Before the EPA
Trans-Tasman Resources Ltd Ironsands Extraction Project

In the matter of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

And

In the matter of a board appointed to consider a marine consent application made by Trans-Tasman Resources Ltd to undertake iron ore extraction and processing operations offshore in the South Taranaki Bight

Statement of Evidence in Chief of Shawn Thompson on behalf of Trans-Tasman Resources Ltd

16 February 2014
Executive Summary

1. My evidence sets out the current level of engineering definition achieved and the strategy underpinning the development of the feasibility study for Trans-Tasman Resources Limited’s (TTR) proposed ironsands extraction project (the Project). This study is the culmination of all the exploration, investigation, engineering and research work that has gone into defining the geological, mining, metallurgical, marine and ancillary aspects of the Project’s scope of work.

2. This evidence shows that, based on the technologies and processes adopted by TTR:

(a) the Project is technically sound, economically viable, and is constructible and operable within the proposed environment; and

(b) the current level of engineering work and development provides a firm design basis for the Project, and will ensure that the detailed design and construction phases proceed with only relatively minor changes.

Introduction

3. My name is Shawn Thompson. I hold a Masters degree in Construction Management conferred by The Auckland University of Technology in 2010. Further, I am a qualified:

(a) Aircraft Mechanic, through an apprenticeship with Atlas Aircraft Corporation (SA) completed in 1984; and

(b) Mechanical Design Draughtsman, through an internship as a Mechanical Design Engineer at Atlas Aircraft Corporation from 1984 to 1987.

4. I am a full member of the Institute of Mechanical Engineers (IMechE), and Institute of Engineering Designers (UK) and am also registered as an professional engineer, (IEng), with the UK Engineering Council.

5. I am an experienced engineer and project manager with sound background in design and construction, and proven experience in project
management and leadership. My experience has all been associated with the improvement, development and installation of major mining and metallurgical process plant. I also have extensive international project management experience in the heavy industrial and mining industries, with a focus on delivery throughout the entire project life cycle. My involvement in major projects is from the concept phase through to pre-feasibility, feasibility and execution phases. My responsibilities have included managing processes and leading multi-disciplinary project teams in the engineering, procurement, construction and commissioning phases of various projects in South Africa, Saudi Arabia and New Zealand.

6. I joined TTR in March 2013 as a TTR Executive and Project Director. In this role I am directly responsible for leading the Project evaluation and engineering development through each of the progressive definition stages through to first production. My duties include, but are not limited to:

(a) The development, implementation and maintenance of strong health and safety and environmental policies, processes and cultures;

(b) The development and implementation of a technically mature, robust and environmentally acceptable engineering solution and operating paradigm that will lead to first production; and

(c) The development and implementation of processes that ensure that all engineering and operational development is done to a standard that supports all TTR license and consent applications.

7. Directly prior to my appointment as the Project Director with TTR I was engaged by Transfield Worley Limited as the Auckland Divisional Manager. In this role I managed a division that consistently delivered positive results within the industrial project arena. My time with Transfield Worley also included a two year period in which I personally managed the Taharoa Ironsands Expansion Project on behalf of New Zealand Steel. I was also the Transfield Worley Regional Mining & Metals and Project Management Lead tasked with overseeing and managing the engineering, design, and construction of projects across the Northern Region of New Zealand within the mining and metals sector.
8. My association with iron sand mining in New Zealand began in 2006/2007, where as an associate of Beca I was seconded to New Zealand Steel to manage the development of the “Taharoa 2010” project. The “Taharoa 2010” project was tasked with providing a better business proposition for New Zealand Steel's Iron sand business at Taharoa. The project involved increasing the capacity of the operation, by implementing a “Dry Mining” concept, from 1 million tons of concentrate to 2.7 million tons of a beneficiated product with an increased iron (Fe) content. In 2008, during the controversial sale process of Taharoa to CKI, I was appointed as Mine manager at Taharoa. I continued in this role through the withdrawal of CKI from the sale process for a period of one year.

9. In May 2010 I joined Transfield-Worley as a Senior Project Manager and on request from New Zealand Steel was seconded back into New Zealand Steel to manage the development and execution of a capital project at Taharoa that included:

   (a) The relocation of the Single Buoy Mooring (SBM), 500m further out to sea. This portion of work included a detail engineering assessment of the existing buoy and its future proposed use;

   (b) The extension of the associated “offshore” ship-loading pipes;

   (c) Modifications to the pumping capability of the current ship-loading system; and

   (d) The obtaining of all Environmental consents and Maritime regulatory licenses supporting the activities as listed above.

10. This project was completed successfully and currently delivers the operational capability to the Taharoa ship-loading facility.

11. Ongoing world population growth together with the developing world’s economic transformation continues to grow demand within the minerals and metals industries. Ongoing requirement for new sources of minerals and metals, is inextricably linked to the economic transformation of developing countries. A good illustration is the growing requirement in these developing countries for the extended generation and distribution of power. These new power generating solutions that are being demanded,
whether by fossil fuels or renewable sources, will require the construction materials obtained from extracted minerals and metals.

12. As a project professional dedicated to the development of resource based industries, I am excited by the advent of opportunities for new sources of minerals within the EEZ, which has given new impetus to the development of a safe, environmentally acceptable and economically viable extraction and processing system.

13. In my view this Project represents an opportunity to develop a unique suite of New Zealand owned Intellectual Property (IP), based on the integration of mature technological processes, focussed on providing a safe, environmentally acceptable and economically viable EEZ minerals extraction system.

**Code of Conduct**

14. I confirm that I have read the ‘Code of Conduct for Expert Witnesses’ as contained in Schedule 4 of the Judicature Act 1908 and the Environment Court Consolidated Practice Note 2011. I agree to comply with these Codes of Conduct. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

**Scope of Evidence**

15. My evidence sets out the current level of engineering definition achieved and the strategy underpinning the development of the feasibility study for TTR’s proposed ironsands extraction project (the Project). This study is the culmination of all the exploration, investigation, engineering and research work that has gone into defining the geological, mining, metallurgical, marine and ancillary aspects of the Project’s scope of work.

16. This evidence shows that, based on the technologies and processes adopted by TTR:

(a) the Project is technically sound, economically viable, and is constructible and operable within the proposed environment; and
(b) the current level of engineering work and development provides a firm design basis for the Project, and will ensure that the detailed design and construction phases proceed with only relatively minor changes.

Background

17. I was engaged by TTR as Project Director in time to finalise the Project’s prefeasibility study, which was then based on a Trailer Suction Hopper Dredge (TSHD) concept. This initial concept included using dredging ships (the TSHDs) to extract sediment and dump tailings. This initial solution proposed using two (2) TSHDs to dredge a selected area and deliver the dredged material to a permanently anchored process vessel. The TSHD would then collect tailings from the process vessel and deposit the tailings on an area previously dredged.

18. During the pre-feasibility review it was recognised that this option, though efficient, simple, proven and established in multiple locations around the world, presented serious environmental and economic challenges. Apart from the excessive handling and operational costs from an initial tailings area remote from any mining area, the plume creation and affected area would be exacerbated by the deposition of tailings through the entire water column.

19. TTR made the decision to investigate a more environmentally and economically viable solution. The integrated crawler extraction system employed by DeBeers Marine off the west coast of Africa was identified as a viable alternative to the TSHD option.

20. Together with IHC Merwede, TTR then embarked on a detailed evaluation of the integrated crawler option that resulted in the conclusion that an integrated sediment extraction device, i.e. a crawler system, provided the best overall mining solution, particularly because it facilitated an acceptable tailings management strategy. With the integrated solution the tailings are deposited on a recently mined area in a controlled manner from a deposition pipe positioned only 4m from the seabed. The effect is to drastically reduce the plume creation and the associated plume affected area.
Development and Feasibility Strategy

21. TTR adopted a project development philosophy that mandated the use of mature and “best practice” project technologies and processes. This approach is in acknowledgement of the sensitivity around the extraction of minerals within the EEZ and the lack of public awareness in New Zealand of the successful extraction of subsea minerals around the world.

22. International best practice methodologies and processes for project management and evaluation are consistent and similar across industry discipline and international boundaries (IPENZ, ECUK, IMechE, AusIMM, IPMA, PMI, etc.), with the requirements for disclosure in mining projects well developed and documented i.e. JORC: Australia; NI-43-101: Canada; SAMREC: South Africa.

23. The methodologies and processes referred to above all confirm the iterative nature of project evaluation and engineering development within any mining project through to first production. The final full feasibility study and the decision to proceed to production are the last (and most detailed) of a long series of technical and economic evaluations.

24. Consistent with international best practice, TTR has employed a four stage approach for the development of its Bankable Feasibility Study (BFS):

(a) Conceptual study;

(b) Pre-feasibility study;

(c) Feasibility study (Stage 1); and

(d) Feasibility study (Stage 2).

25. The intent of this recognised staged approach has been to drive rigour throughout the process, ensuring that efforts are focused upon the most critical items that influence project viability. It is a process of continual review and refinement, where risk registers, process models, process flow sheet, equipment specifications, cost estimates and schedules are continually adjusted based upon latest information.
26. This process has enabled TTR to be progressively informed of project risks, status and project viability. As the project has moved through each stage, there has been an improved understanding of the environmental, geotechnical, engineering, construction and operational risks and opportunities. The progression through each stage has provided further definition and increased levels of certainty around the cost and scheduling aspects of the project. The team of local and international consultants assembled by TTR ensure that the development options for Project are continually reviewed at both a technological and practical level, and that the opportunities, costs and risks are carefully and thoroughly evaluated.

27. Using mature and “tried and tested” technologies as the foundation of the integrated solution, TTR has been able to mitigate both technical and environmental risks. “Tried and tested” technologies also allow access to real established operational data, which TTR has used to identify the limits of the proposed technology. This has lead to the discovery of further value opportunities such as the development of new magnetic process equipment which will be the focus of an extended research and development program.

28. In resourcing the further evaluation and engineering development, as required for project feasibility, TTR has essentially “cherry picked” available individuals with industrial processing expertise from leading New Zealand industrial process consultants, namely BECA, Worley Parsons NZ and Fitzroy Engineering:

(a) BECA is one of the largest employee-owned engineering and related consultancies in the Asia-Pacific. As well as numerous engineering consultancy services, they offer planning, project and cost management services. Beca supplies engineering and related consultancy services to many markets including industrial, buildings, government, water, transport and power;

(b) Worley Parsons is regarded as the largest provider of engineering, project management, construction management, and maintenance services in Australia and New Zealand. Worley Parsons has worked with many of New Zealand's leading industrial companies, successfully delivering services ranging from concept evaluation and
feasibility studies, through detailed engineering and design, to procurement and construction, maintenance and operations support; and

(c) Fitzroys/Dialogue is one of New Zealand’s largest heavy fabrication and multi-disciplinary engineering companies. A long tradition of service to the demanding oil and gas, geothermal, petrochemical and energy industries has resulted in Fitzroy Engineering being a preferred partner for high specification, time sensitive engineering fabrication and maintenance requirements.

29. Where technology and expertise were not available in New Zealand TTR has selected and engaged experienced, leading international professionals, specifically Golder Associates, IHC Merwede, DeBeers Marine, MTI Holland BV, DRA International, Vuyk Rotterdam BV, The CSL Group Inc, and the American Bureau of Shipping. Each of these, and its role in the Project, is discussed below.

30. Golder Associates is an internationally recognised organisation providing definition and verification of mineral resources and ore reserves. Golder has specialised services in mining operations which include grade control, mining geology, mine planning, scheduling and reconciliation.

31. Golder Associates has been engaged by TTR to assist with the definition and scheduling of the resource and providing a mineral resource statement and mine plan in accordance with the Australian JORC code.

32. IHC Merwede is recognised as the global market leader in the design, development and construction of dredging and Mining Vessels and equipment. IHC Merwede has over 3,000 employees based at various locations in The Netherlands, Brazil, China, Croatia, France, India, Malaysia, the Middle East, Nigeria, Singapore, Slovakia, South Africa, the United Kingdom and the United States.

33. TTR has engaged IHC Merwede as a primary contractor to deliver the mining component, specifically to complete the design of the extraction crawler, lift and recovery system and mooring system. IHC Merwede will also play a role in TTR's project management team and with the
integration of other key systems, including the transportation of the ore, power generation and the processing plant.

34. *DeBeers Marine* (DBM) commenced full-scale subsea mining off the west coast of Africa in 1991 and has a current fleet capability of eight (8) large deep water (>70 m) diamond Mining Vessels, as well as other special purpose geo-survey platforms. DBM operates across the entire value-chain spectrum from geology and geo-survey, through sampling to mining, and finally ore processing into high value concentrate.

35. TTR has engaged DBM as the “Owners’ Representative Operational Advisor”, to support the design, integration and estimation of the processing and marine components of the complete mining solution. DeBeers Marine has specifically been engaged to provide operational advice and support to all aspects of the project including:

(a) Engineering process design;

(b) Maintenance;

(c) Manning;

(d) Provisioning;

(e) The design of the IHC integrated mining system, i.e. Crawler, Lift and Recovery System, and Mooring;

(f) The installation of the process equipment on a marine based platform; and

(g) The integration of all components on the Mining Vessel.

36. *MTI Holland BV* (MTI) is the global leading knowledge centre in the area of translating dredging, mining and deep-sea mining processes into the specification, design and application of equipment. MTI has over 50 years of experience in the field of dredging engineering, mining engineering, process engineering, geophysics, geology and geo-techniques, ship dynamics and design, mechanical engineering, fluid dynamics engineering and multi-phase dynamics engineering.
37. TTR has commissioned MTI in co-operation with Delft University of Technology to evaluate the behaviour of the de-ored sand (tailings) when it is re-deposited on the seabed. The behaviour of the tailings plume in the near-field zone, was addressed for a worst case scenario using detailed 3D CFD (Computational Fluid Dynamics) modelling. Outputs were also used to inform the commissioned NIWA far field modelling. MTI was also central with regards to the determination of the breaching characteristics of the iron sand. These characteristics pertain to the “flowability” of the in-situ resource. Together with MTI, TTR conducted an exhaustive tank test program in its test facility in Porirua.

38. **DRA International** (DRA) is a recognised leader in the mining industry with regards to mine design, mineral processing plants and plant operations. DRA is headquartered in Johannesburg, South Africa, but also has offices throughout Africa and in the Americas, Australia, India, China and Kazakhstan.

39. TTR has engaged DRA to review and qualify the Process Flow Diagram (PFD) and to verify the selection of the grinding technology specified within the PFD.

40. **Vuyk Rotterdam** (Vuyk), as a subsidiary of IHC, is an internationally recognised naval architecture company serving the maritime industry. Vuyk provides consultancy and engineering services in the areas of ship design, equipment design, marine operations and building supervision. Vuyk has specialised in work vessels for the dredging and offshore mining industries.

41. Vuyk has been engaged to provide the concept design and “Approval in Principle” from the appointed classification society for the integrated extraction, processing and storage vessel (the Mining Vessel).

42. **The CSL Group Inc** (CSL) is a leading provider of marine dry bulk cargo handling and delivery services and the world’s largest owner and operator of self-unloading vessels. CSL delivers more than 70 million tonnes of dry-bulk cargo a year for customers around the world.

43. Because of the experience and successful history in providing trans-shipping services, CSL has been engaged to firstly provide the concept
design and “Approval in Principle” from the appointed classification society for the proposed 60 kt Trans-shipment Vessel (also referred to as the FSO) and secondly a proposal to provide the trans-shipping services on a contract basis.

44. The American Bureau of Shipping (ABS) is a leading marine and offshore classification society with the responsibility to verify that marine vessels and offshore structures comply with internationally accepted rules that have been established for design and construction of marine vessels.

45. ABS is a Maritime New Zealand (MNZ) approved classification society and has also been engaged by MNZ to assist with its port state obligations. ABS has been engaged by TTR to provide this service for both the Mining Vessel and Trans-shipment Vessel.

Current Engineering Definition

46. The final objective of the TTR feasibility study (Stage 2) is to have removed all significant doubt and to present a technical solution and estimate to a high degree of certainty. The ultimate aim of the TTR feasibility study is to determine within a reasonable confidence whether or not the Project can be constructed and operated in a technically sound and economically viable manner. Capital and operating costs will be estimated to an accuracy of 10–15%, including realistic contingencies, based on the level of engineering completed.

47. Within the current stage of the feasibility study (Stage 1) apart from addressing critical items that influence project viability TTR is executing a proportionate level of engineering to support a cost estimate to an accuracy of 15-20%.

48. All of the engineering executed and commissioned during the current and preceding stages has been supported by a detailed basis of design. This provides the technical basis and data that will support all engineering e.g. geotechnical data, environmental data; wave wind and tide data for the last two decades, time usage models etc.

49. Mining and processing operations are planned to occur throughout the year, with the quantity of raw material that can be processed each year
dependant on the crawler operation on the sea bed and operation of the processing equipment on the Mining Vessel. Extraction of sea bed material by the crawler will be impacted by the manner in which the crawler mines the 300 m x 300 m blocks, including time to reverse and set up for each new lane. Operation of the Mining Vessel is impacted by, amongst other things, the sea state. The equipment on the Mining Vessel is designed to operate with wave heights up to 4.0m. However, when wave height exceeds 4.5m the crawler operation stops and the processing plant is shut down in a controlled manner if required.

50. Overall, it is expected that the crawler and Mining Vessel together will be capable of processing raw material at the specified design rate of 8000 tph for an average of 6,200 hours out of the available 8,736 hours per annum (i.e. 71% of the time).

Integrated Mining Vessel (Mining Vessel)

51. TTR currently envisages the integrated Mining Vessel to be a large 180 kt vessel designed to accommodate the extraction module at its rear, with the processing, operating and utility modules integrated above deck. The vessel and its ancillary systems will be designed to support the interrupted extraction and processing up to a 4m significant wave height. When the captain of the vessel deems it necessary or when forecasts indicate conditions approaching that would exceed this wave height limit, the crawler will be lifted on deck and processing will be adjusted to accommodate this interruption and in extended periods of inclement weather even halted.

52. The vessel will designed in accordance with the rules and regulations of ABS as a special purpose Mining Vessel for site-specific mining activities according to ABS classification rules and regulations with the Flag State for this vessel being New Zealand.

53. In the ship building regime there are statutory regulations and classification rules. The statutory regulations are governed by the laws of the Flag State, in this case New Zealand; they are mandatory and cover design, construction, maintenance, Manning and operation. The statutory regulations stem from International Maritime Organisation (IMO)
Conventions. The three most important International Conventions which impact on the design and construction of ships are Safety of Life at Sea (SOLAS), Load Line (ILLC) and Marine Pollution Prevention (MARPOL). Classification Rules are generally concerned with design, construction and maintenance and are developed, maintained and implemented by the Classification Societies.

54. Classification Society Rules are developed to establish standards for the structural strength of the ship's hull and its appendages, and the suitability of the propulsion and steering systems, power generation and those other features and auxiliary systems which have been built into the ship to assist in its operation.

55. The classification process consists of:

(a) A technical review of the design plans and related documents for a new vessel to verify compliance with the applicable Rules;

(b) Attendance at the construction of the vessel in the shipyard by a Classification Society surveyor(s) to verify that the vessel is constructed in accordance with the approved design plans and classification Rules;

(c) Attendance by a Classification Society surveyor(s) at the relevant production facilities that provide key components such as the steel, engine, generators and castings to verify that the component conforms to the applicable Rule requirements;

(d) Attendance by a Classification Society surveyor(s) at the sea trials and other trials relating to the vessel and its equipment prior to delivery to verify conformance with the applicable Rule requirements;

(e) Upon satisfactory completion of the above, the owner’s request for the issuance of a class certificate will be considered by the relevant Classification Society and, if deemed satisfactory, the assignment of class may be approved and a certificate of classification issued;
(f) Once in service, the owner must submit the vessel to a clearly specified programme of periodical class surveys, carried out onboard the vessel, to verify that the ship continues to meet the relevant Rule requirements for continuation of class.

56. The Mining Vessel will have the following main particulars / limitations:

(a) Length overall: 345.00 m;

(b) Length between perpendiculars: 330.00 m;

(c) Breadth moulded: 60.00 m;

(d) Depth: 26.25 m: and

(e) Design draught: 12.00 m.

57. The Mining Vessel will be fitted with a 4 point, thruster-assisted, winch mooring system, allowing it to be continually positioned on a predetermined extraction and associated tailings deposition pattern that has been determined as a function of the overall vessel length. The position keeping system consists of 6 thrusters (three at the bow and three at the stern) of 5,000 kW each. This corresponds to about 850 kN of thrust for each thruster.

58. The Mining Vessel will be designed to maintain production capability in conditions where the significant wave height equals 4m and will be able to "sit out" major storm events. The vessel will be required to fulfil all ABS requirements for a steel vessel operational off the west coast of New Zealand.

59. The accommodation on board the Mining Vessel will cater for a complement of 120 persons. Besides the cabins, the Mining Vessel will at least contain the following spaces:

(a) Change rooms (Male & Female);

(b) Hospital;

(c) Office;
(d) Conference room;
(e) Mess room;
(f) Galley;
(g) Provision stores with cooling/freezing area;
(h) Laundry room;
(i) Recreation room;
(j) Gymnasium;
(k) Cinema;
(l) Helicopter reception area;
(m) Helicopter safety equipment room;
(n) Server room and IT room;
(o) Wheelhouse; and
(p) Air-conditioning rooms.

Mining Module

60. The mining system has been defined at an 8,000 tonnes per hour nameplate capacity. The mining system consists of two Subsea Sediment Extraction Devices (SSED or Crawler), SSED launch and recovery system(s), the electrical distribution system for the mining system, the Mining Vessel four point wire rope mooring system and the Mining Vessel overboard tailings disposal system.

61. The weight of the crawler SSED is currently estimated at 420 tonnes and will have a depth rating of 70 m (50 m working depth plus 12 m layer thickness, rounded up). The Crawler will be fitted with a highly accurate acoustic sea bed navigation and imaging system, and will extract sediment by systematically advancing along a pre-determined 'lane'. The pump fitted on the crawler will allow the transport of the sediment slurry at
a rate of 8,000 tph resulting in a slurry velocity in the hose of around 6.5 m/s. The suction velocities directly at the nozzle entry will typically be around 1.5 – 2m/s and degrade rapidly as the distance increases from the nozzle face. The estimated intake velocities 1m away from the nozzle will be 0.5m/s maximum.

62. The Crawler will be designed for continuous operation with routine planned maintenance once a week and at least one major maintenance shutdown biannually. One of the two SSEDs held on the Mining Vessel will be in operation at all times, conditions permitting. The system will be automated as far as practically possible with the requirement for minimal operator intervention. All structures and equipment will be designed for durability and robustness in an offshore environment with minimum requirements for major in-service maintenance.

63. The hydraulic and lubricating oil for the SSED will be of a bio-degradable type. TTR accepts that the use of Bio-degradable oils will impose an additional monitoring cost and increased maintenance regime with regards to the equipment affected by this decision. The biggest issue that DBM encounters is water ingress into the hydraulic and lubrication systems and this has undoubtable influenced their decision to use non bio-degradable oils as the presence of water starts the degrading process. TTR will filter the oil on a continual basis, removing the sludges formed in the degrading process. It is TTR’s intention that these environmentally clean sludges will be homogenised into the engine fuel.

64. The Launch and Recovery System (LARS) is the system that:

(a) lifts the SSED off the Mining Vessel and lowers it onto the sea-bed during the launch phase; and then

(b) lifts the SSED off the seabed and recovers it onto the Mining Vessel during the recovery phase.

65. The system includes a main hoist winch, compensating system, A-frame and lifting line, an umbilical winch, umbilical sheave, riser tensioner system (including plant connection) and a sliding door. The LARS will be classed and designed in accordance with ABS rules for underwater vehicles, systems and hyperbaric facilities.
Process Module

66. The Project involves the excavation of up to 18 million cubic metres per year (up to 50 million tonnes per year) of seabed material containing iron sand from a water depth of 20 to 50m. Around 10% of the extracted material will be processed into iron ore concentrate for export (up to 5 million tonnes), with residual material (approximately 45 million tonnes) returned to the seabed as de-ored sediment via a controlled discharge at depth below the Mining Vessel.

67. The proposed processing technologies include screening, magnetic separation classification, grinding, and rinsing with fresh water, with seawater used as the transporting medium. The process does not involve the addition of any chemicals or other products. The aim of the mining and processing operation is to produce a Vanadium Titano-magnetite (VTM) concentrate at 55-57% Fe. The feasibility engineering progression, as described in paragraph 23, continues to provide process improvements. Current work around the grinding circuit has indicated a considerable value improvement that would entail adopting a different grinding technology. This new technology will decrease the amount of material being ground thus reducing the amount of fines generated. This process improvement will also allow TTR to effectively increase the yield of the process plant. The evidence in chief as provided by Bruce Souter of DRA will address some of the process improvements currently under review.

Power Generation Module

68. A central power generation module will be installed on the Mining Vessel which will supply power to all aspects of the Mining Vessel, including the SSED, LARS, vessel positioning systems (thrusters and anchor cable winches), iron ore processing plant, and vessel accommodation block.

69. The configuration currently proposed for the generation module comprises multiple medium speed reciprocating engines of varying sizes in the 2 – 18 MW range. This will match the Mining Vessel electricity load profile under varying operating scenarios including start up, shut down, and vessel only loads. The engines and generators, including an emergency generator running on diesel, will be located in one room below deck.
70. The power requirement to date is a maximum coincident load of 80 MW. This is considered to be conservative, with the generating target being 50 MW. Electricity will be generated at 6.6kV, 50Hz. The final determination of power generation requirements will be dependent upon the completion of the detailed design phase which will occur as part of the feasibility study (Stage 2). The medium speed reciprocating engines will be fired with grade 380 cSt heavy fuel oil (HFO). These engines will also be able to operate on diesel, typically prior to shut down to flush the fuel lines of HFO. The engines will operate to IMO Tier II emission levels, with no exhaust gas treatment systems.

71. The project did consider Liquid Natural Gas (LNG) as a fuel but the current lack of bunkering facilities in New Zealand and the fact that “ship to ship” bunkering is in its infancy has excluded the use of LNG at this time. The engine “dual fuel” technology does exist to transfer to the use of LNG when the bunkering technology has been developed. We note that LNG-fuelled vessels make up less than 1% of the total commercial marine fleet, with only 20 – 25 in operation currently (excluding LNG carriers).¹

72. Engine cooling will be closed loop for each of the engine and generator, with the heat rejected through sea water heat exchangers. Some of the rejected heat will be used to heat the sea water entering the desalination plant, which is discussed below.

73. All generation will occur at 6.6kV / 50Hz, with all 6.6kV feeders from the generators arriving in a single 6.6kV switchroom located adjacent to the generation room. Low voltage sub distribution is proposed to be at 690Vac, 415Vac and 230Vac.

74. TTR will follow the classification society and IMO rules and regulations to ensure the design, construction, installation, survey, and operation of machinery and equipment associated with power generation are done to minimize risks to the vessel, crew, and the environment. TTR will include systems and equipment to reduce gaseous exhaust emissions species legislated through the International Maritime Organization (IMO) Annex VI

Regulations 13 and 14 for nitrogen oxide (NOx) emissions from diesel engines and sulfur oxide (SOx) emissions from all fuel burning equipment on board.

**Desalination Plant**

75. Fresh (desalinated) water is required in the process to wash the iron ore concentrate to achieve the target Chloride content of <350ppm. This is accomplished while transferring the iron sand concentrate from the Mining Vessel to the Trans-shipment Vessel.

76. Sea water is pumped from the sea chest in the Mining Vessel structure through a process which involves screening, heating, straining, filtering, and then reverse osmosis (RO) desalination. The plant has a capacity of 30,000 m$^3$/day of fresh water. Storage aboard the Mining Vessel for 24,000 m$^3$ of fresh water is provided to support the maximum transfer rate of product to the Trans-shipment Vessel. The final configuration and selection of equipment for the plant remains to be confirmed, but it will consist of multiple trains of equipment which allow individual filter and/or RO elements to be taken out of service for repair/regeneration without impact on the rest of the plant operation. The straining and ultrafiltration (UF) stages are required to address the potential for a relatively high sediment load in the sea water as a consequence of the plume from the mining and beneficiation process discharges. The seawater will be heated to approx. 20ºC to improve the effectiveness of the UF membranes. The heat energy will come from the power generation engine jacket cooling system.

77. Four 250 m$^3$ tanks will be installed for the purposes of UF backwash, UF Filtrate Storage (a buffer ahead of the RO stage), and RO flushing. An energy recovery system will be utilised to reduce pumping power loads by recovering some of the pressure in the RO discharge and transferring this to the RO inlet flow stream.

78. Pumps to transfer the produced water to the storage tanks and to transfer brine to the waste water pipe are not required as both streams will exit the desalination plant under pressure.
Trans-shipment Self Unloading Vessel

79. TTR has commissioned CSL to provide a transhipment system consisting of a built-for-purpose self-unloading, Trans-shipment Vessel with a cargo capacity of 60,000 mt.

80. The loading system aboard the Trans-shipment Vessel consists of a dewatering plant and a mechanical, deck conveying system. Product will be slurried with fresh water and pumped via floating hoses from the Mining Vessel at a concentration of 50% by weight to the Trans-shipment Vessel.

81. The dewatering plant will consist of a number of Hyperbaric Disc filters, sized to the expected particle size and quantity of the slurry. The machine consists of discs divided into segments, each of which is covered by a filter cloth on each side. The discs rotate with the bottom 35% (approximately) of the discs submerged in a slurry bath. Each segment is connected to a vacuum system, which allows the concentrate to form a cake on the filter cloth as the discs are submerged. Once the filter cloths have been "seeded" i.e. been rotated through the slurry a couple of times, the percentage of fines passing through the cloth and subsequent formed concentrate cake is estimated to be round the 50ppm mark. The Dewatering of the concentrate takes place as the segments leave the bath and the cake is discharged into a separate chamber.

82. Once fully loaded, the Trans-shipment Vessel will sail to the area designated for “dry” transfer onto Ocean Going Cargo Vessels. The “dry” cargo discharge system on the proposed Trans-shipment Vessel is gravity based, a proven system widely used across CSL’s global fleet of vessels.

83. The dewatered iron ore flows through gravity feeder gates at the bottom of the Trans-shipment Vessel’s cargo holds, depositing cargo onto an inclining tunnel belt that will elevate the cargo to the main deck of the Trans-shipment Vessel. The cargo is then deposited onto two separate incline conveyors, each feeding a ship-loader located fore and aft. The ship-loaders can slew, luff and telescope and are capable of loading and trimming Ocean Going Cargo vessels of up to 57m beam.

84. Capt. Ian Ives, Director of CSL, the supplier of the Trans-shipment vessel (FSO) will provide a Statement of Evidence in Chief separately.
Ancillary Operational Components

85. An overview of ancillary operational components is provided below, namely the anchor handling tug, personnel numbers, personnel transfer, and fuel handling and transport.

Anchor Handling Tug

86. The Project has provision for a full time 80t e bollard pull Anchor Handling Tug (AHT) to assist with the relocation of anchors during Mining Vessel moves. The AHT will also:

(a) assist with provisioning of the Project’s operational vessels;

(b) assist with the connection of floating hoses;

(c) provide refuelling assistance; and

(d) be equipped to assist in case of any fuel spillage and fire.

Personnel Numbers

87. The personnel levels for the Project have been developed based on those for the two FPSOs currently operating in the Taranaki offshore oil fields, both of which have been operating since 2007. It is envisaged that the TTR will employ the same 21 day on and 21 day off roster used on the current FPSOs. This is a typical arrangement in the offshore oil and gas industry and results in two crews being engaged for each vessel. There are essentially two complete crews on board at a time, one for day shift and the other for night shift.

88. The total personnel complement required, with an allowance for relief during holiday periods, will be:

(a) 139 persons for the Mining Vessel;

(b) 34 persons for the Trans-shipment Vessel; and

(c) 24 persons for the AHT.
89. There are currently plans to incentivise the use of either New Zealand citizens or New Zealand residents as crew on all operational vessels.

**Personnel Transfer**

90. Personnel and emergency/specialist supplies will be transferred on a regular basis to the Mining Vessel and Trans-shipment Vessel by helicopter. Given that these operations are some of the most dangerous in the Project, the safety precautions are very specific and require a number of trained specialists. Some of the considerations will be:

(a) Security;

(b) Communications;

(c) Cold water survival training;

(d) Weather parameters;

(e) Fire fighting capability; and

(f) Rescue capability.

91. New Zealand has a major helicopter port based in New Plymouth which carries out a number of flights each day to New Zealand offshore installations. STOS for instance has strict H&S standards and procedures which allow them to operate around and land on oil installations, and as a minimum, as a user of the same services, these will be applied to TTR's offshore operations. The standards and procedures include adherence to Civil Aviation Rules; Safety Case methodology, and Risk & impact assessments. In the absence of specific NZ standards TTR has referenced the “Guidelines for the Management of Offshore Helideck Operations” by the UK Offshore Operators Association to provide guidance with regard to offshore helicopter operations.

92. The location of TTR's heliport is still to be established. Things that will be considered will be the location of the Contractor's maintenance facility, support and provisioning capability, location of the majority of the workforce and the flight distance over water.
Fuel Supply and Transfer

93. The ship to ship fuel transfer will be conducted under Maritime New Zealand regulations. A similar operation is conducted by Seafuels Limited which currently operates a refuelling vessel service for commercial ships calling at the Port of Auckland. The 3,900 tonne Seafuels tanker the “Awanuia” transfers fuel directly to these vessels using a Ship to Ship process.

94. Standard marine fuel storage, handling and treatment systems will be installed on board the Mining Vessel. Heavy fuel oil grade 380 cSt will be used to fuel the power generation plant. Medium fuel oil (diesel) will also be stored on the vessel and used to flush the fuel system on the engines prior to shut down, to run the generators when in port, and for the emergency generator. Fuel will be transferred at sea from a bunkering vessel to the Mining Vessel. A standard package boiler fuelled on MFO and HFO will be used to supply the energy needed to maintain the required temperature in the HFO storage tanks and prior to injection in the engines.

95. Please refer to the Statement of Evidence in Chief of Geraint Bermingham.

Scenario Modelled for Oil Spill

96. The “worst case” oil spill scenario for coastal impacts was modelled by MetOcean Solutions Ltd (MetOcean), and is discussed in the evidence of Dr Beamsley. The spill quantity modelled in this scenario was that which could reasonably be expected from operations with the highest likelihood of a spill. This translates into a spillage of an estimated 100 mT of a Grade IV oil as classified by Lenting, V., & Pratt, C. (1998) “The New Zealand marine oil spill risk assessment 1998” with a specific gravity of approximately 0.98.

97. The project evaluated different spill scenarios and also the mitigating measures that would be included during the design of the vessel i.e. ship to ship fuel transfer operations indicated less voluminous spills with the current technology available to minimise spills such as using automatic shut-off valves. The use of the Anchor Handling Tug, fitted out with both
fire-fighting and spill response gear, would contain any spillage from bunkering operations and it is also important to note that the AHT will be in attendance throughout all ship to ship transfers.

98. Please refer to the Statement of Evidence in Chief of Geraint Bermingham.

Response to Further Information Request

99. The EPA requested the following further information from TTR:

(a) Quantification of the suspended sediment concentration in the freshwater discharge. I have I have addressed this issue at paragraph 81 of my evidence;

(b) Sources to justify TTR assumptions on iron ore prices, freight costs, electricity costs and other production costs. This is addressed in the evidence of Tim Crossley and Dennis Karp; and

(c) Further information on how vessel design and safety information will be compiled and delivered to the relevant agency / agencies. This is addressed in paragraphs 52 to 55, and paragraph 74 of my evidence.

Response to EPA Staff Report

100. In the EPA Staff Report it identified the following gaps/uncertainty in information provided by TTR:

(a) The levels of suspended sediment in the freshwater discharge. This is addressed at paragraph 81 of my evidence;

(b) The intake velocity of the Crawler’s pump, in relation to the risk of fish entrainment. This is provided at paragraph 61 of my evidence;

(c) The suitability of alternative sources of fuel for the vessels to meet international best practice with respect to sulphur and nitrogen oxide emissions." This is addressed at paragraphs 70 and 74 of my evidence;
(d) Information on the measures proposed to limit Mining Vessel workers’ exposure to contaminants caused by air pollution from the vessel(s). This is addressed at paragraph 74 of my evidence;

(e) Whether the FPSO will be classed as a vessel or an installation. This is addressed at paragraph 52 of my evidence.

Shawn Thompson
16 February 2014