Cape Lambert Port B Development

Ecosystem Research and Monitoring Program

February 2017

Prepared by Rio Tinto
As a requirement (Condition 10) of EPBC 2008/4032

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Rio Tinto is implementing the Cape Lambert Port B Development which involves an expansion to its existing Cape Lambert Operations. The environmental aspects of Cape Lambert Port B Development were subject to environmental assessment by both Western Australian and Commonwealth agencies. Within the work that has already been undertaken for those assessments, Rio Tinto has identified a number of areas where research and monitoring programs can be conducted to improve understanding of the marine environment around Cape Lambert and so increase capacity to predict impacts and design future management programs.

The following Ecosystem Research and Monitoring Program (ERMP) has been prepared to describe the research and monitoring works to be completed before, during and/or after the implementation of the Cape Lambert Port B Development. This ERMP has been prepared in accordance with the EPBC Act approval 2008/4032 (the approval) that was granted on 26 October 2010 under Part 9 of the *Environment Protection and Biodiversity Conservation Act 1999*. Conditions 10, 11, 12 and 13 of the approval require an ERMP to be prepared and submitted to the Minister of the Department of Environment and Energy (DotEE) (formerly the Department of Sustainability, Environment, Water, Population and Communities) for approval. On 25 October 2011 the ERMP was approved in accordance with condition 10 of the approval.

The aim of the ERMP is to improve the knowledge base for marine resources and process within the Cape Lambert area such that there is a better understanding of the current status of these and how they respond to dredging. Thus the plan outputs are twofold:

- establish the current status of marine resources which may be affected by dredging;
- better understand the potential impacts from the port development and dredging activities.

In addition to allowing evaluation of impacts of the current proposal, the ERMP outcomes will assist inform future environmental assessments for similar developments in the Cape Lambert region.

The approval specifies broad categories of research and monitoring to be completed including coastal processes; condition of listed/threatened migratory species populations; behaviour of listed threatened/migratory species; water quality; and benthic habitat. Rio Tinto has focused research and monitoring programs on areas of knowledge gaps within the region; areas at risk of being impacted by the Cape Lambert Port B Development; and the extent of WA State and Commonwealth Government interest. In addition, these programs generally align with Rio Tinto's Cape Lambert environmental priorities.

Fifteen programs for the Cape Lambert Port B Development are presented in **Table 1**. Each program details the program title; a summary scope and key output; the broad approach to be adopted; who will conduct the work; the timeframes for implementation and reporting; and the linkages between categories of research/monitoring.

Table 2 provides historical water quality and benthic community research and monitoring at Cape Lambert. The data was collected between 2006 and 2010 and was derived from monitoring completed for the Cape Lambert operations and during the approval and implementation of recent port expansion projects. The design approach for monitoring programs for the Cape Lambert Port B Development took this data into account and has been considered in the development of this ERMP. The historical results will be compared to monitoring data collected under Program 9.

Table 1. Cape Lambert Port B Development - Ecosystem Research and Monitoring Program – February 2017

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
Category 1. Coastal Processes						
1. Beach sand colour monitoring	Assessment of the colour of sand and sediments at beaches before, during and after dredging. **Output:** A time series of images and colour chart assessments of sand and sediment at beaches around Cape Lambert before, during and after the Cape Lambert Port B dredging program.	Standardised colour charts are to be used to identify or describe the colour of sand and sediment found on selected beaches around Cape Lambert, including Cooling Water Beach, Bells Beach, Sam's Creek and the front beach at Point Samson. Photographs will also be taken at the same sites as the colour charting assessments are made. This is intended to show any changes in sand and sediment colour over the life of the dredging program and beyond. The assessments commenced just prior to the commencement of dredging in December 2010 and will be continued every fortnight. If little changes are observed after the first 12 months of colour assessments, no further assessments will be undertaken.	RTIO Site HSE Department and/or consultancy commissioned by Rio Tinto.	**Commence:** One week prior to dredging (already commenced). **Completion:** Three months post-dredging, or after 12 months of assessments if little or no change is observed. **Status:** Complete.	A report will be prepared within 3 months of completion (ie 3 months after the final assessment is completed). The report will be submitted to DotEE within 2 months of finalisation.	Also applicable to Category 2.
2. Local coastal water processes	Study of local coastal processes, principally water current and sediment transport patterns and their effect on beach profiles. **Output:** Understanding of coastal processes and how these affect beach profiles, especially for known turtle nesting beaches.	The scope of work will be finalised in consultation with an oceanographic consultancy or a tertiary institution to be commissioned by Rio Tinto. This study will assist in developing a better understanding of the effects of near-shore current flows and sediment transport on the supply of sediment to and maintenance on beaches. Understanding the natural drivers that replenish or remove sand from beaches will provide insight into the longer term viability of turtle nesting areas. This will also look at the effect of near-	Oceanographic consultancy or a tertiary institution and/or consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of approval of ERMP. **Completion:** Within 18 months of commencement. **Status:** Complete.	Once agreement is reached between Rio Tinto and the oceanographic consultancy or tertiary institution, the methodology for the coastal water processes study will be submitted to DotEE. The report on the outcomes will be submitted	Also applicable to Category 2.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		shore current flows on sediment plumes from future dredging programs; plume tracking from potential marine oil spills; coral larvae transport; and possibly surface and sub-surface implications for turtle hatchling movements. Based on initial discussions with a tertiary institution (James Cook University), the preferred option is for the study to be undertaken as an ARC linkage grant to support a student. However, if there is insufficient academic interest, the study may be undertaken as a direct consultancy.			to DotEE within 2 months of finalisation.	
3. Beach profiling of turtle nesting areas	Time sequence assessment of the beach profiles of local known turtle nesting areas. **Output:** A report on temporal and spatial patterns of change in the beach/dune profile of known turtle nesting areas.	The scope of work will be finalised in consultation with a consultancy or a tertiary institution to be commissioned by Rio Tinto. It is planned to undertake beach profiling of selected known mainland turtle nesting areas and one mainland non-turtle nesting beach. The turtle nesting areas will include Bells Beach, Cooling Water Beach and Cleaverville Beach. Sam's Beach (a non- turtle nesting beach) will also be profiled as a reference site. Beach profiling would be undertaken twice a year (once post summer cyclone season and once post winter season) over 4 years. The information collected by the beach profiling study will be integrated with the results of the sediment transport/coastal processes study to develop a better understanding of coastline stability, with an emphasis on turtle nesting areas.	Tertiary institution or a consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of approval of ERMP. **Completion:** Within 4 years of commencement. **Status:** In progress.	Once agreement is reached between Rio Tinto and the consultancy or tertiary institution, the methodology for the beach profiling of turtle nesting areas will be submitted to DotEE. A report will be prepared within 3 months of completion. The report will be submitted to DotEE within 2 months of finalisation. Report due to be submitted by 30 April 2017.	Also applicable to Category 5.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		This study would be a mapping and profiling exercise using surveying techniques. Historical satellite imagery or aerial photography would be used as references.				
Category 2. Condition of Listed/Threatened Migratory Species Population Associated with Habitat and Commonwealth Marine Areas						
4. PhD research project on turtle ecology (including behaviour and population dynamics)	A PhD research project (subject to student availability) on the ecology of turtles using island and mainland rookeries in the Pilbara region. **Output:** A PhD theses and published papers.	The specific scope of work will be finalised in consultation between Rio Tinto, the Department of Parks and Wildlife (DPAW) (formerly Department of Environment and Conservation (DEC)) and a State-based tertiary institution and prospective PhD student (subject to academic interest and the nomination of a suitable candidate). Should a suitable candidate not be sourced, Rio Tinto will manage the work through internal role/s and/or will engage a suitably qualified and experienced consultant. A PhD research project on aspects of the ecology of turtles utilising island and mainland turtle rookeries. The scope of the research project will need to be developed with a suitable candidate and supervisors but is expected to include investigation of existing population demographics and dynamics, movement patterns of marine turtles between beaches in the Dampier Archipelago and Pilbara region, behaviour and relationships with key biophysical parameters, particularly those which may affect turtles at Cape Lambert. Rio Tinto is conducting satellite tracking of several marine turtles. It is envisaged that this research project will incorporate additional satellite tracking of marine turtles with live tracking and will be exhibited on www.seaturtle.org as per the current Rio Tinto tracking program.	State-based tertiary institution.	**Commence:** Within 9 months of approval of ERMP. **Completion:** Within 5 years of commencement. **Status:** Partially complete/in progress.	Once agreement is reached between Rio Tinto, DPAW and the State-based tertiary institution, the methodology for the research project will be submitted to DotEE. The outcomes of the research project will be submitted to DotEE within 3 months of completion (completion is defined as submission of final research project document to institution for assessment). Remaining items due to be submitted by 25 July 2017.	Also applicable to Category 3.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		Rio Tinto will fund and assist in the implementation of the research project and provide access to its turtle data. Aspects of the research project will be written as published papers in established journals.				
5. Research project on reviewing and interpreting existing turtle tagging data	Review the implications and value of existing turtle tagging data established for the region to better understand turtle movements, especially in the Dampier/Cape Lambert region. **Output:** Masters or Honours or consultant research project on interpretation of existing turtle tagging data in the broad Cape Lambert region in relation to turtle movements and behaviour.	The specific scope of work will be finalised in consultation between Rio Tinto, DPAW and a State-based tertiary institution and prospective Masters or Honours student (subject to availability). Should a suitable candidate not be sourced, Rio Tinto will manage the work through internal role/s and/or will engage a suitably qualified and experienced consultant. An extensive amount of data has been generated from historical and ongoing turtle tagging programs, including data collected over a 16 year period at Rosemary Island, offshore from the Burrup Peninsula near Dampier. DPAW hold an extensive range of data generated from marine turtle monitoring programs in the Pilbara region. There has been little consolidation or interpretation of that regional data. Subject to suitable access to existing data (and Intellectual Property issues being resolved), there is community and regulatory benefit of some form of interpretation of that data. It is anticipated that the research project will be essentially non-field based. Rio Tinto will fund and assist in the implementation of the research project and provide access to its turtle tagging data. Preliminary discussions have been held with the DPAW on the value of this research project and available	A suitably qualified and experienced consultancy was commissioned by Rio Tinto.	**Commence:** Within 9 months of approval of ERMP. **Completion:** Within 2 years of commencement (if Honours) Within 3 years of commencement (if Masters or consultant). **Status:** In progress.	Once agreement is reached between Rio Tinto, DPAW and the research author on the methodology, the project will commence. The outcomes of the research project will be submitted to DotEE within 3 months of completion. Report due to be submitted by 31 July 2017.	Also applicable to Category 3.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		options and opportunities to implement this research.				
Category 3. Behaviour of Listed Threatened/Migratory Species, including Monitoring of Potential Important Habitats (eg whale resting areas)						
6. Determining the level of whale visitation and patterns of use of the Nickol Bay area	Conduct an intensive short duration monitoring program of the suspected Nickol Bay whale resting area on an annual basis over 5 years in the Cape Lambert area. **Output:** Improved understanding of the level of whale use and use patterns in the Nickol Bay resting area and the Cape Lambert area.	Subject to final scoping agreed between representatives of Rio Tinto and a consultancy or tertiary institution. The planned methodology is to conduct an intensive, short duration, whale monitoring program within the suspected Nickol Bay region whale resting area. The planned duration of each whale monitoring event will be 7 days during the peak southern whale migration period. The timing of this survey will be based on observations elsewhere on the coast and advice from experts. The 'predicted occurrence' of the southward migration of Humpback whales is between August and October each year. Some Humpback whales 'potentially occur' in November as part of the southern migration. Monitoring is planned to be undertaken from a fixed wing aircraft on a pre-determined flight pattern on a daily basis over the 7 day survey period. The Cape Lambert area will also be incorporated into this pre-determined flight path. Recording of information will include: whale species, number of whales, location and activity being undertaken. In addition to whale sightings, records will also be made of any whale sharks or dugongs observed during the pre-determined flight patterns.	Tertiary institution or a consultancy or other suitable group commissioned by Rio Tinto. Suitably qualified Rio Tinto personnel may also participate in the surveys.	**Commence:** Within 3 months of approval of ERMP (and within following full southern Humpback whale migration season). **Completion:** Within 5 years of commencement. Annual monitoring data was collected between 2012 and 2016. **Status:** Complete.	Once agreement is reached between Rio Tinto and the consultancy or tertiary institution, the monitoring methodology will be submitted to DotEE. The outcomes of each annual monitoring will be submitted to DotEE within 2 months of completion. The Cape Lambert Port B Development – Ecosystem Research and Monitoring Program 6: Humpback Whale Aerial Surveys 2012-2016 Review dated January 2017 was submitted to DotEE on 20 January 2017.	Also applicable to Category 2.

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		Some liaison with other potential future operators in the area (Mt Anketell) may be required to ensure effort is not duplicated.				
7. Determining the level of visitation of whales to the Cape Lambert Operation area	Record whale sightings from pile driving barges being used for the Cape Lambert Port B for supplementing the existing national database of cetacean sightings. **Output:** Contribute to the knowledge of whale abundance and visitation in the Cape Lambert Operation area.	The monitoring of whales during the pile driving program is outlined in the approved Cetacean Management Plan (SKM 2011). Sightings of whales from the pile driving barges will be recorded in the template form provided as Appendix D in the Cetacean Management Plan (CMP). Where it is possible and practical, data generated from this monitoring will supplement the monitoring of whales in the Nickol Bay area (Item 6). Cetacean observations from previous dredge operators in the Cape Lambert region will be investigated. Data logs of cetacean (and dugong and turtles) observations are routinely compiled by Marine Fauna Observers stationed on dredgers and other support vessels. These data record sightings, species (where possible) and time and location. The logs from recent Cape Lambert dredging programs will be analysed for trends in sightings with factors such as time of day, season and weather state.	Construction and operational personnel, with a review of previous data to be done by a consultancy commissioned by Rio Tinto.	**Commence:** Start of Cape Lambert Port B pile driving program (and once whale migration season commences). **Completion:** End of Cape Lambert Port B pile driving program (or once whale migration season ends). **Status:** Complete.	Data collected from the whale surveys will be available to DotEE from time of collection as stated in the CMP; cetacean records will be lodged with the National Cetacean Sighting and Strandings Database at the Australian Antarctic Division.	Also applicable to Category 2.
8.Pile driving vibration and marine turtle eggs	Fund calibration of Honours project findings that has examined the effects of pile driver induced vibration on Flatback turtle eggs against vibration from pile driving associated with Cape Lambert Port B. **Output:** Assessment report of likely effects of	An Honours research program was undertaken in 2010 through the Charles Darwin University into the effects of pile driver induced vibration on marine turtle eggs. The research was undertaken on Flatback turtle eggs sourced from Bare Sand Island, Northern Territory. The effect of various vibration levels on embryonic	Charles Darwin University, supervised by Dr Mick Guinea.	**Commence:** Within 4 months of approval of ERMP (while pile driving still being undertaken). **Completion:** Within 3 months of	A report will be prepared within 3 months of the fieldwork. The final report will be submitted to DotEE within 2 months of completion (ie	Also applicable to Category 2.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
	recorded pile driver vibration on turtle egg embryos at Cooling Water Beach.	development was assessed in the laboratory to determine the stage where an impact is detectable. It is intended to retrospectively fund part of that Honours research and to measure levels of vibration recorded in sands at Cooling Water Beach to compare with the findings of that research. Cooling Water Beach is the nearest beach to the Cape Lambert Port B pile driving and is located within the Cape Lambert Operation area and experiences noise/vibration from operational activities. This will involve getting the student/supervisor to manage the recording of ground vibration at Cooling Water Beach (very low turtle usage beach) during pile driving activities and to calibrate the vibration levels against those tested in the laboratory undertaken as part of the Honours research work. This will allow some assessment of likely effects of recorded pile driver vibration on turtle egg embryos at Cooling Water Beach.		end of pile driving. **Status:** Complete.	within 5 months of the end of the fieldwork).	
Category 4. Water Quality						
9. Long-term water quality and sedimentation monitoring	Continue water quality, sedimentation and particle size distribution (PSD) monitoring for a period of 12 months after the cessation of the Cape Lambert Port B dredging program. These data, and data collected previously during the baseline for Cape Lambert Port A (~8 months), and Cape Lambert Port B (~18 months) will be investigated. These three data sets will provide a measure of water quality at a subset of monitoring sites for a total of about 38 months and therefore can be examined for correlations between the various parameters	Recent historical water quality monitoring undertaken in the Cape Lambert region is summarised in **Table 2**. The following water quality measurements are to be collected during the Cape Lambert Port B development dredging and spoil disposal program: • Turbidity (NTU) – in situ logging, every 30 minutes, 24 hours a day • Temperature (^{o}C) – in situ logging, every 30 minutes, 24	Consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of completion of Cape Lambert Port B dredging program. **Completion:** 12 months after first round of post dredging water quality and sedimentation and PSD monitoring. **Status:**	Investigation of the data sets and preparation of a draft report will be completed within 6 months of the end of the 12 month data collection period. The final report will be submitted to DotEE within 2 months of	Also applicable to Category 5.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
	measured and season, cyclones, tides, and weather conditions. Water quality monitoring is to be continued for 12 months after the completion of dredging and will produce a data set of ~38 months of baseline for a sub-set (5 sites) of the monitoring sites being used for the Cape Lambert Port B dredging program. Additional water quality (TSS) data will be obtained through the post-processing of a representative range of Moderate Resolution Imaging Spectroradiometer (MODIS) imagery for a 12 month period. Sedimentation monitoring and Particle Size Distribution (PSD) monitoring are to be undertaken 4 times per year for a total of 3 baseline years at a sub-set (5 sites) of the monitoring sites being used for the Cape Lambert Port B dredging program. **Output:** A better understanding of background water quality and patterns of sedimentation for the Cape Lambert region and a better understanding of any long term effects of dredging and port operations on physical water quality, sedimentation rates and sediment composition (PSD).	hours a day • Light (umol/m2/day) – in situ logging, every 30 minute, 24 hours a day • Gross sedimentation rates (mg/cm2/day) – sediment traps, every 3 months • Particle size distribution (PSD) – sediment traps and surrounding benthos – every 3 months The loggers are to be retrieved and the data downloaded every three months. Gross Sedimentation data are to be collected every three months (using a modified methodology to suit the extended time frame) and PSD samples are also to be collected quarterly at each of the monitoring locations. Treatment of sediment samples will be in accordance with methods outlined in the DSDMP. It is proposed that water quality and sedimentation monitoring is completed for a total period of 3 baseline (non-dredging) years in the Cape Lambert region. In situ continuous water quality logging of turbidity/NTU, temperature and light will be recorded at 5 selected sites (a sub-set of the 13 sites being used for the Cape Lambert Port B dredging monitoring program) for 12 months following completion of dredging. Water quality data will be downloaded and loggers will be maintained approximately every 3 months during this period. MODIS imagery is currently being obtained on a daily basis throughout		Complete.	submission of a draft report to RioTinto.	

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		the Cape Lambert Port B dredge monitoring program for the purposes of visually tracking the dredge plume and extracting TSS data over a wide spatial coverage. An accurate algorithm has been developed for the Cape Lambert area that is used to extract TSS data from MODIS imagery. It is proposed that TSS data continues to be obtained through post-processing a representative sample of MODIS imagery for 12 months after the completion of the Cape Lambert Port B dredging program. TSS data extracted from MODIS imagery will compliment in situ logger data to provide a wide spatial coverage and inform the analyses of the relationships between turbidity, sedimentation and various physical parameters such as depth, tides, season and weather in the Cape Lambert region. It is proposed that sedimentation data is obtained from each of 5 sites (a sub-set of the Cape Lambert Port B monitoring sites) using sediment traps. Sediment traps will be emptied and the contents will be analysed to determine gross sedimentation levels every 3 months over a 3 year period following completion of dredging. It is proposed that PSD data is obtained from sediments collected in traps, as well as from sediment grab samples collected from the substrate, at each of 5 sites every 3 months over a 12 month period following completion of dredging.				

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
Category 5. Benthic habitat, including but not limited to coral, seagrass, mangrove						
10. Long term changes in coral health	Coral health monitoring is being undertaken in accordance with the approved Dredging and Spoil Disposal Management Plan (DSDMP) before, during and after dredging. This monitoring also builds on coral monitoring undertaken during the Cape Lambert Port A dredging program. These combined datasets will be examined (along with relevant dredging, water quality and metocean data) to assist characterise the temporal dynamics of coral communities in the Cape Lambert region and identify any long-term natural or dredging-related impacts to coral health. **Output:** A characterisation of natural temporal dynamics of coral communities at Cape Lambert. An assessment of the relationship between changes in coral health and dredging activities, water quality, seasonal and metocean conditions. The development, where possible, of a relationship between water quality and coral health to provide a better understand of the potential impacts of dredging and to allow development of more realistic management triggers.	The coral health monitoring undertaken for the Cape Lambert Port B dredging program is described in detail in Section 5.3 of the DSDMP. The coral health monitoring program has been designed to provide a quantitative measure of coral health (percent bleaching or mortality) which can be assessed against triggers, which, if reached, would instigate management measures that would minimise the likelihood of further impacts. Coral health data has been collected for approximately 2 years before the commencement of the Cape Lambert Port B dredging, during dredging and will be collected for two months following completion of dredging. Monitoring is being undertaken at 1 impact site, 5 indicator sites, 5 influence sites and 2 reference sites and 2 contingency reference sites on an approximately fortnightly basis. Coral health monitoring was also undertaken during the recent Cape Lambert Port A upgrade for a period of approximately 2 years and many sites were consistent with those being monitored for the Cape Lambert Port B dredging program (refer **Table 2**). Upon completion of the Cape Lambert Port B monitoring, it is proposed that all coral health data (from both the Port A and Port B monitoring programs) is examined to characterise the temporal dynamics and natural range of variability in coral bleaching	Consultancy commissioned by Rio Tinto.	**Commence:** Upon completion of the Cape Lambert Port B monitoring program. **Completion:** Within 9 months of the completion of the Cape Lambert Port B monitoring program. **Status:** Complete.	A report will be prepared within 3 months of completion. The final report will be submitted to DotEE within 2 months of completion (ie within 5 months of completion)	Also applicable to Category 4.

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		and mortality at Cape Lambert. This data will help to inform the ecological significance of dredging impacts for Cape Lambert Port B and future projects in light of natural changes. An assessment of the relationship between changes in coral health and dredging activities, water quality, seasonal influences and metocean conditions will also be undertaken. If impacts to coral health are observed during the Cape Lambert Port B project (no impacts were observed during the Cape Lambert Port A program), it may be possible to develop relationships between water quality and coral health to allow for more accurate impact predictions in future projects and to assist in developing more realistic management triggers.				
11. Macro-algal seasonal abundance and distribution surveys	Collect estimates of seasonal cover of macro-algal canopy (video tows). **Output:** Assessment of the seasonal distribution and abundance of macro-algae communities.	Subject to final scoping agreed between representatives of Rio Tinto and a consultancy or tertiary institution. It is planned that estimates and basic mapping of seasonal cover of macro-algal canopies is undertaken using video tows in the Cape Lambert region. The nominated focus area will be around Delambre Island near Cape Lambert, but other areas may be targeted. Surveys will be undertaken every 6 months for 3 years following the cessation of Cape Lambert Port B dredging. One survey will be undertaken in the winter season and another survey will be undertaken in the summer season each year.	Tertiary institution or a consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of approval of ERMP and after the cessation of dredging. **Completion:** Within 3 years of commencement. **Status:** Complete.	A report will be prepared within 3 months of the final survey (after 3 years). The final report will be submitted to DotEE within 2 months of completion.	Also applicable to Category 4 and maybe Category 1.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
12. Increased knowledge of the distribution and composition of benthic communities	Collate all available benthic habitat distribution data for the Cape Lambert region and produce a combined benthic habitat map. Identify any significant knowledge gaps in the distribution and compositions of benthic communities in the Cape Lambert region to assist prioritise future survey work. If and where required, collect additional data to fill knowledge gaps. **Output:** A combined habitat map illustrating the distribution and composition of benthic communities in the Cape Lambert region. A list of knowledge gaps and priority areas requiring investigation. If required, the collection of additional data on benthic communities in the Cape Lambert region to fill the identified gaps.	Subject to final scoping agreed between representatives of Rio Tinto and a consultancy or tertiary institution. A range of benthic habitat mapping studies have been undertaken in the Cape Lambert region associated with environmental approvals for a range of development projects. However, to date, these studies have been conducted largely in piecemeal fashion in terms of the areas covered and data obtained, related to the objectives of each project. It is planned that all available studies on the distribution and composition of benthic communities will be collated and a unified habitat map produced. This map will assist in identifying any significant knowledge gaps (e.g. specific areas or community types not currently covered) which can then prioritise future survey work. Where significant knowledge gaps are identified, surveys may be undertaken to provide additional information to fill these gaps. For example, towed video may be used to provide additional data on the distribution of benthic communities. It is currently planned that up to 2 surveys may be undertaken within this program where significant knowledge gaps have been identified.	Tertiary institution or a consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of approval of ERMP. **Completion:** Within 18 months of commencement (allows for one field survey to be undertaken, if required). **Status:** Complete.	A report will be prepared within 3 months of completion. The report will be submitted to DotEE within 2 months of finalisation.	Also applicable to Category 4 and maybe Category 1.
13. Mapping of marine areas using remote sensing techniques	Testing of remote sensing techniques (such as hyper-spectral, satellite, aerial, LiDAR or other imagery) in the mapping of intertidal and shallow sub-tidal marine habitats in the immediate Cape Lambert area.	Subject to final scoping agreed between representatives of Rio Tinto and a consultancy or tertiary institution. In broad terms, this study will investigate the utility of hyper-spectral	Tertiary institution or a consultancy commissioned by Rio Tinto.	**Commence:** Within 6 months of approval of ERMP. **Completion:** Within 18 months of commencement.	A report to be prepared within 6 months of the field survey. The report will be submitted to DotEE within 2	Also applicable to Category 1.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
	Output: A set of images for intertidal and where successful, shallow sub-tidal marine habitats that have been classified and contrasted with existing ground truthing data.	imagery (or other more suitable imagery) to provide detailed images that can be used to map intertidal and shallow sub-tidal marine habitats in the immediate Cape Lambert area with resolution beyond that of currently available commercial satellite products. This output will be contrasted with historically available imagery such as Landsat to determine if estimates of historical change can be constructed. The focus will be on whether this technique can be used for mangroves, intertidal mixed mosaic habitats and seagrass beds. Existing aerial/satellite imagery will be used to provide historical context for comparison. Participate in similar regional collaborative programs in the future – if these arise. If the technology is effective and the outcomes are worthwhile, an extension to the program may be considered. This will initially be a single image capture run, with an option for every 2 years afterward if the approach proves beneficial/effective.		**Status:** Complete.	months of finalisation.	
14. Point Samson Beach Intertidal Reef field guide booklet	Development and publication of a pictorial field guide booklet on the fauna and flora of the intertidal communities recorded on the Samson Beach intertidal reef community at Point Samson. **Output:** Field guide booklet that raises public awareness and appreciation of the Samson Beach intertidal reef community.	Baseline data was obtained on intertidal reef communities at Samson Beach (at Point Samson) and West Reef (adjacent to Cape Lambert Port B). This was collated and reported in SKM 2009. Existing data and information obtained during that baseline work will be extracted and used to develop a pictorial field guide booklet for the Samson Beach intertidal reef	Consultancy commissioned by Rio Tinto.	**Commence:** Within 3 months of approval of ERMP. **Completion:** Within 12 months of commencement. **Status:** Complete.	Copy of the final field guide booklet to be submitted to DotEE within 2 months of printing.	Also applicable to Category 1.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		community designed for use and awareness by the Point Samson/Wickham local communities. The field guide booklet is anticipated to supplement the reef-protection zone established in June 2006 (under Section 43 of the *Fish Resources Management Act 1994*) for the area between north of Sam's Creek to south of old Point Samson jetty. It is envisaged that the field guide booklet will contain an introduction, outline the physical and biological setting and document (pictorially and with some basic text) common species of fish, algae, corals, sponges, echinoderms, molluscs, crustaceans and worms found on the Samson Beach intertidal reef. A limited production run of about 60-80 copies is envisaged. Copies will be made available free of charge to the local community (through the Point Samson Progress Association) and libraries within the Shire of Roebourne.				
15. Comparative mapping of mangrove community between Cape Lambert and Point Samson	Review and mapping of the extent of the distribution of mangrove communities located between Cape Lambert and Point Samson between 2007 and 2016. **Output:** Maps and commentary of any changes in the extent of the mangrove communities located between Cape Lambert and Point Samson in 2013 and 2016 compared against that for 2007 and 2010.	Aerial photography will be sourced for 2007 and 2010. These aerial photos will be analysed and the extent of the distribution of the mangrove communities located between Cape Lambert and Point Samson will be systematically mapped. Similarly, aerial photography will be sourced in 2013 and 2016. These aerial photos will be analysed and the extent of the distribution of the mangrove communities located between Cape Lambert and Point Samson will be systematically mapped in the same manner as for the 2007 and 2010 photography.	Rio Tinto or a consultancy commissioned by Rio Tinto.	**Commence:** First future mapping round by end 2013, second mapping round by end 2016. **Completion:** 30 June 2017. **Status:** In progress.	Summary report to be submitted to DotEE within 2 months of finalisation (31 August 2017).	Also applicable to Category 1.

Program Title	Summary Scope and Key Output	Approach	Who	Implementation timeframe	Reporting timeframe	Linkage between categories
		A brief report that summarises any changes observed in the extent of mangrove communities in the stated subject area between 2007, 2010, 2013 and 2016 will be prepared. Should there be no detectable change in the extent of mangrove communities (outside that directly caused by other developments between Cape Lambert and Point Samson– eg by Shire of Roebourne) by 2016, no further comparative assessment will be undertaken.				

References:

Sinclair Knight Merz. 2009. Cape Lambert Port B Development. Baseline Intertidal Report. Report prepared by SKM for Pilbara Iron Pty Ltd.
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Table 2. Recent historical water quality and benthic community research and monitoring previously undertaken at Cape Lambert

Monitoring Type	Survey	Dates	Sites	Activities involved	Reference
Port A development					
Water quality Monitoring	Cape Lambert Upgrade 85 Mtpa Baseline Water Quality Monitoring	February 2007 to July 2007	BLR, BZI, BZR, CLW, DIE, DIW, DLI, DLN Total suspended solids and dissolved contaminants sampling undertaken at all sites as well as the Wharf and PWR station	Turbidity (NTU), Temperature, Conductivity, dissolved oxygen, pH, total suspended solids, light attenuation (PAR), gross sedimentation, dissolved contaminants (metals and TBT)	(SKM 2007)
	Dredging and Post Dredging Water Quality Monitoring	July 2007 to January 2008	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN	Turbidity (NTU), Temperature, Conductivity, dissolved oxygen, pH, total suspended solids, light attenuation (PAR), gross sedimentation, dissolved contaminants (metals and TBT)	(SKM 2008a)
	Pre and post dredging particle size distribution study	May and November 2007	20 sites radiating along 4 axis from the wharf	PSD assessment of surficial sediments (0-10 cm) at 250 m, 500 m, 1000 m, 2000 m and 5000 m from the wharf.	(SKM 2008b)
Benthic Community Surveys and Monitoring	Benthic Primary Producer Habitat Mapping	Late 2006 / early 2007	Areas west of the Wharf	Drop camera work to map benthic habitats	(RioTinto 2009)
	Baseline Coral Health Monitoring	February 2007 to July 2007	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN, DLNE	Coral Health assessment using tagged coral transects	(MScience 2007)
	Dredging and Post Dredging Coral Health Monitoring	July 2007 to January 2008	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN	Coral Health assessment using tagged coral transects	(MScience 2008)
	Post-Dredging Coral Health Survey	Initial December 2007- poor images due to weather conditions- not analysed. Re-surveyed in March 2008	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN, DLNE	Coral community structure Coral recruitment Coral size	(SKM 2008c)
	Annual Post Dredging Survey	November 2008	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN	Coral community structure Coral recruitment Coral size	(SKM 2009a)
	2 Year Annual Post Dredging Survey	November 2009	BZI, BZR, BLR, CLW, DIE, DIW, DLI, DLN	Coral community structure Coral recruitment Coral size	(SKM 2010a)
Port B development					
Water quality Monitoring	15-month Baseline Monitoring Program	February 2008 to May 2009	BLR, BTR, BZI, BZR, CLW, DIE, DLI, HAT, MAN, MDR, PLR, PWR, SMSB	Turbidity (NTU), temperature, light (PAR), particle size distribution (PSD) and sedimentation	(SKM 2009b)
	Pre-dredging Marine Environmental Monitoring	20 May 2010 to 17 August 2010	BLR, BTR, BZI, BZR, CLW, DIE, DLI, HAT, MAN, MDR, PLR, PWR, SMSB	Turbidity (NTU), temperature, light (PAR), particle size distribution (PSD) and sedimentation	(SKM 2010b)
	Pre –dredging Sediment Particle Size Distribution Study	August 2010	20 sites radiating along 4 axis from proposed dredging footprint	PSD assessment of surficial sediments (0-10 cm) at 250 m, 500 m, 1000 m, 2000 m and 5000 m from the proposed dredging footprint.	(SKM 2010c)

Monitoring Type	Survey	Dates	Sites	Activities involved	Reference
Benthic Community surveys and Monitoring	Benthic Primary Producer Habitat Mapping	February / March 2008	186 deep water sites 36 shallow water reef sites	Towed video transects and divers for ground truthing to describe the distribution and abundance of benthic subtidal habitats.	(SKM 2008d)
	Intertidal surveys	February 2008	Two mainland fringing reefs One mangrove area	Intertidal areas surveyed on foot to determine the distribution and abundance of benthic intertidal habitat	(SKM 2008d)
	Benthic Survey	November 2007	Cooling Water Discharge Bay	Intertidal and subtidal assessment of benthic habitats	(SKM 2008e)
	Benthic Primary Producer Habitat Monitoring (Subtidal)	July 2008 to May 2009	BLR, BTR, BZI, BZR, CLW, DIE, DLI, HAT, MAN, MDR, PLR, PWR, SMSB	BPPH Benthic cover- video transects BPPH algae composition- photoquadrats Coral partial mortality measures	(SKM 2009c)
	Intertidal Baseline Monitoring	July 2008 to April 2009	Samson Beach West Reef	Recording the distribution of benthic habitats on intertidal platforms through the use of permanent transects and random quadrats	(SKM 2009d)
	Pre-dredging Marine Environmental Monitoring	20 May 2010 to 17 August 2010	BLR, BTR, BZI, BZR, CLW, DIE, DLI, HAT, MAN, MDR, PLR, PWR, SMSB, DOI, DPI	Coral partial mortality measures	(SKM 2010b)
	Pre-Dredging Benthic Primary Producer Habitat (BPPH) Monitoring	July / August 2010	BLR, BTR, BZI, BZI-SE1, BZI-SE2, BZI-SE3, BZR, CLW, CLW-WEST, DIE, DLI, HAT, MAN, MDR, MDR-SOUTH, MDR-NORTH, PLR, PWR, SMSB. Mapped additional areas near Power station, Bezout Island and Middle Reef	Towed video transects and diver swam repeatable transects were undertaken to determine the distribution and community composition of BPPH at present in areas in and adjacent to the Zone of Impact for comparison post dredging.	(SKM 2010d)

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