1. INTRODUCTION

1.1 PROPONENT

The Thunderbird Mineral Sands Project (the project) is a greenfield heavy mineral sands project proposed to be developed by Sheffield Resources Limited (Sheffield, or the proponent). Sheffield is a mineral sands focused explorer and developer, headquartered in Perth, Western Australia. It is listed on the Australian Securities Exchange (ASX).

The proponent can be contacted at:
Sheffield Resources Ltd
Level 2, 41 - 47 Colin Street
West Perth WA 6005

The key contact for the project is:
Mr Bruce McFadzean
Managing Director
Telephone: (08) 6555 8777
Email: info@sheffieldresources.com.au

1.2 PROJECT OVERVIEW

1.2.1 Project Summary

The project is a greenfield project and will comprise:

- Mining of heavy mineral sands over a 40 plus year period from the Thunderbird deposit. The initial rate of mining will allow excavation of a nominal 7.5 million tonnes per annum (Mtpa) of ore for the first four to five years, before increasing to a nominal 15 Mtpa of ore for the remainder of the project life.
- Onsite primary and secondary processing of ore to produce a range of saleable mineral sands products (ilmenite, primary zircon, zircon concentrate, titano-magnetite and HiTi88 Leucoxene). Construction of processing facilities will be staged with production doubled to 15 Mtpa after approximately year five.
- Abstraction and reinjection of groundwater from the Broome Sandstone Aquifer to allow mining and supply ore processing needs. As the orebody is mined, there will eventually be a positive water balance (more water being pumped from the pit than can be used in processing) so that a portion of the extracted water will be re-injected into the Broome Sandstone Aquifer downstream of mining operations.
- Development of infrastructure to support the project including power generation facilities, accommodation village, administration and maintenance buildings, internal roads, communications infrastructure, and waste storage and disposal facilities.
- Upgrade and extension of the existing pastoral road (Mt Jowlaenga Road) from the Great Northern Highway to form a 30 km Site Access Road.
- Transport of mineral sands products from the Mine Site via the Site Access Road and Great Northern Highway to Derby or Broome Ports for storage prior to export.
- Export of bulk mineral sands products from Derby Port via King Sound and packaged mineral product from Port of Broome to international customers.

Construction of the project is scheduled to commence in Quarter 3 2017, with mining and production scheduled to commence in early 2019. The project will be fully operational in early 2019 with the first export of product anticipated by end of 2019.

The project is considered in terms of two separate Development Envelopes; Mine Site and Derby Port. These will contain the majority of project-related activities and will both require construction of new infrastructure. Whilst export of packaged mineral sands products will also occur from the Port of Broome, this will use existing facilities and no changes are required to allow the project to use this infrastructure. As such, the Port of Broome has not been considered as a Development Envelope.

1.2.2 Location

The project is located on the Dampier Peninsula within the west Kimberley region of Western Australia (Figure 1). The project comprises two geographically separate locations, namely the Mine Site Development Envelope (including the Site Access Road) (Figure 2) and the Derby Port Development Envelope (Figure 3). There are no other mining projects located on the Dampier Peninsula. The nearest mines are the Koolan Island iron ore mine located offshore approximately 200 km northeast of the project, and Ellendale diamond mine located approximately 200 km east of the project, both of which are temporarily suspended (Geoscience Australia 2016). Derby Port is an operational port and has been previously used for export of mineral products but is currently not being used for this purpose. Derby Port is located in King Sound, which is currently home to several aquaculture and pearling enterprises.

The Mine Site Development Envelope is located approximately 75 km west southwest of Derby and 95 km northeast of Broome (Figure 1). It is accessed from the Great Northern Highway via a proposed 30 km long Site Access Road.

The Mine Site Development Envelope is located within Mt Jowlaenga Pastoral Lease (H910623), held by the Yeeda Pastoral Company Pty Ltd. An existing pastoral road that connects the Great Northern Highway to the abandoned Mt Jowlaenga Homestead will be upgraded to form part of the Site Access Road for the project. The Site Access Road intersects the Great Northern Highway approximately half way between Broome and Derby; the intersection is approximately 110 km to Derby and 100 km to Broome by road.

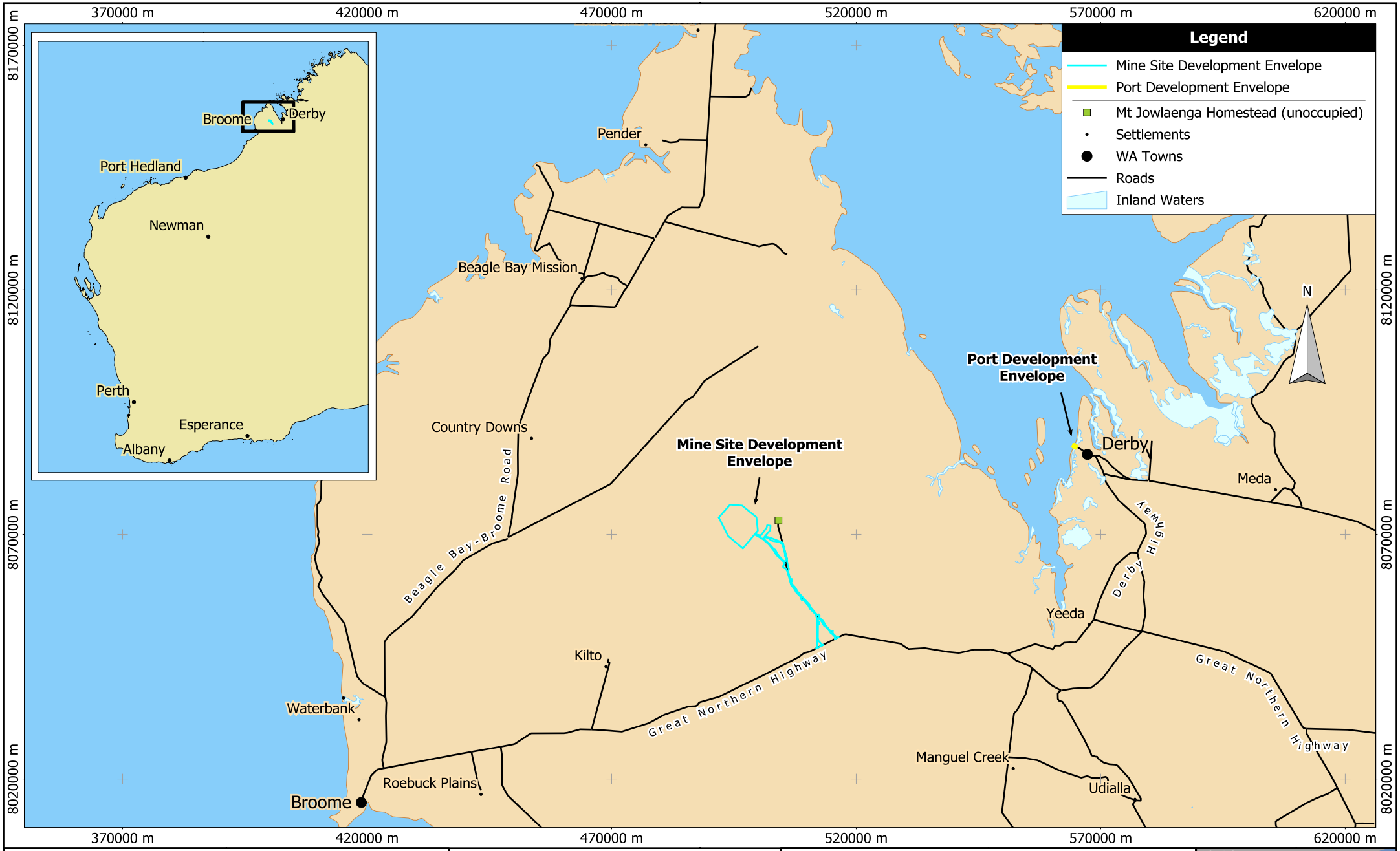
Several tenements are held by Sheffield for the Mine Site components of the project; these are detailed in Table 1 and shown in Figure 2.

Table 1: Thunderbird Mineral Sands Project Tenements

Tenement	Area (hectares)	Holder	Granted	Expiry
M04/459	4,525	Sheffield Resources Pty Ltd	Pending	N/A
L04/82	633	Sheffield Resources Pty Ltd	Pending	N/A
L04/83	219	Sheffield Resources Pty Ltd	Pending	N/A
L04/84	120	Sheffield Resources Pty Ltd	23/04/2015	22/04/2036
L04/85	237	Sheffield Resources Pty Ltd	23/04/2015	22/04/2036
L04/86	191	Sheffield Resources Pty Ltd	23/04/2015	22/04/2036

Bulk mineral sands products will be transported by road from the Mine Site to Derby Port, located 2 km northwest of the Derby township, where they will be stored prior to export. A Product Storage Facility will be located at the Port adjacent to the existing wharf facility and is accessed via a manmade causeway (Jetty Road) that traverses the mudflats of King Sound (Figure 3). Smaller volumes of packaged product will be exported from the Port of Broome using existing facilities. No additional development of facilities is proposed for the Broome Port.

The storage facility at Derby Port will be located on the site of a previous mineral product export storage facility. Product will be transferred from the storage facility to dedicated transhipment vessels via a covered transhipment vessel loading conveyor. Transhipment vessels will then transfer product for 33 km to ships at a dedicated sea transfer point. Existing port infrastructure will be used with minor improvements made as required.



Scale: 1:1000000
Original Size: A4
Grid: MGA94(51)

0 40 km

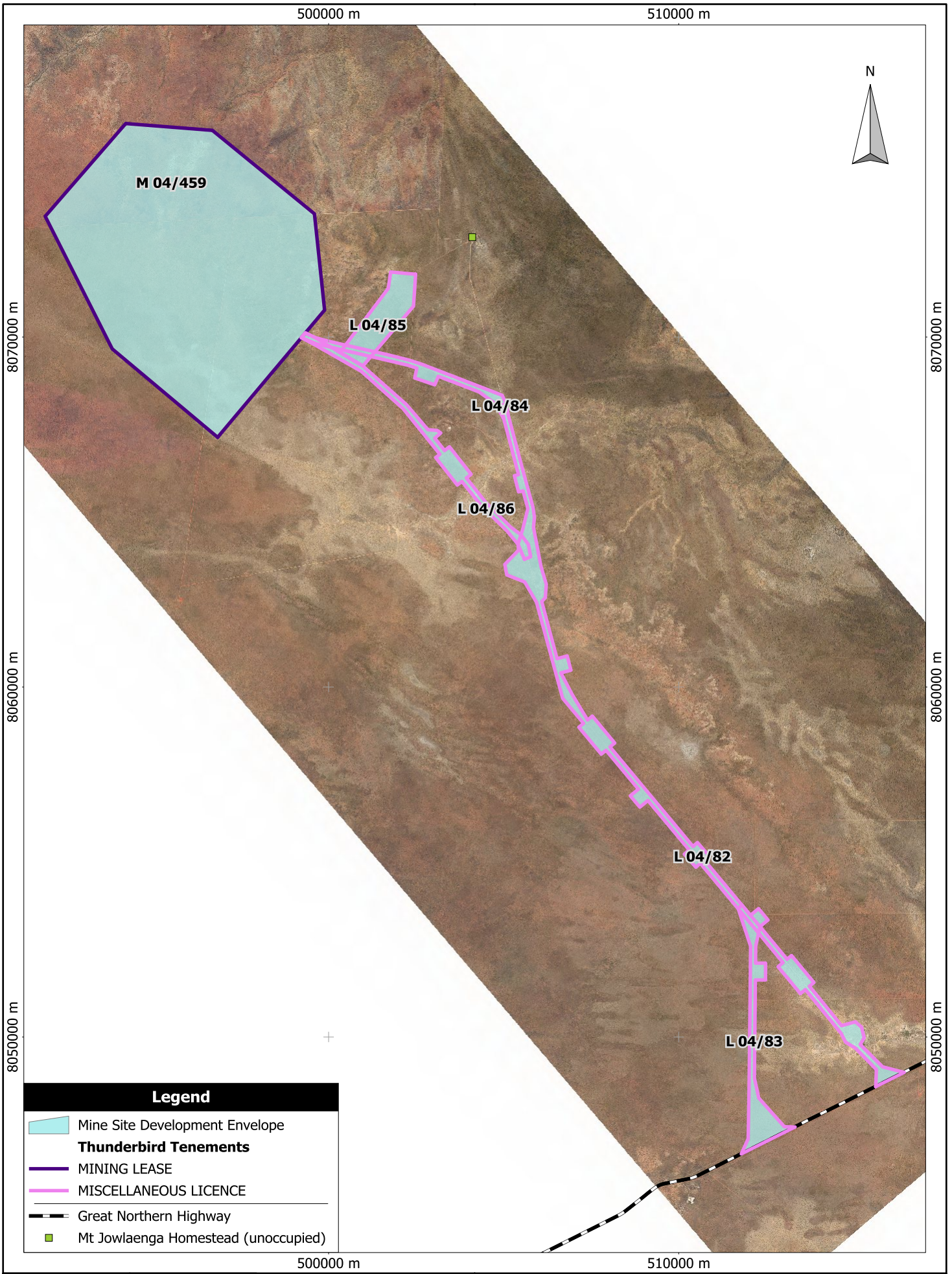
Sheffield Resources Limited
Thunderbird Mineral Sands Project

Figure 1

Project Location

4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au
MBS ENVIRONMENTAL

W:\Sheffield Resources\PER\Drawings\PER Location Plan.map 11/11/2016 F1 Project Location Layout



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Original Size: A4
Air Photo Date: 2015
Grid: Australia MGA94 (51)
0 4 km

Sheffield Resources Limited
Thunderbird Mineral Sands Project

Figure 2

Mine Site Development Envelope and Tenements

Martinick Bosch Sell Pty Ltd
4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au

MBS ENVIRONMENTAL

W:\Sheffield Resources\PER\Drawings\PER Map.map 11/11/2016 F2 Mine Site Development Envelope and Tenements Layout

Scale: 1:20000
Original Size: A4
Image: Landgate Locate WA
Grid: Australia MGA94 (51)

0 500 m

Sheffield Resources
Thunderbird Mineral Sands Project

Figure 3

Port Location Plan

4 Cook St
West Perth WA 6005
Ph: (08) 9226 3166
Fax: (08) 9226 3177
info@mbsenvironmental.com.au
www.mbsenvironmental.com.au
MBS ENVIRONMENTAL

W:\Sheffield Resources\PER\Drawings\PER Derby Port.map 11/11/2016 F03 Port Location Plan Layout

1.2.3 Justification and Objectives

Sheffield is a mineral exploration company with extensive tenure throughout Western Australia, including the Dampier Peninsula. In September 2011, Sheffield was granted an Exploration Licence E04/2083 covering the Thunderbird deposit. With development of the project, the proponent will transition into a production/mining company.

The Thunderbird deposit was discovered by Sheffield in 2012, following earlier exploration by Rio Tinto Exploration Pty Ltd between 2003 and 2009. Using drilling and analysis, Sheffield defined a mineral resource and ore reserve. This information was used as part of the Pre-Feasibility Study, completed in December 2015.

The objective of the project is to establish an operating mineral sands mine and processing facilities with supporting infrastructure and services for production and export of heavy mineral sands products including ilmenite, primary zircon, zircon concentrate and HiTi88 Leucoxene. A by-product, titano-magnetite, may also be sold. These mineral products constitute about 5% of the ore, with the remaining 95% returned to the mining void after processing. This is driven by worldwide need for ceramics, paint and other commonly used materials that contain these heavy minerals.

Heavy mineral sands are an important ingredient in many everyday products and the project represents an opportunity for Western Australia to benefit from the development of this resource. The project will have a positive impact on the Kimberley region over an extended period. The project will create employment opportunities for local Indigenous and non-Indigenous people, and create opportunities for local Indigenous and non-Indigenous businesses. The project will also add to scientific knowledge through ongoing monitoring of the environment. Specifically, the project will:

- Create 140 permanent local jobs as well as opportunities for partnerships with Indigenous businesses.
- Produce an important product used in everyday items such as toothpaste, artificial joints, crockery, tiles and porcelain, paint, food colouring, medicines, and sunscreen.
- Have a long intergenerational life of greater than 40 years.
- Provide increased direct and indirect business opportunities in Broome and Derby through operation of the mine and shipping activities.

1.2.4 Alternatives

The project will provide 140 local jobs for more than 40 years and will provide economic benefits to the Kimberley region and the State. It is amongst the world's largest mineral sands deposits discovered in the last 30 years, and is the largest discovery of zircon in the last 30 years. If the project was not developed, economic and social benefits to the State, Kimberley region, local businesses and Traditional Owners would not be realised.

Several alternative project options were considered during the preliminary and bankable feasibility studies, planning, and design processes. Key alternative options considered and/or implemented and the change to the impact on the environment of the project as a result is detailed in the following sections. These alternatives were considered as implementation, design, temporal, or spatial considerations.

1.2.4.1 Mining

The Thunderbird deposit is proposed to be mined using a conventional dry mining approach which is used successfully in Western Australia for several projects. The dry mining method allows for minimal disturbance at any given time, and progressive backfill of the mining excavation and is the most appropriate mining method for the project. The location of the ore reserve cannot be changed and as such the overall location of the mineral deposit area is fixed, however alternatives were considered for the following aspects:

- **Mining method** (implementation consideration) – Wet (dredge) mining was considered during the feasibility and design process, however was not considered feasible due to the slime content of the ore and

large capital cost of a dredge.

- **Mining Rate** (temporal consideration) - Sheffield modelled various mining rates during Scoping and Pre-Feasibility studies, and the scale of the mining and processing operations in terms of capital and operating costs and production impacts on the mineral sands markets. The decision to adopt an ore mining rate of 7.5 Mtpa for the first 4 years, then ramping up to 15 Mtpa after that over a period of more than 40 years was considered and is proposed. This will:
  - Reduce water requirements and aquifer recovery time.
  - Extend the life of the project and the benefits to the region.
  - Reduce the area of clearing required annually and the amount of land under rehabilitation at any given time.
  - Reduce capital costs, and potential adverse impacts on the market.
- **Mining excavation footprint** (spatial consideration) - The mining footprint has been reduced from the original proposed footprint to maintain an adequate buffer for identified Aboriginal Heritage sites. The heritage buffers have been defined by Traditional Owners over the past five years and therefore are a result of extensive consultation.

1.2.4.2 Ore Processing

Alternatives considered included processing methods and locations such as primary and/or secondary processing offsite. These include specifically:

- **Offsite Processing** (spatial consideration):
  - Primary processing on site and secondary processing offsite was considered to potentially reduce the impact of air emissions generated by secondary processing on the surrounding environment, however, the remote location of the project is considered as a buffer to sensitive receptors.
  - The location of the processing plant components has been optimised to reduce the capital cost, and thus footprint of the project. The initial processing stage Mining Unit Plants are located within the mining excavation and thus no additional land clearing is required for this equipment. These units are skid-mounted and will be relocated as the mining excavation advances.
- **Annual Throughput** (temporal consideration): As discussed in Section 3.3 the proposed ore processing throughput was originally 12 Mtpa at start-up then increased to 18 Mtpa at Year 7, but was reduced to an initial start-up rate of 7.5 Mtpa increasing to a maximum of 15 Mtpa in Year 4 to 5 of the project. This reduced throughput:
  - Reduces annual water requirements and aquifer recovery time.
  - Extends the life of the project and the benefits to the region.
  - Reduces the area of clearing required annually and the amount of land under rehabilitation at any given time.
- **Processing method** (design consideration): Several alternatives to the processing method have been considered throughout the feasibility and design process. Some of the changes made to the process method are listed below:
  - Low temperature roasting and magnetic fractionation was added to the process to lower the iron content of the primary ilmenite product, and increase the TiO2 grade. This step adds value to the product on-site, as opposed to a similar process taking place off-shore, thereby maximising benefits to the State.
  - Hot acid leach process on the non-magnetic fraction of the Heavy Mineral Concentrate (HMC), and screening and scrubbing of oversize added to improve the separability and recovery (increased quality) of final products from the zircon process.

- Design changes to reduce water use and increase water recovery and recycling. For example, approximately 50% of water from the co-disposal stream will be reclaimed and reused.
- Creation of alternative secondary products and/or concentrates previously produced as a waste stream (e.g. zircon concentrate derived from primary zircon and HiTi Process streams).

1.2.4.3 Process Water Sources

A large borefield was originally proposed south of (and external to) the mining lease to supply make-up water prior to mining below the water table. Investigations to improve the efficiency of water use in processing, along with a reduced mining rate (Section 3.3), mean that a smaller borefield is more appropriate. Make-up water will now be sourced from a smaller borefield located within the mining lease.

1.2.4.4 Mine Dewatering

Surface discharge, and/or storage and evaporation of excess water were considered as alternatives to the current proposal of reinjection back into the aquifer when this is required. Surface discharge and storage/evaporation would result in a larger disturbance footprint and greater water loss through evaporation potentially resulting in an extended aquifer recovery time. Reinjection of excess water is anticipated to assist the aquifer to recover more readily.

1.2.4.5 Site Access

Several different routes were considered for the Site Access Road. This included:

- Using the existing roads only (Mt Jowlaenga Road and Station tracks).
- Using the existing road with modifications.
- Building a completely new access road.

Using the existing Mt Jowlaenga Road with modifications was selected as the most cost effective, and environmentally and socially beneficial option. Baseline surveys were conducted to assist in selecting the proposed road alignment, which included consideration of the following:

- Avoiding water courses and low-lying areas likely to be subject to inundation during the wet season, minimising the need for engineered crossings.
- Avoiding known locations of Bilbies.
- Avoiding heritage areas and any associated buffers.
- Minimising additional land use and thus vegetation disturbance.
- Minimising disruption to pastoral activities undertaken at Mt Jowlaenga Station, including minimising traffic passing near the Mt Jowlaenga Homestead.
- Maximising line of sight, minimising blind corners, and minimising areas of difficult terrain for road user safety.
- Maximising proximity to potential water resources to allow use of a single corridor for vehicle access and water transfer to the mining and ore processing areas, and associated support facilities.
- Designing a safe intersection with the Great Northern Highway.
- Reduction in product haulage vehicle emissions.

1.2.4.6 Transport and Shipping

A summary of alternatives considered for transport and shipping for the project are detailed below. Alternatives with the least impact on the environment and amenity were incorporated into the project:

- Smaller trucks (triple road trains) were considered to minimise amenity impacts in Derby, however by using

quad road trains, the number of truck movements is significantly reduced, which will reduce the impacts on amenity from transport of product.

- Potential to load the mineral sands products at Derby Port via a lock system constructed and operated by a third party was considered. As the lock system is currently in the scoping stage, there is no guarantee the system will be constructed and available for use once export of mineral sand product commences. Therefore, for the proposed project to be feasible, existing options have been selected (transhipment vessel loading system).
- Potential alternatives to bulk product export via Derby Port included export via Broome Port. Export of bulk produce via Derby Port and export of packaged product via the Port of Broome was found to be the preferred option. Key reasons for this selection are:
  - Derby Port has existing transhipment vessel loading infrastructure suitable for a bulk product loading that can be used by Sheffield, meaning lower construction requirements.
  - Derby Port has space to accommodate building of a product storage shed or silos for storage of bulk product and can be connected to the existing loading conveyor.
  - Derby Port is located about 2 km away from residential areas meaning there is a significant buffer distance for any potential noise and air emissions.
  - Derby Port has greater capacity to accommodate the planned shipping arrangements compared to the Port of Broome.
  - Derby Port does not have infrastructure to allow efficient transfer of packaged products from the wharf to barges.
  - The Port of Broome has existing storage sheds and transfer infrastructure to allow storage and transfer of packaged products to an ocean-going vessel which can moor at the wharf. No additional infrastructure would be required to allow use of the Port of Broome.
  - Road infrastructure to access the Port of Broome was upgraded as part of the Royalties to Region Scheme to bypass residential and commercial areas of Broome. Use of the bypass will minimise amenity impacts on residents.
  - The Port of Broome does not currently have infrastructure to allow for the bulk loading of product to marine vessels.
  - The Port of Broome is currently underutilised and has significant capacity to accommodate Sheffield's proposed use whilst still allowing for other potential future users.
- Transport of ore to other ports was considered cost prohibitive due to transport costs and lack of existing infrastructure.
- Transport options include shipping in bulk or using 'break bulk' logistics and shipping in smaller packages. Break bulk logistics will be carried out at the Mine Site.
- A potential increase in capacity of the ship loading conveyor could be carried out if required in consultation with Shire of Derby/West Kimberley.

1.3 PURPOSE AND SCOPE

The project was referred to the Western Australian Environmental Protection Authority (EPA) by the Proponent on 20 November 2015. On 21 December 2015, the level of assessment was set as Public Environmental Review (PER) with a four week public review period.

The project was referred to the (then) Commonwealth Department of the Environment (now named the Department of Environment and Energy), and on 7 April 2016 it was determined to be a Controlled Action under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). This project is being assessed under the Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia, made

under Section 45 of that Act.

An Environmental Scoping Document (ESD) was prepared by the Proponent to address Commonwealth and State impact assessment requirements. This was approved by the EPA and released as final on 5 July 2016. The ESD outlines the preliminary key environmental factors and work requirements for inclusion in the PER.

During preparation of the Bankable Feasibility Study, a number of additional technical studies provided greater clarity on project design. This allowed refinement of project key characteristics since submission of the ESD. The most significant changes comprised additions to product exporting plans to include export of packaged products through the Port of Broome, an increase in project power generation requirements, clarification of groundwater abstraction volumes over the 40+ year project life and minor changes to the total amount of land clearing required. Sheffield subsequently submitted a request to change the relevant key characteristics of the proposal under Section 43A of the *Environmental Protection Act 1986* (*EP Act*) in November 2016. These changes were deemed by the EPA to be unlikely to significantly increase any environmental impact of the project. As such, updates have been made to incorporate these project changes into the environmental impact assessment in this PER. The Section 43A application and approval letter are provided in Appendix 1.

This PER has been prepared to fulfil the requirements for assessment of the project pursuant to Part IV of the Western Australian *EP Act* and relevant requirements of the *EPBC Act* and Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000*.

This PER has been prepared in accordance with the *EP Act Environmental Impact Assessment - Administrative Procedures 2012*, the OEPA Guidelines for Preparing a Public Environmental Review (2015), the ESD, Section 43A application and the checklist for documents submitted for Environmental Impact Assessment (Appendix 2).

1.4 ENVIRONMENTAL COMMITMENT

Sheffield's Environmental Policy outlines its intentions and commitment to environmental performance as a company and to the project specifically. Sheffield's Environmental Policy is provided in Appendix 3.

Sheffield is developing an environmental management system (EMS) to facilitate the management of environmental responsibilities for all phases of the project (construction, operation, and closure), and to enable continuous improvement of the proponent's environmental performance. Over the life of the project, the EMS will enable Sheffield to systematically assess and review its environmental impacts and obligations, and implement programs for their management.

The Sheffield EMS will be based on AS/NZ ISO 14001:2004 Environmental Management System Standards, which are internationally accepted and include a model for continuous improvement.

Environmental Management Plans will form the cornerstone of the project's EMS as they will document actions and responsibilities for protection of the conservation values of the project.

1.5 DOCUMENT STRUCTURE

The PER is structured to meet the requirements of the EPA Guidelines for Preparing a Public Environmental Review (EPA 2015a). An overview of the key sections of the PER is provided in Table 2.

Table 2: PER Sections Summary

No.	Heading	Description
1	Introduction	Introduction to the project, including the location, objectives, purpose and scope and the proponent's commitment to environment.
2	Legislative Framework	Summary of applicable legislation and management of the project within the Commonwealth and State legislative framework.
3	Project Description	Detailed description of the project, including mining, processing, waste management, water requirements, land use, and other key mine site infrastructure. Transport and export of product are described, as well as closure and rehabilitation of the site at cessation of mining.
4	Existing Environment	Detailed description of the existing environment at the Mine Site and Derby Port Development Envelopes including geology, soils, hydrogeology and hydrology, flora and vegetation, terrestrial and subterranean fauna, land use, heritage, and amenity.
5	Environmental Management Framework	Description of the Environmental Policy, EMS, and EMPs for the project. Sheffield's commitment to the EPA's Principles of Environmental Protection is detailed in this section.
6	Community and Stakeholder Consultation	Overview of stakeholder and community consultation plan, consultation carried out to date, and issues raised and resolved.
7	Assessment Method	Description of the systematic approach that has been used to identify and assess potential impacts and to determine the mitigation and management measures required to prevent or minimise potential impacts.
8	Environmental Impact Assessment - Key Environmental Factors - Mine Site Development Envelope	Detailed environmental impact assessment for each key factor for the Mine Site Development Envelope including statutory requirements, assessment of potential impacts, management measures, and predicted outcome in terms of achievement of the EPA objectives for each factor.
9	Environmental Impact Assessment - Key Environmental Factors - Port Development Envelope	Detailed environmental impact assessment for each key factor for the Derby Port Development Envelope including statutory requirements, assessment of potential impacts, management measures and predicted outcome in terms of achievement of the EPA objectives for each factor.
10	Environmental Impact Assessment - Other Environmental Factors - Mine Site Development Envelope	Detailed environmental impact assessment for each 'other' factor for the Mine Site Development Envelope including statutory requirements, assessment of potential impacts, management measures, and predicted outcome in terms of achievement of the EPA objectives for each factor.
11	Environmental Impact Assessment - Other Environmental Factors - Port Development Envelope	Detailed environmental impact assessment for each 'other' factor for the Derby Port Development Envelope including statutory requirements, assessment of potential impacts, management measures, and predicted outcome in terms of compliance with EPA objectives for each factor.
12	Environmental Impact Assessment - Integrating Factor - Rehabilitation and Decommissioning	A description of policies, potential impacts, management measures and predicted outcomes in terms of compliance with the EPA objectives for the integrating factor related to rehabilitation and closure.
13	Environmental Impact Assessment - Matters of National Environmental Significance	Detailed description of Matters of National Environmental Significance within the Mine Site Development Envelope, assessment of potential impacts, management measures and predicted outcomes.
14	Environmental Impact Assessment - Integrating Factor - Offsets	A description of offset policies, mitigation sequence, and significant residual impacts is provided along with requirements for offsets as assessed against Commonwealth and State offset assessment tools and the offset strategy.
15	References	Detailed list of references used in preparation of the PER.