall events.

The approximate area of disturbance, estimated from the mine pit and waste dump outlines, is 5.8 km^2. Any effects on water quality resulting from mining operations will be minimal due to the small percentage (0.2%) of total area occupied by the mining activities within the regional catchment area (MWH 2012, p. 36).

A Minesite Stormwater Management Strategy will be developed for diversion channels to divert upstream surface water flows around the mine site area and into the downstream receiving environment. Stormwater diversion will be designed and maintained to control erosion and downstream sedimentation. Run-off from within the site will be contained and treated within sedimentation ponds to reduce sediment and particulates prior to being release to the environment.

11.4.5 Dust generation

Dust generated during earthworks and vehicle movements may potentially have physical effects on plants. Vegetation located close to roads, excavation areas and other sources of dust is more likely to be affected. HPPL will implement appropriate dust management strategies to minimise dust generation resulting from the Project. The proposed control measures should ensure that the effect of dust emissions on vegetation and flora is minimal. This factor will be controlled under the 'prescribed premises' works approval and associated licence under Part IV of the EP Act.

Dust emissions and proposed management actions are addressed in more detail in Section 15.3.

11.4.6 Spread of weeds

A total of 15 environmental weed species have been recorded in the areas surveyed, none of which occur on any of the national weed lists or are listed as a Declared Plant under the *Agriculture and Related Resources Protection Act 1976.*

Increased disturbance in the Project area through clearing or vehicle usage increases the risk that weeds present will spread into new areas and/or new species will be introduced.

The occurrence of weeds, particularly Kapok Bush, Buffel Grass and Birdwood Grass is expected in areas of disturbance; however, broader occurrences of weeds in and around the Project area will be controlled to minimise the risk of spreading the weed infestation.

The potential for environmental degradation resulting from the introduction and spread of weeds can be mitigated via implementation of appropriate measures that will be outlined in the EMP. The key management measures that will be adopted are described in Section 11.5.2.

11.4.7 Increased incidence/frequency of fire

Construction and mining activities may provide ignition sources resulting in an increase in the risk of fire. Increased vehicular traffic and personnel movement during construction and operation will also increase the risk of accidental outbreaks of fire in adjacent vegetated areas. This may lead to an increase in fire frequency and/or intensity in these areas, that can favour the establishment of weeds and prevent the regeneration of (or destroy) native vegetation.

A fire management regime will be implemented as part of the Project, which is outlined in Section 11.5.3 and will be addressed in an EMP.

11.5 Management measures and performance standards

11.5.1 Vegetation and flora protection measures

HPPL will implement the following management measures in order to minimise potential impacts flora and vegetation within the Project area:

- vegetation clearing will be minimised so that only areas that are considered absolutely necessary for safe construction and operation are cleared
- existing access tracks and cleared areas will be utilised where possible to minimise clearing
- clearing will be managed through an internal ground disturbance permit (GDP) procedure
- boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries and provided to dozer operators
- no unauthorised clearing will be permitted and clearing beyond approved limits will be reported using the Environmental Incident/Non-conformance Report
- ground disturbance or access will be limited to the extent absolutely necessary within the buffer of the Priority 1 PEC ‘Four plant assemblages of the Wona Land System’
- all employees/contractors will be inducted on the importance of significant vegetation and flora, minimising vegetation clearing and disturbance, and “no access” areas
- a significant flora and weed identification guide will be made available for all employees and contractors
- areas disturbed for construction but not required for permanent infrastructure will be rehabilitated as soon as practicable after use
- following rehabilitation, areas will be monitored and treated for weeds
- revegetation and rehabilitation activities within the mine area will be undertaken as per the EMP and closure planning

- vegetation and topsoil will be stripped and immediately placed on areas to be rehabilitated or stockpiled for later use in rehabilitation.
- vegetation will be stockpiled in windrows or used as cover on topsoil stockpiles
- vehicles and machinery will only use designated tracks/roads
- appropriate dust suppression methods will be implemented where necessary to minimise dust lift-off
- a Minesite Stormwater Management Strategy will be developed to manage surface water flows around the mine site area and minimise downstream effects.

In the event that the Project is not assessed under the EP Act, HPPL will apply to the DMP for a Clearing Permit under the EP Act for any clearing associated with the Project. Under this process, native vegetation proposed to be cleared will be assessment against the ten clearing principles under the Environmental Protection (Clearing of Native Vegetation) Regulations 2007. Disturbance to flora and vegetation resulting from the Project can be managed and regulated through conditions applied to the Clearing Permit.

11.5.2 Weed control measures

Weeds will be managed in accordance with the EMP that will be developed for the Project. The management plan will address the following key management measures:

- use of existing baseline weed mapping data and routine weed inspections
- areas of high risk for weeds will be flagged and signposted
- construction corridor access will be restricted to signposted hygiene points
- appropriate weed hygiene measures will be undertaken, particularly in high risk areas
- clearing will be carried out in weed-free areas prior to infested areas, where practicable
- construction areas containing weeds will be sprayed to reduce seed loads in topsoil, where appropriate
- environmental induction training of the workforce to include identification of weed species, reporting of infestations and hygiene procedures to prevent the introduction and spread of weeds
- ensuring vehicles, machinery and materials on site adhere to weed, disease and pest hygiene requirements
- minimising site disturbance by preventing unnecessary clearing of vegetation, particularly in areas adjacent to creeklines and drainage lines.

11.5.3 Fire

The risk of fire and subsequent impacts will be reduced through the following measures:

- undertaking basic fire awareness and fire fighting training for appropriate personnel prior to commencing work
- providing appropriate fire fighting equipment (e.g. fire extinguishers) on site and in all vehicles at all times
- maintaining fire fighting equipment to comply with relevant fire safety standards
- maintaining adequate fire breaks across the Project area and around working areas, where appropriate
- checking vehicle undersides for any material stuck around exhaust manifolds and removing it as part of normal vehicle check routines
- conducting hot work activities (e.g. welding, grinding, flame cutting) in areas clear of flammable material
- paying particular attention to fire risks associated with the use of earthmoving equipment that can result in sparks
- prohibiting the burning of cleared vegetation, rubbish or open fires anywhere in the Project area.

11.6 Predicted environmental outcomes

Following the application of management measures described in Section 11.5, the Project is expected to result in the following outcomes in relation to flora and vegetation:

1. Up to 890 ha will be disturbed by the Project.
2. Clearing will not significantly affect the local or regional distribution of any vegetation community.
3. There are no Conservation Estates, Schedule One Areas or EPA Redbook Areas located within the Project area.
4. No TECs will be affected by the Project.
5. No PECs will be directly affected.
6. Groundwater drawdown from the Project will be minimal and not expected to significantly affect groundwater dependent ecosystems.
7. Conservation significant flora identified during baseline surveys are not expected to be affected as a result of the Project.
8. The potential for indirect impacts resulting from the Project are not expected to be significant and can be addressed through the implementation of appropriate engineering design and management standards and the EMP.

The Project will not significantly affect the local or regional distribution of flora or vegetation communities present and; therefore, the EPA objective for this factor will be achieved.

12. Terrestrial fauna

12.1 Relevant environmental objectives, policies, guidelines, standards and procedures

12.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals 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.

12.2 Findings of surveys and investigations

A number of vertebrate fauna surveys have been undertaken across the Project area, which are summarised in Table 27.

Table 27 Fauna surveys within the Project area and region

Title reference	Survey summary
Ecologia (2009a) *Hancock Prospecting Pty Ltd, Murray's Hill Level 1 Fauna Survey,* November 2009	This report provides details of two fauna surveys, conducted in November 2008 and August 2009, which surveyed the Exploration Lease (E47/1244), Mining Lease (M47/206), proposed Haul Road and eight Borrow Pits (L47/339 and L47/340) at Murray's Hill. The surveys conform to Level 1 surveys, comprising a desktop review and reconnaissance survey, as per EPA Guidance Statement No. 56. Principles outlined in EPA Position Statement No. 3 were also considered in the development and implementation of the study. A risk assessment was also undertaken.
Terrestrial Ecosystems (2011a) *Level 2 Fauna Assessment for the Abydos Plain Section of the Roy Hill Infrastructure Rail Corridor between Port Hedland and the Roy Hill Mine (Chainage 92 to 180)*	Terrestrial Ecosystems was commissioned by Roy Hill Infrastructure Pty Ltd to undertake a Level 2 fauna assessment of a 70 km by 2 km wide section of corridor on the Abydos Plain (starting approximately due west of Gillam Siding and ending at the southern edge of the Abydos-Woodstock Reserve; chainage 92 to 180) section of the proposed rail line. The survey area overlaps the majority of the Coonarrie railway access road within the Abydos-Woodstock Reserve.
Terrestrial Ecosystems (2011b) *Assessment of the presence of Northern Quoll (Dasyurus hallucatus) on the Abydos-Woodstock Section of the Roy Hill Infrastructure Railway (Chainage 92 to 180)*	Terrestrial Ecosystems was commissioned by Roy Hill Infrastructure Pty Ltd to undertake a survey focussed on identifying areas where Northern Quoll should be trapped and translocated prior to vegetation clearing for the construction of the railway.
Terrestrial Ecosystems (2013) *Preliminary Vertebrate Fauna Investigation for the Mulga Downs Project*	This investigation provided an indication of the vertebrate fauna assemblages in the vicinity of the Project; identified gaps in knowledge of the vertebrate fauna within or adjacent to the Project area; identified potential risks and cumulative impacts on the listed fauna; and describing what additional vertebrate fauna assessments and surveys are required.
Ecologia (2009b) *HPPL Murray Hills Short Range Endemic Pilot Survey*	Ecologia undertook a Level 2 survey of potential short range endemic (SRE) fauna at the proposed Murray's Hill mine site. This included wet and dry pit trapping at 15 sites. The specimens collected belonged to genera, which are known elsewhere in Australia, and none were confirmed to be short-range endemic species.

Title reference	Survey summary
Phoenix Environmental (2010) *Short-range Endemic Invertebrate Fauna Survey at Murray's Hill Transport Corridor*	Phoenix undertook a Level 2 survey for potential SREs along the Murray's Hill transport corridor. The study considered that there were few landscape and biogeographical features within the study area that would drive short-range endemism. Two species considered likely to be a SRE and one possible SRE species were recorded outside the disturbance area.
Biologic (2012) *Short-range Endemic Invertebrate Impact Assessment – Mulga Downs Project*	Biologic undertook a cumulative impact assessment on terrestrial SREs in the Project area and surrounds, taking into account other infrastructure projects within the region.

Most recently, Terrestrial Ecosystems was engaged to undertake a detailed Level 2 fauna survey within tenements M47/206, L47/339, L45/316, L47/675 and the majority of E47/1244 (fauna survey area) in November 2012 (Terrestrial Ecosystems (2013). The survey included:

- fauna habitat mapping
- targeted survey for Northern Quolls, Mulgara, Bilbies, Pilbara Leaf-nosed Bats, Ghost Bats and Pilbara Olive Pythons
- generic vertebrate fauna trapping program
- assessing the possible presence of Northern Quoll, Mulgara and Bilbies within the Project area (Terrestrial Ecosystems 2013, pp. 5-6).

The survey report is provided as Appendix 5.

12.2.1 Fauna habitat

A habitat assessment has been undertaken based on species likely to be present in each land system occurring within the fauna survey area (Figure 29). Specific assessment was undertaken by Terrestrial Ecosystems (2013) to determine potential habitat for Northern Quoll, as this was considered the conservation significant species most likely to be affected by the Project (Figure 30). Areas already cleared were also identified based on vegetation mapping undertaken by Maia (2012b).

12.2.2 Occurrence of vertebrate fauna

Murray's Hill mine and Fenceline Road

Terrestrial Ecosystems (2013) identified 395 species that have the potential to be present within the fauna survey area, comprising 197 birds, 135 reptiles, 52 mammals and 11 amphibians. Field surveys recorded the presence of 124 native vertebrate species and one introduced species (Terrestrial Ecosystems 2013; Ecologia 2009a). An additional 17 species were recorded by Ecologia (2009a).

Table 28 Fauna species recorded - Murray's Hill mine and Fenceline Road

Group	Number of potential species	Number of recorded species
Reptiles	135	45
Mammals	52	17
Amphibians	11	0
Birds	197[1]	79
Introduced species	-	1
Total Species	395	142

[1] Many birds are shore or water birds associated with the proximity of the Project to Fortescue Marsh and are not expected to be seen in the Project area.

Reptiles

The 2013 trapping program recorded 34 species of reptiles with an additional six observed during site searches (Terrestrial Ecosystems 2013, p. 51). Few elapids and varanids were caught, which is expected for carnivorous predators. No conservation significant reptiles were caught during the trapping program (Terrestrial Ecosystems 2013, p. 19).

Skinks and geckos were the most abundant reptile families caught.

Mammals

Of the 52 mammal species potentially present in the fauna survey area, six native species were caught through the 2013 trapping program (Terrestrial Ecosystems 2013). However, an image of the Common Rock-rat was recorded by a motion sensitive camera and Pebble-mound Mice mounds were also recorded at multiple locations (Terrestrial Ecosystems 2013, p. 21, 51). Seven bat species were identified through call detection (Terrestrial Ecosystems 2013, p. 51).

The overall number of small mammals caught was considered very low. No conservation significant mammals were caught during the 2013 trapping program (Terrestrial Ecosystems 2013, p. 21).

Seven species of bats were recorded, all of which are common in the Pilbara. Six species were recorded in all habitat types surveyed (Terrestrial Ecosystems 2013, p. 21, 51).

Targeted searches were conducted for Northern Quoll, Bilbies and Mulgara. No Bilby burrows, diggings or scats and no Mulgara burrows were found during the fauna habitat assessment. It was concluded that no Bilbies or Mulgara are present in the fauna survey area. An image of a Northern Quoll was recorded by a motion sensitive camera and scats were found at three locations (Terrestrial Ecosystems 2013, p. 31).

Pilbara Leaf-nosed Bats and Ghost Bats were not recorded in the survey area during the echolocation survey. Habitat suitable for the Pilbara Leaf-nosed bat was not recorded in the fauna survey area; however, potential roost sites were present for the Ghost Bat (Terrestrial Ecosystems 2013, p. 31).

Amphibians

Eleven species of amphibians are potentially found in the fauna survey area all of which are abundant and widespread in the Pilbara. No amphibians were captured during the fauna survey. This was expected given the high maximum daily temperature (40˚C) and the lack of rain (Terrestrial Ecosystems 2013, p. 18).

Birds

Sixty eight species of birds were recorded during the 2013 surveys with an average of six species recorded at each site (Terrestrial Ecosystems 2013, p. 22). A further nine species were added through incidental observations. Four conservation significant species were recorded: Grey Falcon, Rainbow Bee-eater, Bush Stone-curlew and Australian Bustard (Terrestrial Ecosystems 2012, p. 23).

Railway access road

Terrestrial Ecosystems (2011a) undertook a fauna assessment for the Abydos Plain section of the Roy Hill Infrastructure Railway (Chainage 92-180). The results of this survey have been used to infer the fauna assemblage that may be present within the area of the railway access road options (Table 29).

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Mulga Downs Project
Figure 29
Fauna habitat

650000 655000 660000 665000 670000 675000 680000 685000

7555000

7550000

7545000

7540000

MCK NEW BGD JAM JUR HOY BRO ROC WON BNY CAL COB CWA FAN CHR

Mulga Downs Road

Great Northern Highway

Legend

- Major road
- Development Envelope
- HPPL Tenements
- Access road
- Mine
- Existing cleared areas
- Fenceline road
- Waste dump
- Infrastructure
- Camp track (30m wide)
- Camp
- Borrow areas
- Fauna survey boundary

Landsystems

BGD, BNY, BRO, CAL, CHR, COB, CWA, FAN, HOY, JAM, JUR, MCK, NEW, ROC, WON

N

0 1.5 3

Kilometres

Datum GDA 94 MGA Zone 50

prepared by: jcrute

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Mulga Downs Project
Figure 30
Potential Northern Quoll habitat

650000 655000 660000 665000 670000 675000 680000 685000

7560000 7555000 7550000 7545000 7540000

Mulga Downs Road

Great Northern Highway

Legend

- Major road
- Minor road
- Development Envelope
- Access road
- Mine
- Fenceline road
- Northern Quoll habitat
- Waste dump
- Infrastructure
- Camp track (30m wide)
- Camp
- Borrow areas
- Fauna survey boundary

N

0 1.5 3

Kilometres

Datum GDA 94 MGA Zone 50

prepared by: jcrute

Table 29 Fauna species recorded during field surveys over the railway access road area

Group	Number of recorded species
Reptiles	55
Mammals	7
Bats	5
Amphibians	7
Birds	62
Total Species	136

The list of small trappable reptiles, mammals and amphibians recorded was comparable with other vertebrate fauna surveys in adjacent areas. The number of mammals caught was low, attributable to seasonally dry conditions over the preceding years. The reptile assemblage was likely to be distorted due to the closure of traps during the day. The number of bird species was less than expected, again possibly because of depleted food resources due to dry seasons in preceding years, and heavy rainfall in inland arid areas (Terrestrial Ecosystems 2011a, p. iv).

12.2.3 Conservation significant fauna

Based on database searches a total of 33 conservation significant species have the potential to occur in the Project area (Terrestrial Ecosystems 2011; 2013). Of these, 14 species are listed under the EPBC Act and 15 species are listed under the WC Act. Eighteen species are also listed as Priority species by the DEC.

The potential effect of the Project on these species has been inferred from an assessment of its relative abundance in the area; its potential to move from the area; its retreat site(s) and its ecology (Terrestrial Ecosystems 2011; 2013).

Six conservation significant species of birds (two considered infrequent visitors), five species of mammals and three species of reptiles are considered likely to be found in the area of the Murray's Hill mine and Fenceline Road (Table 30). Based on the survey of the Roy Hill Infrastructure Railway, a total of 16 conservation significant species comprising eight mammals, five birds, and three reptiles may be found in the area of the railway access road (Terrestrial Ecosystems 2011, Roy Hill 2010).

12.2.4 Short-range endemics

A pilot survey of short-range endemic (SRE) species at Murray's Hill mine was undertaken by Ecologia in 2009. The survey comprised 15 sites, which focussed on available microhabitats within key geological features and areas of dense vegetation. Wet pitfall trapping was supplemented by opportunistic sampling with dry pitfall traps and excavation (Ecologia 2009b).

Phoenix Environmental Services (Phoenix) was also engaged by HPPL in 2010 to undertake a survey of SREs over a proposed haul road from Murray's Hill mine to the Great Northern Highway, including miscellaneous lease 47/339.

Most recently, Biologic (2012) undertook a literature and database review and impact assessment of SRE invertebrate fauna of the Project area and surrounds. The impact assessment drew on the findings of the surveys by Ecologia (2009b) and Phoenix (2010) together with seven other surveys previously undertaken within a defined regional impact area.

The cumulative impact assessment undertaken by Biologic (2012) resulted in the following conclusions:

- there are no known, likely or potential SRE fauna recorded from, or within the vicinity of, the Project area
- the Project is not expected to directly affect habitat that may be suitable for SRE invertebrate fauna
- a system of ridges and gullies located to the north of the Project area may provide suitable habitat (Figure 31). This habitat will not be directly affected; however, the location of the camp and access road may result in a potential dispersal barrier (Biologic 2012, p. 40).

A copy of the impact assessment report is provided as Appendix 6.

Table 30 Conservation significant species in the area of the Project

Species (Common name)	EPBC Act	Conservation status WA	Likelihood of occurrence	
			Murray's Hill mine and Fenceline Road	Railway access road [8]
Western Pebble-mound mouse		P4	Present. Active and in-active mounds were located in the Project area	Possible. Mounds are present in the area.
Bush Stone-curlew		P4	Present. This species was heard calling in the area.	Possible. This species has been recorded in the area.
Rainbow Bee-eater	M	Sc3	Present. This species has been recorded in the area.	Possible. Recorded during surveys of the area.
Australian Bustard		P4	Present. This species has been recorded in the area.	Possible. Recorded during surveys of the area.
Grey Falcon		P4	Present. This species has been seen in the area.	Unlikely. No Grey Falcons were seen in the survey of the area.
Northern Quoll	EN	Sc1	Present. One individual was recorded during a survey of area.	Possible. Targeted surveys recorded this species in the area.
Pilbara Olive Python	VU	Sc1	Possible. While not recorded, habitat considered suitable for this species occurs in the area.	Possible. This species has been seen in the area.
Ghost Bat		P4	Possible. Ghost bats may forage in the area.	Possible. Ghost bats calls have been recorded in the area.
Ctenotus nigrilineatus		P1	Possible. This species was not recorded during surveys but may be present in the area.	Possible. This species was not recorded during surveys but may be present in the area.
Ramphotyphlops ganei		P1	Possible. This species was not recorded during surveys; however, the species known from the Hamersley and Chichester Ranges.	Possible. This species was not recorded during surveys but may be present in the area.
Long-tailed Dunnart		P4	Possible. This species was not recorded but may be present in areas of stony and rocky areas, and breakaways.	Possible. Records exist within the general area.
Northern Short-tailed Mouse		P4	Possible. This species was not recorded during surveys; however, it has been recorded in similar habitats.	Possible. Records exist within the general area.
Peregrine Falcon		Sc4	Infrequently. These species are known from a variety of habitats in the vicinity of the Fortescue Marsh and Fortescue River.	Possible. This species was not recorded during the survey but may be present in the area.
Fork-tailed Swift	M	Sc3	Infrequently. Although this species was not recorded in the Project area it has been recorded in other surveys in the bioregion.	Possible. This species has been recorded in the area.
Pilbara Leaf-nosed Bat	VU	Sc1	Unlikely. Pilbara Leaf-nosed Bat and their preferred habitat were not recorded in the area.	Unlikely. Calls were not recorded during surveys however, they may be found around granite outcrops.

[8] Discussion on the likelihood of occurrence of conservation signification species in the area of the railway access road options are based on the Terrestrial Ecosystems (2011a) fauna assessment for the Abydos Plain section of the Roy Hill Infrastructure Railway (Chainage 92-180).

Species (Common name)	EPBC Act	Conservation status WA	Likelihood of occurrence	
			Murray's Hill mine and Fenceline Road	Railway access road [8]
Bilby	VU	Sc1	Unlikely. Bilbies were not recorded in the Murray's Hill mine and Fenceline Road area and the habitat was generally unsuitable for this species.	Possible. No active Bilby burrows were detected during the RHI survey of the Abydos Plain section of its rail corridor; however, old holes were recorded and they could be present within the Abydos-Woodstock section of the RHI rail corridor. However, habitat considered 'very suitable' for Bilby is not present in the area of the railway access road options.
Mulgara	VU	Sc1	Unlikely. Mulgara were not recorded in the area.	Possible. Mulgara tracks were recorded in the northern portions of the RHI rail corridor during the conservation significant fauna habitat assessment. Mulgara are therefore probably locally abundant within the Abydos-Woodstock section of the RHI rail corridor. However, habitat considered 'very suitable' for Mulgara is not present in the area of the railway access road options.
White-bellied Sea-eagle	M	Sc3	Unlikely. The White-bellied Sea-eagle is mostly a coastal species that has also been recorded in the vicinity of the Fortescue Marsh.	No
Western Star Finch		P4	Unlikely. There is little to no suitable habitat in the Project area.	Unlikely. Not seen during the survey of the area.
Great Egret	M	Sc3	Unlikely. There is little to no suitable habitat in the Project area.	Unlikely. Not seen during survey of the area.
Cattle Egret	M	Sc3	Unlikely. There is little to no suitable habitat in the Project area.	Unlikely. Not seen during surveys of the area.
Oriental Plover	M	Sc3	Unlikely. There is little to no suitable habitat in the Project area.	No
Oriental Pratincole	M	Sc3	Unlikely. There is little to no suitable habitat in the Project area.	No
Night Parrot	CR	Sc1	Unlikely. The proposed mining area and haul road represent a small fraction of similar habitat in the Pilbara bioregion. There is no evidence to indicate that the Project area is important habitat for the Night Parrot. This species may infrequently be seen in the Pilbara Bioregion, but the Project is not expected to have a significant effect on this species.	Unlikely. Not recorded in surveys of the area. This species may infrequently be seen in the general area, but the Project is not expected to have a significant effect on this species as it will readily move into adjacent areas.
Fortescue Grunter		P4	No suitable habitat for this fish species found in the Project area.	Unlikely to be found on the Abydos Plain.
Black-flanked Rock-wallaby	VU	Sc1	No suitable habitat for this species found in the Project area.	Unlikely. No Black-flanked Rock-wallabies were seen during the RHI survey of the Abydos Plain and they are not expected to be present in this section of the RHI rail corridor.
Little Northern Freetail-bat		P1	Will occasionally overfly Project area, but will not utilise it directly.	Unlikely. Given the lack of suitable habitat, this species is not expected to be recorded in the Project area.
Lerista planiventralis maryani		P1	No suitable habitat for this species found in the Project area.	Unlikely. Site is outside the known range of this species, which is between Onslow and Barradale.

Species (Common name)	EPBC Act	Conservation status WA	Likelihood of occurrence	
			Murray's Hill mine and Fenceline Road	Railway access road [8]
Lerista quadrivincula		P1	No suitable habitat for this species found in the Project area.	Unlikely. *Lerista quadrivincula* is known from a single population about 25 km south-east of the Karratha homestead, which is outside of RHI rail corridor.
Lerista macropisthopus remota		P2	No suitable habitat for this species found in the Project area.	Unlikely. Known records are to the east or south-east of Newman, so this species is not expected to be found in the RHI rail corridor.
Spectacled Hare-wallaby		P3	No suitable habitat for this species found in the Project area.	Possible. No Spectacled Hare-wallabies were seen during the RHI survey of the Abydos Plain, but based on earlier records it could be found in the RHI rail corridor.
Flock Pigeon		P3	No suitable habitat for this species found in the Project area.	Unlikely. The Flock Pigeon is not expected to be seen in the Abydos Plain. This species is not expected to be significantly affected by construction activities as the species will move to adjacent areas if disturbed.
Princess Parrot		P4	No suitable habitat for this species found in the Project area.	Unlikely. No Princess Parrots were seen during the RHI bird survey of the Abydos Plain.

[1] Conservation significance: M = migratory; VU = vulnerable; CR = critically endangered; EN = endangered; P1 = Priority 1; P2 = Priority 2; P3 = Priority 3; P4 = Priority 4; Sc1 = Schedule 1; Sc3 = Schedule 3; Sc4 = Schedule 4.

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Mulga Downs Project
Figure 31
Short-range endemics potential ridge and gully habitat

650000 655000 660000 665000 670000 675000 680000 685000

7555000

7550000

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Mulga Downs Road

Great Northern Highway

Legend

- Major road
- Minor road
- Development Envelope
- HPPL Tenements
- Access road
- Mine
- Fenceline road
- Waste dump
- Infrastructure
- Camp track (30m wide)
- Camp
- Borrow areas
- Potential ridge and gully habitat

N

0 1.5 3

Kilometres

Datum GDA 94 MGA Zone 50

prepared by: jcrute

HPG12172_02_R003_RevD_F031_A3

12.3 Potential sources of impact

Potential direct and indirect effects of the Project on fauna include:

- **loss and fragmentation of habitat** from vegetation clearing resulting in a direct loss of species, and reduced breeding and foraging habitat
- **increased injuries and mortalities** from vehicle movements, infrastructure, machinery and the workforce
- **degradation of habitat** from altered hydrological regimes, increased human access, noise, dust and weed invasion
- **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
- **introduction of feral 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.

12.4 Assessment of likely direct and indirect impacts

12.4.1 Loss and fragmentation of habitat

Habitat quality in the fauna survey area varies from highly disturbed to high quality. The fauna habitats present in the fauna survey area are similar to those in adjacent areas. The fauna assemblages in these habitats are also likely to be similar to that in found in adjacent areas (Terrestrial Ecosystems 2013, p. viii).

Vegetation clearing required for the Project will result in the loss of up to 890 ha of fauna habitat. The effect of this disturbance will generally be localised when placed in a bioregional context. The fauna habitats within the Project area support a range of fauna species. Several conservation-significant fauna species have the potential to occur in the Project area (Table 30).

Clearing can result in fragmentation of habitats and lead to the inability of individuals to move between areas of habitat. Predation events can also increase as individuals move across cleared areas. In addition, raised linear structures such as haul roads may potentially:

- partition existing activity areas and home ranges
- isolate sections of established communities
- alter long and medium-term patterns of movement around established home ranges particularly for small mammals and reptiles (Terrestrial Ecosystems 2013, p. 46).

Clearing for the Murray's Hill mine and Fenceline Road will predominantly occur in the flat plains of the Jamindie land system, with small amounts of clearing in the Newman and McKay land systems (Figure 9). Vegetation in the Jamindie land system includes mulga woodland over bare ground, or a mosaic of low shrubs and annual grasses or spinifex (Terrestrial Ecosystems 2012, p. vii). Indicative borrow pit locations are predominantly located along the boundary between the Jamindie and Newman land systems (Figure 9). Species that prefer mulga woodland and mosaic low shrub and grasses ecosystems are more likely to be affected by the Project.

The potential effects of the Project on conservation significant species likely to occur within the Project area are described in Table 31 (Terrestrial Ecosystems 2013 – unless otherwise indicated).

Table 31 Predicted effects of clearing on conservation significant vertebrate fauna species

Species (Common name)	Status	Habitat	Potential effect
Western Pebble-mound mouse	P4	Rocky hill slopes covered with spinifex and supporting a surface layer of regularly-sized pebbles (Ecologia, 2009, p. 22).	Some Pebble-mound Mice may be affected during clearing, but this is not expected to have a significant effect on the survival of the species in the bioregion.
Bush Stone-curlew	P4	Lightly wooded areas adjacent to the preferred daytime shelter of thickets or long grass (Ecologia, 2009, p. 28).	The Bush Stone-curlew can readily move to adjacent areas and vegetation clearing in the Project area is therefore not expected to cause a significant impact. The distribution of this species will not be affected by the Project given the broader distribution of habitat and limited extent of disturbance of habitat. The conservation status of this species will not be affected by the Project.
Rainbow Bee-eater	Sc3 M	Open country of most vegetation types, with dunes, banks suitable for construction of breeding tunnels (Ecologia, 2009, p. 28).	Rainbow Bee-eaters are able to move away from a disturbance. This species is migratory, abundant and wide-spread and any effects are expected to be negligible, particularly given that there are no permanent water bodies within the Project area. The conservation status of this species will not be affected by the Project.
Australian Bustard	P4	Open grasslands, chenopod flats and low heathland (Ecologia, 2009, p. 28).	Clearing is not expected to significantly affect this species as it will readily move to other areas that have similar habitat. The most significant effect on Australian Bustards would be destroying a nest containing eggs or chicks during the vegetation clearing process. The conservation status of this species will not be affected by the Project.
Grey Falcon	P4	Lightly wooded coastal and riverine plains (Ecologia, 2009, p. 28).	This species is not expected to be significantly affected by the Project as it can readily move to other areas. The most significant effect on the Grey Falcon would be destroying a nest containing eggs or chicks during the vegetation clearing process. The conservation status of this species will not be affected by the Project.
Northern Quoll	Sc1 EN	Gorges, rocky escarpments, ephemeral rivers and creek lines bordered by mature trees (Terrestrial Ecosystems 2012, p. 34).	Northern Quolls are present in the rocky hills and breakaways in the northern area and eastern end of the Fenceline Road corridor. A total of 1232 ha of potential Northern Quoll habitat has been mapped at the mine site and Fenceline Road by Terrestrial Ecosystems (Terrestrial Ecosystems, 2012, Figure 6). Of this, less than 1% is anticipated to be disturbed by the Project. Targeted surveys were undertaken along the Abydos Plain section of the RHI rail corridor. The survey recorded two areas as containing a low density of Northern Quolls, both of which are located north of the proposed access roads. Based on the outcomes of this survey, the area within which the access road options are located was not found to support Northern Quoll. The Project is not expected to have a significant effect on this species given the broad distribution of the northern quoll habitat in the Pilbara bioregion and the relatively small scale of clearing of habitat considered suitable for this species. The conservation status of this species will not be affected by the Project.

Species (Common name)	Status	Habitat	Potential effect
Pilbara Olive Python	Sc1 VU	Rocky areas, rocky outcrops and cliffs, particularly in the vicinity of watercourses and water holes (Terrestrial Ecosystems 2012, p. 38).	Habitat that is suitable for Pilbara Olive Python includes the rocky areas on the northern edge of the Project area, and the rocky outcrops on the eastern end of the haul road corridor to the Great Northern Highway. This habitat is similar to that of the Northern Quoll. No Pilbara Olive Pythons, their scats or skins were recorded during the survey, however, there is likely to be a small number of these pythons present in the northern section of the Project area. As for Northern Quoll, limited areas of clearing (less than 1% of the mapped habitat within the survey area) are anticipated. This species was also not recorded within the RHI rail corridor. Potential impacts on Pilbara Olive Pythons include vegetation clearing, injuring or killing individuals on tracks and roads, being killed when mistaken for venomous snakes and injuring or killing pythons that have crawled into infrastructure. Avoidance of critical habitat will also be achieved through engineering for the haulage roads that will be designed to avoid very rocky landscape. These impacts are not expected to be significant when considered in a regional context. The conservation status of this species will not be affected by the Project.
Ghost Bat	P4	Roost in caves beneath bluffs of low rounded hills and granite rock piles in the eastern Pilbara (Terrestrial Ecosystems 2012, p. 40).	Ghost Bats may forage in the Project area and potential roost sites for this species were also present in the 2013 survey area. This species will be affected by the Project if a maternal roost is disturbed. The conservation status of this species will not be affected by the Project.
Ctenotus nigrilineatus	P1	Known only from spinifex at the base of rocky outcrops (Coffey Environments 2011, p. 20).	A potential effect on *C. nigrilineatus* is injuring or killing individuals during clearing. The Project area does not constitute a major proportion of their known geographical distribution, so the potential effects are likely to be low. The conservation status of this species will not be affected by the Project.
Ramphotyphlops ganei	P1	Little known about habitat preferences. Previously has been found in clay/loam with spinifex (Ecologia 2009, p. 29).	Some individuals could be adversely affected during clearing. However, this is not expected to be significant in a bioregional context. The conservation status of this species will not be affected by the Project.
Long-tailed Dunnart	P4	Little known of habitat preferences. The species has been recorded in plateaux of boulders and stones near breakaways and scree slopes, vegetated with mulga and spinifex as well as in open mulga woodland (Terrestrial Ecosystems 2013, p, 39).	Some Long-tailed Dunnarts could be affected during clearing; however, this is not expected to significantly affect the long-term survival of this species. This species is likely to be abundant in adjacent areas of similar habitat. The conservation status of this species will not be affected by the Project.
Northern Short-tailed Mouse	P4	This species has been recorded from diverse habitats ranging from the monsoon tropic coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, acacia shrublands, tropical eucalypt and melaleuca woodlands and stony ranges (Ecologia 2009, p. 31).	This species is likely to be abundant in adjacent areas of similar habitat and therefore the Project is not expected to significantly affect the long-term survival of this species. The conservation status of this species will not be affected by the Project.
Peregrine Falcon	Sc4	Predominantly seen about cliffs along coasts, rivers and ranges and wooded watercourses and lakes. The species has also been recorded on the Fortescue Marsh and adjacent Fortescue River (Terrestrial Ecosystems 2013, p, 36).	Peregrine Falcons are not expected to depend on the Project area for their survival and have the capacity to move away from a disturbance. The Project is not expected to affect the distribution of this species. The conservation status of this species will not be affected by the Project.

Species (Common name)	Status	Habitat	Potential effect
Fork-tailed Swift	Sc3 M	Migratory, aerial species that fly from ground level to at least 300 m above ground. In Australia, they predominantly occur above coastal areas and inland plains (DSEWPaC 2012).	This species mostly forages in the air, and will readily move away from a disturbance. The species is not expected to be affected by the Project. The conservation status of this species will not be affected by the Project.
Bilby	VU Sc1	Largely restricted to the inland sandy deserts in two broad habitat types; mulga woodlands with lateritic red earth and spinifex grasslands with high fire frequency, again with the red earth, where soils are suitable for burrow digging (Terrestrial Ecosystems 2013, p, 33).	Bilbies were not recorded in the Murray's Hill mine and Fenceline Road area and the habitat was generally unsuitable for this species. Habitat considered 'very suitable' for Bilby is not present in the area of the railway access road options (RHI 2010). The potential effects on this species are low.
Mulgara	VU Sc1	Sandy areas containing moderately dense spinifex (Ecologia 2009, p. 89).	Mulgara were not recorded in the Murray's Hill mine and Fenceline Road area. Habitat considered 'very suitable' for Mulgara is not present in the area of the railway access road options (RHI 2010). The potential effects on this species are low. Given the extent of clearing associated with the railway access road, if this species is present in the Project area, clearing will not have a significant effect on this species.
Spectacled Hare-wallaby	P3	Hummock grasses at a suitable seral stage (Terrestrial Ecosystems 2010, p. 5).	No Spectacled Hare-wallabies were seen during the Roy Hill Infrastructure Railway survey of the Abydos Plain, but based on earlier records it could be found in the Roy Hill Infrastructure Railway corridor. Given the extent of clearing associated with the railway access road, if this species is present in the Project area, clearing will not have a significant effect on this species. The conservation status of this species will not be affected by the Project.

Table 32 provides an assessment of potential habitat for those conservation significant species listed under the EPBC Act or WC Act within each land system in the area surveyed by Terrestrial Ecosystems (2013). Only those land systems affected by the Project area included in the assessment.

Table 32 Potential effects on fauna habitats based on land systems

Land system	Potential habitat				Area surveyed (ha)	Area within development envelope (ha)		Conceptual disturbance footprint (ha) (excluding previously cleared areas)
	Northern Quoll	Pilbara Olive Python	Mulgara	Bilby				
Jamindie	-	-	-	-	7302.21	1899.72		561.94
Newman	X	-	-	-	3829.09	737.27		153.9
McKay	X	X	-	-	567.69	366.4367.17		25.46
Boolgeeda	-	-	-	-	808.53	8.3		7.64
Coolibah	-	-	-	-	244.81	5.61		0.31
Macroy	X	X	X	X	-	Coonarrie	57.01	8.47
						Two Camel	58.53	7.23

Conservation significant species are considered unlikely to occur in the Boolgeeda and Jamindie land systems (Terrestrial Ecosystems 2013, p 53). The Newman land system is potential habitat for Northern Quoll (Terrestrial Ecosystems 2013, p 53). The McKay land system is potential habitat for Ghost Bat, Northern Quoll and Pilbara Olive Python (Terrestrial Ecosystems 2013, p 53). The Macroy land system, in which the railway access road options occur, is potential habitat for Mulgara, Bilby, Ghost Bat, Northern Quoll and Pilbara Olive Python (Terrestrial Ecosystems 2012, p 19).

Given the potential for Northern Quoll habitat to occur within the fauna survey area, additional mapping was undertaken to refine the area of habitat (Figure 30). Approximately 1232 ha of potential Northern Quoll habitat was identified within the fauna survey area. Of the total mapped area, 3.9 ha occurs within the mining lease (47/206) and is isolated within a highly disturbed area (Figure 30). Northern Quoll has not been recorded within the mining lease during the survey by Terrestrial Ecosystems (2013) or an earlier Level 1 survey undertaken by Ecologia (2009). This area is considered to be poor quality habitat and unlikely to support Northern Quoll.

A maximum of 193.89 ha out of a mapped area of 1232 ha (15.7%) of potential Northern Quoll habitat could be cleared within the development envelope. Disturbance to potential Northern Quoll habitat is largely associated with the widening of Fenceline Road. Given Fenceline Road is linear in nature and is based on a 50 m wide disturbance corridor, the Project is highly unlikely to remove more than 8.9 ha of potential Northern Quoll habitat. This equates to less than 1% of potential habitat mapped within the fauna survey area. Suitable habitat extends beyond the area surveyed.

Habitat suitable for Pilbara Olive Python is similar to that of the Northern Quoll. Habitat suitable for Mulgara and Bilby was not identified during the 2012 fauna survey (Terrestrial Ecosystems 2013, p. 29).

An additional area of up to 8 ha associated with the Macroy land system will be required for the chosen railway access road option. Habitat considered ‘very suitable’ for Mulgara and Bilby was not found in the area of the either railway access road options and this area was also found unlikely to support Northern Quoll (Roy Hill 2010, Sheet 2 of 4).

The presence of contiguous habitat surrounding the Project area is expected to substantially mitigate the significance of habitat fragmentation resulting from the Project. Fragmentation of habitat will also be minimised through progressive rehabilitation.

Fenceline Road is an existing access road that has been used for pastoral activities over several decades and; more recently, for exploration activities within E47/1244 and M47/206. The alignment is generally positioned at the transition between the Jamindie and Newman land systems and is not expected to result in fragmentation of habitat for conservation significant species found within the Newman land system to the north.

Fauna habitats and land systems in the Project area are abundant in the adjacent areas. The loss of this habitat is not expected have a significant effect on the vertebrate fauna assemblages in a bioregional context.

12.4.2 Increased injuries and mortality

Vehicle movements associated with clearing, construction and operation may result in the loss of individual terrestrial fauna (particularly less-mobile species or carrion eaters) from vehicle strikes.

The majority of vehicle movements will occur within existing service corridors and those that will be constructed as part of the Project (i.e. access/haul roads). Fenceline Road is an existing access track that will be upgraded.

The site preparation process for the service corridors may result in some fauna mortality. Precautions will be implemented to manage potential fauna loss by setting speed limits, and placing restrictions on vehicle movements. Management of potential effects on fauna will be addressed within the EMP.

12.4.3 Degradation of habitat

Habitat degradation may occur through a number of methods including, increased human access, noise, dust and weed invasion. Altered hydrological regimes due to the damming effect of roads may also affect downstream vegetation communities.

The effect of dust and weeds may affect habitat up to 100 m from roads and tracks (Terrestrial Ecology 2011a, p. 21). Management measures to minimise the spread of weeds and dust effects are further discussed in Sections 11.5.2 and 15.3 respectively.

Hydrological effects can be avoided by appropriate design and location of culverts and are discussed in Section 10. Culverts can also be designed to assist in the movement of small mammals under roads.

12.4.4 Increased fire potential

The Project may increase the risk of accidental fire in the area. Fire may result in the loss of individual species, and may destroy fauna habitat.

Fire prevention measures will be implemented to minimise the risk of fire within the Project area (refer to Section 12.4.4).

12.4.5 Introduction of feral species

The nature of any development that involves human habitation and associated domestic waste may encourage an increase in feral species in the Project area. Management measures will be implemented to minimise the presence of feral species within and around the Project area (see Section 15.3).

12.5 Management measures and performance standards

The effects of the Project on habitat will be minimised through the measures outlined in Section 11.5.1. Additional measures to minimise effects on fauna include:

- clearing will be minimised so that only areas considered necessary for safe construction and operation are cleared
- using existing access tracks in preference to constructing new ones to prevent fragmentation
- 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 and movements limited to defined tracks
- vehicle access will be limited to existing or purpose built access roads and tracks
- clearing will be managed through an internal ground disturbance permit procedure
- once activities have ceased on a cleared area it will be rehabilitated
- rehabilitation will include placing cleared vegetation and logs within the area to provide fauna refuge
- appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes
- lighting will be directed onto construction or operational areas
- contractors and staff shall be advised of specific habitat locations to avoid.

Measures for fire management will be undertaken as outlined in Section 11.5.3.

12.6 Predicted environmental outcome

After application of management measures described in Section 12.5, the Project is expected to result in the following outcomes in relation to fauna:

1. Up to 890 ha of habitat will be disturbed.
2. Conservation significant fauna are not expected to be significantly affected as a result of the Project.
3. The potential for indirect effects resulting from the Project will be insignificant and can be addressed through the implementation of engineering design standards and management actions.

The Project will not significantly affect the local or regional distribution of fauna present and; therefore, the EPA objective for this factor will be achieved.

13. Subterranean fauna

13.1 EPA objectives

The EPA applies the following objective in its assessment of proposals 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.

13.2 Findings of surveys and investigations

HPPL initially engaged Ecologia to undertake a troglofauna survey assessment within its area of exploration activities at Murray's Hill in 2009. The pilot survey identified the presence of a troglobitic community within M47/206, which led to a further survey by Ecologia (2011) in areas unaffected by proposed exploration activities.

More recently, Phoenix (2013) was engaged to undertake additional subterranean fauna surveys of the Project area. The surveys were conducted between October 2011 and January 2012 and comprised a two phase stygofauna survey and a single phase troglofauna survey in accordance with EPA Guidance Statement 54a (refer to Appendix 7).

13.2.1 Stygofauna

The survey undertaken by Phoenix (2013, p. 106) identified 24 stygofauna species from sampled bores of which 10 species were collected in both disturbance area and reference bores. A single species, *Parabathynellidae* 'MH3' was restricted to the proposed disturbance area (Phoenix 2013, p. 25). Figure 32 presents the locations of the stygofauna sampling locations during the 2011/2012 survey at Murray's Hill.

13.2.2 Troglofauna

Ecologia recorded a total of 38 specimens of potential troglobitic arthropods from 11 bores. These consisted of members of the genus *Nocticola* (cockroaches) and the order *Polyxenida* (millipedes). One confirmed troglobite was also identified from a single additional hole from the order *Diplura* (Ecologia 2009, p. 25).

Further studies by Phoenix (2013, p. 106) sampled 27 target species of which 11 were located both within and outside the proposed pit disturbance area. Figure 32 presents the locations of the troglofauna sampling locations during the 2011/2012 survey at Murray's Hill.

The majority of species were recorded from both the disturbance area and reference sites. However, six troglofauna species were found only within the proposed disturbance area:

- *Cryptops* 'MH1' – one specimen found at one impact site
- *Palpigradi* 'MH1' – one specimen found at one impact site
- *Parajapygidae* 'MH1' – two specimens found at two impact sites
- *Pauropoda* 'MH1' – three specimens found at one impact site
- *Schizomida* 'MH2' – one specimen found at one impact site
- *Troglarmadillo* 'MH1' - one specimen found at one impact site.

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Mulga Downs Project
Figure 32
Subterranean fauna sampling locations

650000 655000 660000 665000 670000 675000 680000 685000

7560000 7555000 7550000 7545000 7540000

md_kar5
md0646
md0577
md0578
md0585
md0631
Mulga Downs Road
md0671
md0672
md0673
md0385
md0499
md0525
md0495
md0612
md0533
md0599
md0601
md0482
md0596
md0609
md0562
M47/206
Murrays bore
md0247
md0330
md0253
md0258
md0371
east_reference
md0372
md0259
md0262
md0295
md0314
md0293
md_kar7
md0266
md0268
md0270
md0405
md0408
md0398
md_kar6
md0397
md0439
md0441
md0427
md0402
md0393
md0386a
md0387
md0430
md0429
md0420
md0414
md0415
md_kar4
md_kar3
md_kar1
md_kar2
Calamina bore
Browns bore
Yampire bore
Great Northern Highway
Ebathacalby bore

Legend

- Sampling locations
- Major road
- Minor road
- Development Envelope
- HPPL Tenements
- Mine
- Waste dump
- Infrastructure

N

0 1.5 3
Kilometres

Datum GDA 94 MGA Zone 50

prepared by: jcrute

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As a result of the above findings, further opinion was sought from Bennelongia (2013) on:

- the level of survey effort in relation to EPA guidelines and whether sufficient information is available to undertake risk-based assessment
- the extent of prospective habitat outside the disturbance area and the likelihood that this habitat could support similar troglofauna communities
- the likelihood that the six 'restricted' species could be found outside the impact area.

Bennelongia (2013) reported that, taking into account the number of samples and the methods adopted, the number of troglofauna samples collected was adequate for the purposes of a risk-based approach to the assessment of the impacts of the Project on troglofauna.

Further interpretation and evaluation of the distributional information in the Phoenix (2013) report and the habitat-related geological information revealed that a widely distributed troglofauna community occurs on a local scale. Bennelongia (2013) formed a view that the troglofauna community present at Murray's Hill is not restricted to a single geology and that most species known from single locations are likely to occur in multiple geologies and be more widespread within the local Murray's Hill area.

Bennelongia (2013) found that the distributions of the majority of species with multiple records in the Project survey area included both impact and reference locations, providing strong evidence of biological connectivity between the different geologies and local areas at Murray's Hill.

An assessment was also undertaken for the six 'restricted' species based on the biology of species in the same group (Bennelongia 2013, pp. 4-5):

1. *Palpigradi* 'MH1' – represented by a single animal and treated by Phoenix (2013) as a troglophile. The only described troglofaunal species known from the Pilbara (*Decapauropus tenuis)* is considered to be cosmopolitan (Scheller 2010). A troglophilic palpigrad species is highly unlikely to be restricted to the area of <1000 ha associated with mine pit development.
2. *Schizomida* 'MH2' – represented by a single animal and a troblobite. Schizomids may have ranges as small as 100 ha if their distribution is constrained by strongly defined landscape features. Within continuous but strongly dissected features, such as the Hamersley Range, known linear ranges of only a few kilometres are quite common. However, given the evidence of the whole troglofauna community in the Project survey area extending outside the haematite-geothite impact area, that Schizomida 'MH2' is considered unlikely to be restricted to this relatively small area.
3. *Cryptops* 'MH1' – represented by a single animal and treated by Phoenix (2013) as a troglobite. Information on the distribution of *Cryptops* and related genera is sparse and little can be said about the likely range of this species. The range of this species is best determined by the broad distributional characteristics of the troglofauna community in the Project area, which suggest that no species is likely to be restricted to the impact area.
4. *Parajapygidae* 'MH1' – represented by two animals from different drill holes and treated by Phoenix (2013) as a troglophile. Diplurans are considered to have moderately broad ranges for troglofauna (Halse 2010) although this view is based largely on what is known about Japygidae. However, given the troglophilic characteristics of the species, what is known about the ranges of diplurans and their common occurrence in alluvim-collovium , Parajapygidae 'MH1' is considered likely to extend beyond the haematite-geothite impact area.
5. *Troglarmadillo* 'MH1' – represented by a single animal and a troglobite. The taxonomy of isopods is poorly developed in Western Australia and many subterranean species occur with apparently small ranges and little can be said about the likely range of this species. The likely range of this species is best determined by the broad distributional characteristics of the troglofauna community in the Project area, which suggest that no species is likely to be restricted to the impact area.
6. *Pauropoda* 'MH1' - represented by a single animal and treated by Phoenix (2013) as a troglophile. Although there is evidence that pauropods are speciose in the Pilbara and probably mostly have small ranges, a troglophilic species is considered unlikely to be restricted to the relatively small area of the haematite-geothite impact area.

It was concluded that these species are likely to have ranges that extends beyond the disturbance area (Bennelongia 2013, p. 5). The advice from Bennelongia is provided as Appendix 8.

13.3 Potential sources of impact

The following effects of the Project may affect subterranean fauna values:

- **loss of habitat** from the excavation of overburden and ore and blasting
- **surface and groundwater contamination**, through the spills of hydrocarbons and discharge of wastewater, may degrade the subterranean environment
- **reduction of organic inputs** from clearing of vegetation beyond the mine footprint.

13.4 Assessment of likely direct and indirect impacts

Loss of habitat

The Project requires the development of a new AWT open pit within M47/206 (refer to Section 2) that will require removal of overburden and excavation of material for ore extraction. The excavation works will result in the removal of potentially suitable subterranean fauna habitat.

Excavation activities and the use of blasting methods in mining can also generate vibration, potentially altering the surrounding geology. This may result in a reduction in availability of habitat through compacting and collapsing of cavities.

Mining will occur above the watertable and dewatering will not be required. The results of stygofauna sampling also indicated lateral connectivity and transmissivity of the aquifer (Phoenix 2013, p. 2). This is further supported through available hydrogeological data that suggests a connection exists between recent alluvial deposits, the underlying mineralised detritals and the upper mineralised Marra Mamba Formation (MWH 2012, p. 21). Therefore, the Project is not expected to result in the direct loss of stygofauna habitat (Phoenix 2013, p. 111).

Excavation of the mine pit will result in the direct removal of troglofauna habitat within M47/206. The suitability of troglofauna habitat is primarily driven by the extent and configuration of space within the rock and soil formations. The degree of vugginess of rock formations and the size of interstitial spaces in gravels and soils, as well as broad biogeographic factors, are likely to be the key determinants of the richness and taxonomic composition of the troglofauna community at a site (Bennelongia 2013, pp. 2-3).

Geological units that are currently recognised as core habitat for troglofauna in the Pilbara include hardcap, various mineralized iron formations and tertiary detritals, including alluvium and calcrete (Bennelongia 2013, p. 3).

The Project is based around a node of haematite-geothite that represents a highly mineralised outcrop of the Nammuldi member of the Marra Mamba iron formation. This outcrop is surrounded by alluvium and colluvium, with other nodes of haematite-geothite nearby and moderately extensive expression of less mineralised Marra Mamba to the north (Bennelongia 2013, p. 3). Bennelongia (2013) found strong evidence of biological connectivity between the different geologies and local areas at Murray's Hill. The troglofauna community present at Murray's Hill is not considered restricted and is likely to be more widespread within the local Murray's Hill area.

The Project is not expected to significantly impact the availability of troglofauna habitat within the local Murray's Hill area.

Surface and groundwater contamination

The contamination of surface water, groundwater and soil has potential to result in degradation of the subterranean environment.

The risk of potential hydrocarbon spills will be minimised though application of management, monitoring and contingency measures that will be implemented as part of the Project. Further details of hydrocarbon and waste issues and their management are discussed in Section 15.3.

The EMP will include procedures for the prevention and control of hydrocarbons spills that will ensure the potential impact of contamination on the subterranean fauna is negligible.

Reduction of organic inputs

The clearing of vegetation beyond the mine footprint can potentially lead to a reduction in the availability of organic inputs to underlying subterranean habitats, which may lead to a reduction in abundance and diversity.

The proposed clearing of vegetation outside of mine pit areas is not expected to have a significant effect on the subterranean fauna in addition to the effects of mining. The management of vegetation clearing is discussed in Section 11.

13.5 Management measures and performance standards

Potential effects on subterranean fauna within, and adjacent to the Project will be mitigated through the management measures implemented under an EMP. The key management measures relevant to subterranean fauna include:

- restricting mine pit disturbance to areas approved, in compliance with legislative requirements
- containing and bunding hydrocarbon storage facilities, re-fuelling locations and areas of stationary hydrocarbon usage in compliance with corporate policy, relevant standards and legal requirements
- investigating and documenting opportunities to further reduce the clearing of previously undisturbed and rehabilitated vegetation within approved boundaries.

13.6 Predicted environmental outcomes

After application of management measures described in Section 13.5, the following outcomes will be achieved:

1. No direct loss of stygofauna habitat.
2. Habitat for troglofauna within M47/206 will be removed within the mine pit footprint.
3. The Project will have a limited impact on the extent and availability troglofauna habitat within the local Murray's Hill area.

The Project will have a limited localised impact on subterranean fauna and; therefore, the EPA objective for this factor is expected to be achieved.

14. Cumulative impacts

A cumulative impacts assessment area (Figure 9) has been defined for the purposes of conducting a cumulative impact assessment. The cumulative impacts of the following projects occurring within the cumulative impacts assessment area have been considered in addition to the impacts associated with the Project:

- Roy Hill Infrastructure and Fortescue Metals Group granted SRL corridors
- 100 m wide corridor for BHP Billiton Iron Ore Port Hedland to Newman rail corridor and Chichester Deviation
- 500 m wide corridor for a notional rail line to be developed by Aurizon (formerly QR National)
- Brockman Iron Pty Ltd Railway Infrastructure Project
- Cloudbreak Iron Ore Mine and Proposed Expansion Proposal area.

Table 33 Cumulative impact assessment

Factor	Cumulative impacts
Groundwater	Other than the FMG SRL corridor, there are no existing or approved developments within 30 km of the Project and there will consequently be no overlap of the groundwater footprint is expected. No potential cumulative impacts on groundwater quantity and quality are anticipated.
Surface water	There are no other mining operations within the Goodiadarrie Swamp catchment and the cumulative impact within the catchment will be limited to that of the Mulga Downs Project (MWH 2012, p. 37). There are some mining operations and associated infrastructure within the Yule River catchment. However, the size of the area of disturbance that will be created by the Project within the Yule River catchment is 0.04%. The cumulative impact of this Project within the Yule River catchment will consequently be insignificant (MWH 2012, p. 37).
Flora and vegetation	The main potential cumulative effect on vegetation and flora is the combined effect of clearing vegetation communities from the Project. The cumulative impacts will be less than those estimated, given that impact calculations have been computed using a development envelope i.e. worst-case scenario for clearing (refer to Table 26). **Murray's Hill mine and Fenceline Road** Cumulative impacts to units being directly affected by the Murray's Hill mine and Fenceline Road are generally low. The cumulative impact to Beard vegetation association 562 is estimated to be 10.1% and to association 29, 3.1%. Association 562 is rated as having moderate prioritisation for reservation in the Fortescue Plains subregion while association 29 is rated as having low prioritisation for reservation in the Fortescue Plains subregion (Maia 2012b, p. 100). Cumulative impacts to land systems present within the development envelope are generally less than 2.3% with Jamindie at 11.8%. Approximately 4.7% of the total area of the Jamindie land system mapped in WA is currently located within EPA Redbook areas, 5.2% within Class A reserves and 6.2% within DEC managed lands (Maia 2012b, p. 100). Cumulative impacts to the buffer around the 'Four Plant Assemblages of the Wona Land System' PEC lying over the development envelope is 4.3% (3.26% based on the conceptual disturbance footprint). However, none of the Wona Land System itself occurs within the Project area and will not be directly impacted (Maia 2012b, p. 100). **Railway access road** The cumulative impact to the Beard (1975) vegetation associations and land systems affected by either railway access road option is less than 1%. The addition of the railway access road will add a minimal amount to the impacts from the Roy Hill Infrastructure Railway (Maia 2012b, p. 100). Cumulative impact to the Abydos-Woodstock Reserve is considered to be low at less than 2.5% (Maia 2012b, p. 100).
Fauna	The Project will affect less than 0.09% of Newman, Coolibah, Macroy, McKay and Boolgeeda land systems mapped in the Pilbara, with cumulative effects of less than 2.3% on each system (Table 26). Up to 0.9% of the Jamindie land system may be affected by the Project, with a cumulative effect of approximately 11.8%(Table 26). The cumulative effect on the fauna present as a result of the Project is consequently expected to be insignificant.
Subterranean fauna	There are no other mining operations in the vicinity of the Project and; therefore, there are no potential cumulative impacts on subterranean fauna.

15. Other environmental factors

15.1 Aboriginal heritage

The EPA applies the following objective in its assessment of proposals that may affect Aboriginal heritage sites:

> *To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

The Cultural Heritage Due Diligence Guidelines (DIA 2011) provide guidance to assist in meeting statutory obligations under the *Aboriginal Heritage Act 1972* (WA) (AH Act) and is intended to help identify activities which may adversely affect Aboriginal heritage. This is a guiding document for decision making during the planning and implementation of this Project.

EPA Guidance Statement No. 41 (EPA 2004c) provides guidance on the process for the assessment of Aboriginal heritage as an environmental factor with the objective of ensuring that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with the relevant heritage legislation.

15.1.1 Impact on Aboriginal heritage

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 over burden 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

The Mulga Downs Project is located within two Native Title claim areas. The mine site, mining infrastructure (including accommodation camp) and Fenceline Road are located within the Combined Banjima WAD6096/1998 Native Title claim. The railway access road options are located within the Kariyarra People's WAD6169/1998 claim.

Prior to any ground disturbance, HPPL has an internal approval process that requires the completion of Aboriginal heritage (ethnographic and archaeological) surveys and investigations in consultation with the relevant native title claimant groups and the DAA.

Murray's Hill mine and Fenceline Road

Approximately 120 Aboriginal heritage sites have been identified during surveys, comprising mostly of artefact scatters with a small number of quarries, rock shelters and scarred trees. An excavation program has recently been constructed at three rock shelters located within the Murray's Hill mine area. Two shelters were not considered to contain archaeological features. Excavations occurred at one shelter, which revealed eight artefacts.

During the early stages of development and mine infrastructure construction, up to 51 sites will require ministerial consent under s 18 of the AH Act to allow sites or artefacts to be removed or salvaged. Discussions with the Native Title claimants (the Banjima People) have been undertaken and will continue throughout the development of the Project.

All Aboriginal heritage sites located within the Murray's Hill tenement (M47/206) have been recorded in accordance with the detail required for s 18 applications and will be lodged in 2013 for the salvage of the sites prior to work commencing on the Project. A large portion of the remaining project area within the exploration tenement E47/1244 has also been ethnographically cleared, with archaeological surveys to continue throughout 2013.

Railway access road

The proposed railway access road options are located within the Abydos-Woodstock Protected Area 33.

HPPL has executed a heritage agreement with the Kariyarra to complete heritage surveys in the area and has also obtained a Regulation 10 permit to enter the protected area for the purposes of non-ground disturbing investigations.

An ethnographic and archaeological survey was conducted over the two proposed railway access road alignments from 2-4 April 2013. The survey was attended by elders of the Kariyarra People, anthropologists, archaeologists and a HPPL representative.

No ethnographic sites were identified during the survey. Several small archaeological sites were found only within the Coonarrie railway access road survey area.

HPPL is currently in the process of negotiating a Project Agreement with the Kariyarra People for the transport of minerals through the Kariyarra Native Title Claim area. HPPL is also seeking approval with the appropriate government representatives for the use of the chosen road.

15.1.2 Key mitigation and management measures

HPPL is committed to minimising the extent to which Aboriginal sites are affected, either directly or indirectly. The location of known cultural resources is also being taken into consideration in mine and infrastructure planning and avoided wherever possible.

An Aboriginal Heritage Management Plan (AHMP) will be developed for the Project. The AHMP will contain specific measures relating to heritage that:

- defines heritage management procedures
- provides for ongoing involvement of the Banjima and Kariyarra people through employment and contracting opportunities
- ensures that all staff receive induction and ongoing heritage awareness training
- integrates heritage considerations into the internal GDP process
- requires incidents to be reported to HPPL, DAA and Traditional Owners as required.

The AHMP will be implemented within the Project area, which will provide for Aboriginal monitors to oversee initial clearing earthworks for the construction of the Project within the relevant Native Title claims to ensure that no known Aboriginal sites are inadvertently affected. This will also ensure that changes to the physical environment do not affect Aboriginal heritage.

The key management measures that relate to heritage include:

- identification of Aboriginal heritage sites for inclusion into HPPL Aboriginal Site register
- completing additional survey work within the disturbance area as required
- avoid disturbance of known sites
- where disturbance of known sites cannot be avoided, obtain Ministerial consent under s 18 of the AH Act
- ongoing consultation with traditional owners together with their chosen heritage professionals
- implementing the internal GDP process
- including a heritage monitor from the relevant native title group in the team responsible for initial earthworks clearing
- appointment of a Site Heritage Environment Earthworks Compliance Officer (SHEECO)
- defining the boundaries of heritage sites (i.e. signposts, fencing, awareness programs for personnel)
- auditing and reporting against approval conditions, Project Agreements and procedures to ensure no further impact has occurred as a result of construction or operational activities
- cultural awareness training for all staff and contractors.

15.1.3 Predicted environmental outcome

The Project will comply with the provisions of the AH Act. The Project will also be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004) through implementation of the proposed management measures, relevant Project Agreements and the AHMP. Collectively, the surveys, site delineation, sites register, s 18 consents, internal GDP process and AHMP provide an effective system for managing and protecting the Aboriginal heritage values of the Project area. Where disturbance to a site of heritage significance cannot be avoided, applications will be made under s 18 of the AH Act.

15.2 Mine closure and rehabilitation

15.2.1 Closure overview

The DMP, in conjunction with the EPA, has established *Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2011) to provide expectations of Mine Closure Plans (MCP) and how best to manage the closure process.

An MCP will be prepared for the Project. The MCP will conform to the requirements of the DMP/EPA Guidelines for Preparing Mine Closure Plans (June 2011). Other industry guidelines relevant to closure planning will also be consulted in the development of the MCP. The MCP will be prepared concurrently with the Mining Proposal for submission to the DMP in 2013.

The MCP will address the following:

- HPPL obligations and commitments
- post-mining land use
- objectives and completion criteria for closure
- identification and management of closure issues
- financial provisioning
- closure tasks and implementation
- closure monitoring and maintenance
- unexpected closure.

The Murray's Hill mine is located wholly within Mulga Downs Station, which is currently used for cattle grazing. HPPL owns the lease and manages the pastoral station. HPPL aims to achieve the following broad closure aims for all of its areas at closure:

- compliant with all conditions and commitments
- safe, stable and non-polluting landforms
- comparable to that of surrounding environment
- capable of sustaining an agreed post-mining land use.

15.2.2 Stakeholder consultation

HPPL has been in consultation with key responsible authorities, non-government organisations (NGOs) as well as the local communities since the commencement of feasibility studies. A register of stakeholder consultation undertaken to date is provided in Section 4.

HPPL will continue to identify stakeholders for closure advice during the life of the Project and will provide updates on closure developments on an ongoing basis.

Table 34 provides a list of the stakeholders who will/continue to be contacted. Once the options and schedule for closure have been narrowed down, a targeted consultation strategy will be developed which will provide information to stakeholders and address any concerns raised.

The MCP will be reviewed and updated based on input from stakeholders to ensure all parties are agreed on final land use, decommissioning and rehabilitation procedures.

Table 34 Closure Stakeholders identified

Stakeholder Group	Business/Organisation
Local Landholders	Mulga Downs pastoral station
Aboriginal groups	Kariyarra Native Title Claim Group
	Yamatji Marla Aboriginal Corporation (YMAC)
	Banjima Native Title Claim Group
Government agencies	Department of Agriculture and Food (WA)
	Department of Environment and Conservation (WA)
	Department of Health (WA)
	Department of Aboriginal Affairs (WA)
	Department of Mines and Petroleum (WA)
	Department of State Development (WA)
	Department of Local Government (WA)
	Department of Water (WA)
	Environmental Protection Authority (WA)
	Office of the Environmental Protection Authority (WA)
	Fire and Emergency Services Authority Western Australia (FESA)
	Department of Regional Development and Lands (WA)
	Main Roads Western Australia (WA)
	Pastoral Lands Board
Local government	Shire of Ashburton (WA)
	Town of Port Hedland (WA)
Other tenement holders	FMG
	Roy Hill Infrastructure Pty Ltd

15.3 Other factors

Table 35 briefly outlines potential impacts and activities, and their management, associated with other environmental factors or issues relevant to the Project that were not identified as key factors. These other factors and issues can be regulated by other government agencies under other statutes.

Table 35 Other environmental impacts and activities – other legislation and approvals

Environmental factor	EPA Objective	Description of impact or activity	Approval mechanism	Responsible agency	Statute	Management and Mitigation
Dust	*To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards*	Activities or aspects of the construction and mining operations that may result in dust emissions include: • physical disturbance to the land surface during construction of infrastructure (removal of vegetation, blasting, earthmoving, cutting and filling) and mining activities • haulage and light traffic on unsealed roads • dust lift-off from dry, cleared areas and stockpiles. These dust emissions have the potential to create a dust nuisance for workers and adjacent land users.	Works Approval and Licence to Operate prescribed premises	DEC	EP Act	The generation of dust within the Project area will be controlled through implementation of the following: • clearing work areas only as they are required to limit the extent of soil surfaces exposed at any time • progressive rehabilitation of disturbed areas no longer in use to minimise exposed surfaces • application of water (including recycled water where appropriate) or appropriate suppressants to dry surfaces including rail access roads, haul roads, working surfaces and stockpiles as required • implementation of speed limits to minimise dust generation from roads.
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	Noise will be generated by the Project through blasting and excavation at the mine, ore processing, construction activities and vehicle movements. The main source of ground vibration from the Project will be associated with blasting.		Local government DEC	Environmental Protection (Noise) Regulations 1997	HPPL will implement the following measures to minimise noise emissions: • carry out all construction work out in accordance with Section 6 of AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* • routine maintenance to ensure the effectiveness of noise suppression systems and equipment • ensure compliance with regulation 11 of the Noise Regulations • register any noise-related complaints received and take any necessary corrective action to ensure operational/management procedure(s) and practice(s) are put in place • conduct blasting activities only during daylight hours
Hazardous waste	To ensure that land uses and activities that may emit or cause pollution are managed to maintain: • physical and biological environment and the natural processes that support life • the health, welfare and amenity of people and land uses	If not managed effectively, the on-site storage and use of chemicals, hydrocarbons or other hazardous materials has the potential to result in the following effects: • discharge to the environment, contaminating surface and groundwaters, atmosphere and soil • creation of acute and/or chronic health hazards • creation of flammable or explosive safety hazards.	Dangerous Goods Licence	DMP, Resources Safety Branch	*Dangerous Goods Safety Act 2004*	All hazardous material storage facilities will comply with the *Dangerous Goods Safety Act 2004* and associated Dangerous Goods Safety Regulations 2007, at a minimum. Management and monitoring actions for hazardous materials will be further detailed in an Environmental Management Plan.

Environmental factor	EPA Objective	Description of impact or activity	Approval mechanism	Responsible agency	Statute	Management and Mitigation
	(EPA 2008b). To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.					
Solid and liquid waste	To ensure that land uses and activities that may emit or cause pollution are managed to maintain: • physical and biological environment and the natural processes that support life • the health, welfare and amenity of people and land uses (EPA 2008b). To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	If not managed effectively, waste generated from the operation has the potential to result in the following impacts: • contamination of the receiving environment (surface soil, natural drainage features, surface water and groundwater) • degraded amenity and hygiene • inefficient use of resources.	Works Approval and Licence to Operate prescribed premises	DEC	EP Act Environmental Protection Regulations 1987 Environmental Protection (Controlled Waste) Regulations 2004	Storage and disposal of wastes generated by the Project will be controlled in accordance with conditions set out in an environmental licence, and through implementation of the following management measures: • disposing of putrescible and inert waste to an appropriately licensed facilities (either on or off site) • wastes will be segregated to facilitate recycling and appropriate disposal • collecting and treating ablution effluent in an appropriately licensed sewage treatment facility • maintaining sediment control structures at washdown facilities • maintaining hydrocarbon treatment facilities at the workshop and washdown facilities • disposal of liquid hydrocarbon waste through a licensed contractor • maintaining and servicing equipment regularly An EMP will be prepared which will include measures to address the appropriate handling, storage and disposal methods for solid and liquid wastes on site.

16. Environmental management framework

16.1 Overview

HPPL has applied the principles of avoid, minimise, rectify and reduce during planning and development of the Project and in implementing the mitigation and management measures outlined for each of the environmental factors discussed in this report. HPPL will further ensure that environmental impacts are minimised through:

- maintaining an Environmental Management System (EMS)
- developing and implementing an 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 HPPL Environmental Policy.

HPPL will comply with all relevant current and future statutory requirements.

16.2 Environmental Policy

HPPL is committed to its Health, Safety, Environment, Community and Heritage (HSECH) performance and ensuring continuous improvement. HPPL takes pride in the knowledge that its team displays ownership of actions and the actions of others.

The Company, its employees and contractors will:

- meet HSECH legislative requirements
- apply proven preventative strategies to manage environmental impacts and mitigate our environmental footprint
- work diligently to achieve an interdependent safety culture
- respect the Traditional Owners and foster relationships to preserve their culture and heritage
- implement systems to manage HSECH risks and opportunities
- support employees to work in a safe, responsible, ethical and effective manner
- lead by example to maintain the HSECH focus with all employees and contractors
- communicate clearly, transparently and involve the work force in risk based change.

The HPPL HSECH Policy is communicated to all personnel working on its projects, displayed in prominent locations and is the foundation document for our quality HSECH Management System.

16.3 Environmental Management Plan (EMP)

HPPL is committed to:

- protecting the environment and minimising the effects of its operations
- avoiding disturbance to rare and priority species
- completing projects in compliance with conditions stated in approvals, permits and leases
- complying with applicable legislation and relevant industry standards.

HPPL will minimise environmental effects through the implementation of an environmental management system supported by an EMP and procedures that address the key environmental aspects associated with the Mulga Downs Project.

In addition, to ensure compliance with approval conditions and legislative requirements, environmental management includes:

- reporting and review mechanisms to ensure energy efficiency,
- improved environmental awareness of personnel,
- continuous improvement of environmental performance
- regular communications with stakeholders on environmental matters.

The EMP will 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 EMP will be regularly reviewed and revised where appropriate.

16.4 Summary of environmental control instruments

In reaching a decision as to whether a proposal is likely to have a significant effect on the environment, whether it is likely to meet its objectives for environmental factors and consequently, whether a referred proposal should be assessed, the EPA may have regard to the following:

- values, sensitivity and quality of the environment which is likely to be affected
- extent (intensity, duration, magnitude and geographic footprint) of the likely impacts
- consequence of the likely impacts (or change)
- resilience of the environment to cope with the impacts or changes
- cumulative impact with other projects
- level of confidence in the prediction of impacts and the success of proposed mitigation
- objects of the Act, policies, guidelines, procedures and standards against which a proposal can be assessed
- presence of strategic planning framework
- presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA objectives and principles for EIA
- public concern about the likely effect of the proposal, if implemented, on the environment.

A significance test for the Project has been undertaken against each of these criteria.

Table 36 Significance test

Criteria	Assessment
Values, sensitivity and quality of the environment which is likely to be impacted	The Project is located within the Mulga Downs pastoral lease. The main land uses in the area are grazing and mining. The Project does not affect any significant areas or land features. The Project does not directly impact any TECs or PECs, DRF or threatened flora. Two Priority flora species occur within the development envelope associated with the upgrade to Fenceline Road. Impacts on these species will be avoided or minimised. No fauna species scheduled under the WC Act or species listed under the EPBC Act were recorded during surveys. A Northern Quoll was detected in the northern section of the fauna survey area via motion sensitive camera. Seven fauna species listed under the EPBC Act or Scheduled under the WC Act are considered likely to occur in the area. An additional nine species listed as Priority fauna potentially occur in the Project area. No confirmed short range endemic fauna (SRE) were recorded in areas directly affected by the Project. Subterranean fauna are not expected to be significantly affected by the Project. Fauna habitats and land systems in the Project area are abundant in the adjacent areas. The loss of fauna habitat is not expected have a significant affect fauna assemblages in a bioregional context.
Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts Consequence of the likely impacts (or change) Resilience of the environment to cope with the impacts or changes	Up to 890 ha will be disturbed as a result of the Proposal. Existing cleared areas and access tracks will be used where possible. The total life of the mine is five years. The mine site will be rehabilitated in accordance with a Mine Closure Plan. Impacts to land systems affected by the Proposal are considered low, being less than 1% of the total area mapped. Two Beard vegetation associations occur within the Proposal area (562, 29). The Proposal will result in the removal of 0.6 and 0.2% of the pre-European extent of these vegetation associations respectively. Impacts to seven of the nine site specific vegetation associations found in the development envelope are generally less than 20%. Impacts to community H2 and H3 will be minimised through Project design. Based on the conceptual disturbance footprint, impacts to H2 and H3 are 29% and 2.3% respectively. The overall effects of the Proposal are not expected to be significant at a local or regional level.
Cumulative impact with other projects	Cumulative impacts of the Project have been addressed under each key environmental factor in Section 14. Overall, cumulative impacts to the key environmental factors identified are generally low.
Level of confidence in the prediction of impacts and the success of proposed mitigation	The environmental impacts of this Project will be addressed through the management measures identified within each environmental factor and the development of an EMP which will be address the range of environmental issues expected during the life of the Mulga Downs Project. The EMP will cover the following key factors: Vegetation and Flora; Fauna; Surface Water; and Cultural Heritage. Further management actions specific to the Project are described for each key issue.
Objects of the Act, policies, guidelines, procedures and standards against which a proposal can be assessed	Relevant legislation, policies, guidelines, procedures and standards have been considered. HPPL has considered relevant legislation and the principles of environmental protection in the design of the Project and will continue to do so during subsequent implementation. Relevant guidance statements have been considered in undertaking baseline surveys.
Presence of strategic planning framework	Not applicable
Presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA objectives and principles for EIA	A number of key regulatory controls can be applied to the Project to ensure appropriate management including (but are not limited to): • conditions of works approval(s) issued under Part V of the EP Act for construction of works on prescribed premises (ore processing, landfill facility and sewage facility) • conditions of licence issued under Part V of the EP Act for the operation of activities on prescribed premises (ore processing, landfill facility and sewage facility) • conditions of the licences and permits for activities relating to the construction of bores and abstraction of groundwater under the RIWI Act • conditions of Mining Proposals approved by DMP, including closure management plans In the event that the Project is not assessed, clearing of native vegetation will be undertaken in accordance with clearing permit(s) under Part V of the EP Act. Refer to Section 16.4

Criteria	Assessment
Public concern about the likely effect of the proposal, if implemented, on the environment	A comprehensive stakeholder consultation plan was undertaken during the early design of the Proposal to identify and address concerns. Stakeholder consultation will continue throughout the life of the Proposal through to closure. The Proposal is not expected to generate any public concern.

A number of key regulatory controls can be applied to the Project to ensure appropriate management as outlined in Table 36. Table 37 provides an overview of the proposed regulatory framework for the Project and applicable environmental approvals for each of the identified relevant factors.

Table 37 Proposed regulatory framework and environmental approvals

Environmental factor	Proposed Approvals/ Management	Legislation	Agency
Vegetation and flora	A Clearing Permit application will be submitted under Part V of the EP Act if the Project is not assessed. Under this process, the proposed clearing will be assessed against the 10 clearing principles and any management, mitigation and residual impacts can be conditioned in any approved permit. Rehabilitation will also be managed under a Mining Proposal and Mine Closure Plan, which will be submitted to the DMP under the Mining Act.	EP Act Mining Act.	DMP
Terrestrial Fauna	A Clearing Permit application will be submitted under Part V of the EP Act if the Project is not assessed. Under this process, the proposed clearing will be assessed against the 10 clearing principles, which includes impacts to fauna and fauna habitat. Any management, mitigation and residual impacts can be conditioned in any approved permit. Rehabilitation will also be addressed under a Mining Proposal and Mine Closure Plan, which will be submitted to the DMP under the Mining Act. The Project has also been assessed against the DSEWPaC 'Test of Significance criteria and the Northern Quoll Impact Assessment Guidelines. DSEWPaC has concurred with the HPPL assessment that the Project is unlikely to significantly affect identified MNES.	EP Act Mining Act EPBC Act	DMP DSEWPaC
Subterranean Fauna	The potential effects of the Project on subterranean fauna will be managed in accordance with an EMP which will be submitted to DMP.	Mining Act	DMP
Surface water	A Mine site Stormwater Management Strategy will be developed consistent with the DoW Water Quality Protection Guidelines No. 6 Mining and Mineral Processing – Mine site Stormwater (DoW, 2000). Stormwater management will be addressed in the Mining Proposal which will be submitted to the DMP.	Mining Act RIWI Act	DMP DoW
Groundwater	Applications made to DoW for the construction of wells (26D). A Groundwater Operating Strategy will be submitted as part of a DoW abstraction permit (5C Licence).	RIWI Act	DoW
Mine Closure and Rehabilitation	A Mine Closure Plan will be submitted to the DMP as a requirement of the Mining Proposal under the Mining Act which will address mine closure and rehabilitation relevant to the Project.	Mining Act	DMP
Aboriginal heritage	Section 18 application(s) will be made where Aboriginal heritage sites are to be affected.	Aboriginal Heritage Act	DAA/Minister for Aboriginal Affairs
Dust	Dust can be managed under Part V of the EP Act	EP Act	DEC
Noise	Noise emissions are regulated under the Noise Regulations 1997.	Noise Regulations	DEC/Shire of Ashburton

Environmental factor	Proposed Approvals/ Management	Legislation	Agency
Geochemical risk	Geochemical characterisation of waste rock and ore has concluded that the materials are geochemically benign. AMD can be addressed under a Mining Proposal and Mine Closure Plan.	Mining Act	DMP
Hydrocarbons and hazardous materials management	Explosives storage, fuel storage, explosives transport and fuel transport will comply with relevant requirements/standards.	*Dangerous Goods Safety Act 2004*	DMP
Solid and liquid waste management	Solid and liquid waste can be managed under the provisions of Part V of the EP Act, local government and DoH	EP Act *Health Act 1911*	DEC DoH Shire of Ashburton

In considering the above significance test, the regulatory controls that can be applied to the Project and the implementation of relevant management plans, HPPL is of the view that the Project does not require formal environmental impact assessment.

17. Acronyms and short titles

Acronym/short title	Full title
ANZECC	Australian and New Zealand Environment and Conservation Council
AH Act	*Aboriginal Heritage Act 1972*
AWT	above watertable
AMD	Acid and metalliferous drainage
ARI	annual rainfall index
BIF	Banded Iron Formation
CALM Act	*Conservation and Land Management Act 1984*
DEC	Department of Environment and Conservation
DAA	Department of Aboriginal Affairs
DMP	Department of Mines and Petroleum
DoH	Department of Health
DoW	Department of Water
DSD	Department of State Development
DRF	Declared Rare Flora
DRDL	Department of Regional Development and Lands
DSEWPaC	Department of Sustainability, Environment, Water, Populations and Communities
DSO	Direct Shipping Ore
EMB	Environmental Management Branch
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
ET	evapotranspiration
FEL	Front end loader
FMG	Fortescue Metals Group
HPPL	Hancock Prospecting Pty Ltd
kL	Kilolitres
Km	kilometres
m	metres
MNES	Matter of National Environmental Significance
mbgl	metres below ground level
MCA	Mugarinya Community Association
ML	megalitres
ML/a	megalitres per annum
mg/L	milligrams per litre
Mining Act	*Mining Act 1978*
MRWA	Main Roads Western Australia
MT	million tonnes
Mtpa	million tonnes per annum
mm	millimetres
MWpa	megawatts per annum
Native Title Act	*Native Title Act 1993*

Acronym/short title	Full title
NRMMC	Natural Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
OEPA	Office of the Environmental Protection Authority
ha	hectares
PEC	Priority Ecological Community
PM	particulate matter
RIWI Act	*Rights in Water and Irrigation Act 1914*
ROM	Run of Mine
RORB	rainfall runoff model
SRE	Short range endemic
SRL	Special Rail Licence
TEC	Threatened Ecological Community
TDS	total dissolved solids
TSP	total suspended particulates
YAC	Yindjibarndi Aboriginal Corporation
YMAC	Yamatji Marlpa Aboriginal Corporation
WC Act	*Wildlife Conservation Act 1950*
WWTP	wastewater treatment plant

18. Acknowledgements

HPPL would like to thank the following organisations for their contributions to this document:

- AMC Consultants
- Bennelongia Environmental Consultants
- Battery Limits Pty Ltd
- Biologic
- Duxford Stirling Pty Ltd
- Engenium
- Landloch Pty Ltd
- Maia Environmental Consultancy Pty Ltd
- MWH
- MYR Consulting
- Phoenix Environmental Sciences Pty Ltd
- Strategen Environmental Consultants
- Strategic Mines
- Survey Graphics Mapping Consultants
- Terrestrial Ecosystems
- 4DGeotechnics Pty Ltd.

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List of appendices

The following appendices are found on CD-ROM inside the back cover of this report

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Appendix 2	Soil report
Appendix 3	Surface water report
Appendix 4	Vegetation and flora report
Appendix 5	Terrestrial fauna report
Appendix 6	Short-range endemics report
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