FLANAGAN CONSULTING GROUP
Trusted Advisor to Northern Australia

Ports North

CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX Z: CSDP Trailing Suction Hopper Dredger Cost Estimate - Akuna Dredging

Budget Cost Estimate.

Trailing Suction Hopper Dredger scope.

- Gross dredged quantity options 710,000 m3 and 900,000 m3.
- Material pumped ashore into the Northern Sands Quarry area.

Cairns Shipping Development Project Queensland

Ports North

Akuna Dredging Solutions Pty Ltd

Camp Mountain,
April 2017

ABN 78 149 114 625 www.akunadredging.com.au +61439755308

Table of Contents

The opinions, conclusions and recommendations in this high level production and budget cost estimate report are based on the review of the information made available by Ports North. This report is based on assessments made by Akuna Dredging Solutions Pty Ltd after studying the information provided by the Client. The information made available has not been independently verified or checked as part of the agreed scope of work.

1. Executive summary.

The Cairns Shipping Development Project is a capital dredging programme undertaken by Ports North, which has undergone various phases of scope definition and EIS stages.

On Thursday 23th March 2017, Ports North requested Akuna Dredging Solutions, after previous advice on the spill rates for the plume modelling in May 2014 and the preliminary assessment of the proposed plant and methodologies for the dredging of the "soft" and "stiff" Clays in February 2017, to produce a production and budget cost estimate for the TSHD scope of work.

The information sets received on 13th, 25th and 27th January 2017, mainly containing geotechnical reports and various drawing and sketches of the dredge and land based material disposal areas and the additional information on lines and levels received on 7th April 2017, formed the basis of the production and cost estimate as described in this report.
The received data set has been detailed in the section 'Documents received' of this report.

The soil characteristics for dredging have been based on the Golder Associates assessments of the various Geotechnical Investigations as well as the Geophysical Investigation of which no copy has been received. The data provided and summarised by Golder in their 'Assessment of Material proposed for Dredging' of 16th January 2017, has been used as the basis for this report.

The production and budget cost estimate, as detailed in this document, have been based on the most optimal equipment spread, being the 5,600 m3 TSHD Marieke and the 4,475 kW floating booster station DI 509.

The specifications of the dredging spread utilized during the actual project execution will depend on factors like the dredging market, equipment availability, the project assessment of the contractors invited to submit a proposal and the tender evaluation of the Client.

2. Scope of Work.

2.1. Description of Work.

Ports North, who are presently working on the Environmental Impact Study for the channel development project, are now in the process of writing the dredging methodology, duration and inputs for modeling to be undertaken for the impact assessment.

The project has been re-designed and downsized to make the option for land disposal feasible.
The downsized plan is to dredge less than 1,000,000 m3 in total, of which about 100,000 m3 might be "stiff" Clay.

Ports North is close to settling on a site north of Cairns in the Barron River Delta to accommodate the "soft" material and a site up the Trinity Inlet to accommodate the "stiff" Clays.

The timing for the dredging is now likely start in the 2019 dry season.

Note is made of the Consultant team's "stiff" and "soft" classification based on simply whether the clay is the yellow (alluvial) clays or the grey/black marine sedimentary deposits. This is based on seismic interpretations and is not based on the strength tests taken which, in many cases, show only soft-firm at the top of the "stiff" layers.

2.2. Scope of Work - outline.

The production and budget cost estimate requested from Akuna Dredging Solutions Pty Ltd only covers the dredging operations with the TSHD for the removal of the "soft" Clay layers and disposal of the material via pumping ashore to the Northern Sands Quarry pond.

The total gross quantities has been based on two options:

- Option 1: total dredged quantity of 800,000 m3, of which 710,000 m3 "soft" material with the TSHD and 90,000 m3 "stiff" material with the BHD.
- Option 2: total dredged quantity of 1,000,000 m3, of which 900,000 m3 "soft" material with the TSHD and 100,000 m3 "stiff" material with the BHD.

The details on the scope of work and activities are to be included in the estimate.

The production and budget cost estimate is to be relatively high level without any cost minimization and will be part of the overall project budget at this stage for the purpose of economic justification and funding applications.
The cost estimate will not incorporate project contingencies.

2.3. Deliverables.

The deliverables were to be presented in a report.
The report was requested at the shortest delivery timing possible and preferably not later than 18th April 2017.

2.4. Documents reviewed.

Ports North has made the following reports, drawings, sketches and information available initially for the preliminary review of the methodologies and later for the production and budget cost estimate.
The following data set was used for the calculations as highlighted in this report:

Document	Title
13th January 2017	
1546223-008-R-Rev0	Dredge Materials – Cairns Shipping Development Project Issued by Golder Associates Pty Ltd for Flanagan Consulting Group 16 December 2016
921-004-A	Revised draft EIS Channel – General Arrangement Issued by Ports North 12 December 2016
No reference	2015 Channel Widening Proposal – 100 meter Channel EIS Design Issued by Ports North 12 August 2016
3527-SK02, SK03	Various drawings of Northern Sands Quarry Issued by Flanagan Consulting Group 11 November 2016
3527-SK01	Arial of Wah Day Area Issued by Flanagan Consulting Group 4 November 2016
No reference	Spread sheets with dredged quantities – target depths Issued by Ports North 13 January 2017
No reference	Arial of Stiff Clay Disposal Site Issued by Ports North 25 January 2017
No reference	Arial of Yorkeys Pipeline route – Barron Delta – Northern Sands Issued by Ports North 25 January 2017
25th January 2017	
137632122-001-R-Rev0	Preliminary Geotechnical Investigation – Factual Report – Cairns Shipping Development Project (EIS) – Trinity Inlet, Cairns Issued by Golder Associates Pty Ltd for Ports North September 2013
1546223-006-R-Rev0	Draft Stage 1B Marine Studies – Cairns Shipping Development Project Issued by Golder Associates Pty Ltd for Flanagan Consulting Group 26 August 2016
1546223-008-R-Rev1	Assessment of Materials Proposed for Dredging – Cairns Shipping Development Project Issued by Golder Associates Pty Ltd for Flanagan Consulting Group 16 January 2017
3527-SK04	Drawings of Northern Sands – Option 1 Issued by Flanagan Consulting Group 20 January 2017
No reference	Channel long-sect material props Issued by Ports North 25 January 2017
No reference	Northern Beaches Pump out Location Issued by Ports North 25 January 2017
No reference	Northern Sands pipeline options Issued by Ports North 25 January 2017

27th January 2017

3527-SK06	Wah Day DMPA Issued by Flanagan Consulting Group 19 January 2017
3527-SK01A	Wah Day DMPA Issued by Flanagan Consulting Group 19 January 2017
AUS0264	Admiralty Chart – Trinity Inlet
No reference	Backhoe, barge and tugboat information

7th April 2017

Soft copies of excerpts of the following reports and/or summaries containing:
1. Golder's Report extract with dredge volumes for design channel
2. Spreadsheet with above volumes factored up pro-rata to 900,000 m3 for TSHD.
3. Aerial mark up of existing channel target depths
4. Existing channel target depth table
5. Dredging Quantities table with the proposed TARGET depths as "New Design Level" including insurance and overdredging allowance. Note the Design Declared Depth is 8.8m over the whole channel.

Note: Ports North made the above-mentioned information available in soft copy format.

The above-received information has been taken to be the opinion of the issuing parties and has not been independently verified or checked.

3. Materials to be dredged.

The soil characteristics of the material to be dredged have been derived from the three above-mentioned Golder reports received on the 25th January 2017.
In particular the Appendix C of the 26th August 2016 report was very useful in obtaining a further understanding of the soil characteristics of the "soft" and the "stiff" clays.

The theoretical quantities to be dredged and the split between "soft" and "stiff" as mentioned in the 16th January 2017 Golders report have been taken as facts.
The split has been based on approx. 52km of longitudinal lines and traverse seismic survey lines, presumably executed in 2016, of which no details were provided.

Seismic Reflection Survey (sub-bottom profiling) shows layers and no characteristics, is prone to signal absorption and scattering, shows multiple reflections and with which discontinuities will reflect part of the signal.
Seismic Refraction Survey measures the seismic velocity of the sub soil and requires complex data acquisition and interpretation.
Aquares Resistivity Survey can measure to approx. 25-meter below sea floor depth in marine environments producing a high-resolution data set. The system is not effected by absorption and scattering and presents a qualitative and quantitative 4D geomodel.

It is assumed that the split between "soft" and "stiff" Clay has been based on a Seismic Reflection Survey executed over the "stiff" Clay areas.

3.1. *Very soft and soft silty Clays.*

The materials to be dredged by the TSHD in the inner harbour and the entrance channel has been evaluated and split into the below mentioned 2 soil types.
The following area/soil split up has been based on previous and recent information made available:

Very soft silty Clay, medium to high plasticity.			
PP	range <10 to 50 kPa		average 15 kPa
S vane	all values < 10 kPa		average < 10 kPa
In situ Shear vane	range 4 to 10 kPa		average 8 kPa
Moisture content		average 86	
Liquid Limit		average 64	
Plastic Limit		average 40	
Clay	< 2 mu	37%	
Medium Silt	< 20 mu	70%	
Silt	< 60 mu	91%	
Fine Sand	< 200 mu	98%	
Bulk Density	range 1.10 to 1.63 t/m3		average 1.34 t/m3

This material characteristic is predominantly found in the top layers of the dredge area and will be dredged by the TSHD in one operation with the under laying soft clay layer.

Soft silty Clay, medium to high plasticity.			
PP	range 20 to 50 kPa		average 35 kPa
S vane	all values +/- 10 kPa		average 10 kPa
In situ Shear vane		average 14 kPa	
Moisture content		average 66	
Liquid Limit		average 49	
Plastic Limit		average 29	
Clay	< 2 mu	61%	
Medium Silt	< 20 mu	94%	
Silt	< 60 mu	98%	
Fine Sand	< 200 mu	98%	
Bulk Density	range 1.30 to 1.69 t/m3		average 1.54 t/m3

This material characteristic is predominantly found in the lower layers of the dredge area and will be dredged by the TSHD in one operation with the overlaying soft clay layer.
The majority of the material dredged will consist of the very soft silty Clay.

The above-mentioned materials are to be dredged by the TSHD and pumped ashore at the Northern Sands Quarry area.
The “soft” Clay will be removed by the TSHD prior to the dredging of the “stiff” Clay by the Backhoe Dredger in order to avoid double mobilisation of the Backhoe spread.

During the dredging of the “soft” Clay, the TSHD will also remove the intermediate firm silty Clay layer, leaving only the “stiff” Clay to be dredged by the Backhoe dredger in a later stage.
This reducing of the “stiff” Clay could be driven by the restrictions of the storage area and most probably for economic reason, which will be assessed by comparing the BHD production and costs estimate with this TSHD production and budget cost estimate.

The Golder summary Report of 16th January 2017 makes note of the occurrence of sand layers in the Inner harbour as encountered in a number of boreholes. The thickness of the sand layers varies between 0.2 and 0.75 m, however the extent of the sands has not been assessed. It is noted that the shell contents within the sands were inferred to range from 20 to 40% of the total mass on visual observation.
This fine to coarse-grained Sand will presumably be dredged by the TSHD during the “soft” Clay dredging operations. The pumping ashore of fine to coarse grained Sand with 20 to 40% shell content will require more pumping power as the critical velocity will be higher than for pumping “soft” Clay.
The production and cost estimate for the TSHD has been based on the soft silty Clay with only small quantities of max. 300 mμ sand.

3.2. PASS material.

The January Golder Summary Report concluded that the majority of the PASS material has sufficient neutralising capacity to classify them as self-neutralising PASS.
The Golder Report also notes the locations where PASS material without sufficient neutralising capacity has been identified and it is assumed that all material within these nominated locations will be treated as PASS.

The total quantity of PASS material is assessed to be 247,892 m3.

The dredging of this PASS material by the TSHD will be given priority and will be dredged in an early stage in order to cover this material with self-neutralising PASS material at the Northern Sands Quarry pond. This dredging sequence needs to be addressed in the TSHD Dredge Management.
It is assumed that all dredged material disposed of in the Northern Sands Quarry will remain under water.

4. Methodologies, equipment and cost elements.

The dredging methodology as envisaged at this time and date has been based on the disposal of the capital dredged material in onshore disposal areas, while the maintenance dredging component will still be placed in the offshore material relocation area.

The most economic on-shore disposal solution would be to find an area at a short pumping distance and close-by to the dredging area. This would have opened up opportunities to dredge the “stiff” Clay, together with the “soft” Clay of those areas, with a Cutter Suction Dredger and the “soft” Clay in the entrance channel with a Trailing Suction Hopper Dredger and pumping all materials ashore over a relatively short pumping distance into the same area.

This option seems not to be feasible and the Northern Sands Quarry solution has been assessed in this report.

4.1. TSHD and Booster specifications.

The selection of the TSHD has been based on the revised design, which now has a narrower channel, restricting the overall length of the TSHD to be deployed.
The length of the most economic TSHD Marieke will not allow her to turn in the 100 meter wide channel, not for safety reasons as well as for probable additional re-suspension of soft material due to propeller wash and bow-thruster agitation flows.

The TSHD Marieke has been selected mainly for her overall length and loaded draught, but also in view of her pumping ashore capabilities.

TSHD	**Marieke**
Year built	2006 IHC
LOA [length over all]	97.5 m
LBP [length between perpendiculars]	85.0 m
Breadth	21.6 m
Depth	7.6 m
Dredging draught	7.1 m
Hopper capacity	5,320 - 5,600 m3
Total installed power	6,776 kW
Pump shore power	4,050 kW
Propulsion sailing	4,050 kW
Propulsion dredging	3,450 kW
Bow Thruster	450 kW
Dredge pipe(s)	1x1000mm
Location dredge pipe	Port side aft
Discharge pipe dia	900 mm
Sailing speed unrestricted	12.8 knots
Net Tonnage	1,501 T
Gross Tonnage	5,005 T
Dead Weight Tonnage	8,387 T

Based on the calculations for the required pumping power and the calculated location of the booster station, the following floating booster station was selected for the production and budget cost estimate.

BOOSTER STATION	**DI 509**
Year built	1987 / 2006
Pontoon:	
Length overall	58.5 m
Breadth overall	18.3 m
Moulded depth	3.8 m
Draught	2.5 m
Booster pump:	
Total installed power	4,935 kW
Pump power	4,475 kW

The dredging of the inner harbour requires a high degree of manoeuvring which requires ample propulsion and bow-thruster power.
The dredging of the entrance channel requires turning at specific areas with the same requirements on the TSHD specifications.

The widening of the entrance channel requires dredging of soft Clays along and on top of the batters, which will be executed dependent on the tide, which has resulted in the calculated loading times for the various areas. This operation not only requires good seamanship but also adequate manoeuvring power.

As a result of the “very limited overflow dredging” preference in the soft silty Clay the TSHD Marieke is assessed as having the largest hopper capacity possible.

With a maintained dredged insurance depth of the Cairns Shipping Channel and Harbour of 8.3 m- CD or deeper and a tidal range of 0.7 m at MLWS and 2.55 m at MHWS, the TSHD Marieke will have a UKC of at least 1.5 meter at all times within the present channel boundaries.

The dredging of the shallow batters will be executed at the beginning of the loading cycle and during high water. This will accommodate the TSHD Marieke to dredge at approx. -3.5 m CD with the support of the tugboat with sweepbar to bring the batters down.

4.2. Production estimate.

The production estimate for the gross dredged quantities of 710,000 and 900,000 situ m3 has been attached to this report.

The inner harbour and entrance channel dredge area has been divided in 8 distinct areas.

The plan view of the areas to be dredged and the quantity spread sheets would assume that there might be sufficient options to sweep large quantities with the sweepbar. However when studying the cross sections it is obvious that there is not much depth below the proposed channel design level to accommodate such an optimisation.
The majority of the material needs to be dredged by the TSHD Marieke and disposed of at the Northern Sands Quarry area.
Based on the cross sections an assessment has been made of the quantity that could be swept in the deeper areas.

The average hopper load for the various areas is calculated based on the average depth, the occurrence of 'stiff' Clay in the area and the effect of spot hunting.

The effective loading time for all areas has been calculated to be 35 minutes with 5 minutes overflow to replace the "softer" top layer and to improve the overall loaded density in the hopper.

The LMOB [Lean Mixture Over Board] and turning times are assessed based on the layout of the to be dredged areas.
The LMOB is instrumental to achieve the assessed average hopper load.

Some areas, specifically in the entrance channel, have steep and high banks, which will not facilitate the option to turn the TSHD Marieke during and/or after the loading process, at the most optimal location. These required additional sailing times are incorporated in the cycle times.

The calculated sailing times between the dredging area and the pumping ashore mooring location have been based on the sailing speed limitations as laid down in the Port of Cairns speed restrictions, being 10 knots seaward of beacon 15, 8 knots inward of beacon 15 and an assumed safe sailing speed of 6 knots at the inner harbour.
Due to the squat effect at the remainder of the sailing route a restricted sailing speed of 11 knots with a full load and 12 knots empty has been calculated.

The requirement has been expressed not to have the TSHD staying in position at the pump ashore location using its own propulsion.
Therefor additional time has been calculated to anchor or moor the TSHD after which the floating pipeline coupling procedure can be started.

The pumping ashore will start with filling the pipeline with water, after which the booster station will be added, followed by adding mixture from the TSHD.
When the hopper is empty water is pumped to the Northern sands area to clean the pipeline before the pumping operation is stopped.

The weekly delays are assessed based on the local circumstances:

- The weather delay has been based on the Cairns wave heights and periods
- No cyclone delays are included
- The shipping delay has been assumed to be 6 hrs/week. This needs to be checked as no information has been made available to asses this delay item.

The above explained cycle time elements and the operational hours per week resulted in the weekly production for the various areas and the execution duration.

4.3. Supporting equipment.

The dredging spread will consist, apart from the above mentioned TSHD Marieke and the floating booster station DI 509, out of the following supporting equipment.

A multicat/shoalbuster with a bollard pull of 45T will be deployed at the pump ashore location to support the TSHD Marieke with the anchoring/mooring operations and the floating pipeline coupling activity.
The multicat/shoalbuster will be used for the bunkering of the floating booster station and will be moored along the booster station when not operational.
The multicat/shoalbuster will be working day and night shift.

A tugboat with a bollard pull of 25T will be deployed for the sweepbar operations. The tugboat will be working in dayshift only.

A launch, with 460 kW propulsion, will be deployed for the survey operations and the transport of personnel. The launch will be working in dayshift and will be on standby during the night shift.

A small spreader pontoon with 4 winches and a diffuser will be used at the Northern Sands Quarry for the controlled disposal of the pumped material.

4.4. Pumping ashore with the TSHD.

The pumping ashore mooring location for the TSHD Marieke will be at the -8 m LAT contour line.

An under keel clearance of at least 1 meter at any tide was assumed not only to accommodate for the ships wave movements but also for the restraint of the seabed agitation due to the propeller wash.

The following pipeline lengths have been assessed based on the available information:

- Self-Floating pipeline, with a minimal length for a moored/anchored TSHD, being 200 meter
- Submerged pipeline, with the booster incorporated, being 3,000 meter

- Landline, with bends and possible pipe bridge, being 4,800 meter
- Floating pipeline, at the Northern Sands area, being 300 meter

The calculations with the pumping power of the TSHD Marieke and the booster station DI 509 indicate a location of the booster station at approx. 2,400 meter behind the TSHD and thereby approx. 800 meter from the shore.
The pontoon of the DI 509 has sufficient freeboard to incorporate her in the submerged pipeline at this location.

The pumping ashore process will start with the TSHD Marieke pumping water soon after being coupled to the floating line. Once the water has passed the booster station, the booster engineer will engage the pumps and start assisting with the pumping process.
Once the pipeline is filled and water has reached the reclamation, the TSHD crew will start the process of pumping the material from the hopper. Once the hopper is almost empty the pipeline is cleaned with water in order to avoid blockage when the next load is pumped.

This process will result in a vast amount of additional water to be pumped to the Northern Sands Quarry area.
Calculations of this process have been made in the production sheets for the 710,000 and 900,000 m3 options indicating the expected volume of water and mixture pumped and the resultant dilution factor.

A pond filling method with a spreader pontoon equipped with a diffuser and sufficient floating line will reduce the suspended solids in the higher layers of the pond and thereby create the greatest possibility to stay within the set Total Suspended Solids trigger values. Further study and assessment is required.

The pumping of the fine to coarse Sand layers with the mentioned shell content of 20 to 40% might not be possible as the pumping of coarse Sand and particularly shells will require a much higher pipe velocity and resulting pumping power in order to avoid the tendency to block the pipeline.
The calculations show that we can accommodate a small quantity of max. 300 mμ sand to be pumped mixed with the soft silty Clay.

4.5. Mobilisation and demobilisation.

The mobilisation and demobilisation cost estimate is based on the following assumptions:

- The TSHD Marieke from and back to Singapore
- The Booster DI 509 from and back to Singapore towed by the Shoalbuster on her own keel
- The Shoalbuster from and back to Singapore towing the booster DI 509
- The Tugboat from and back to Brisbane
- The Launch locally hired in Cairns or close surroundings
- The various pipeline components from and back to Batam

All costs include preparations, port clearance, transportation and AQIS hull cleaning.

5. Final remarks.

The details, general information and cost principles have been attached to this report and will form an integral part of the report and the estimates.

It should be noted that the budget cost estimate is based on 1Q2017 price levels.

The M&R and D+I calculations for the TSHD Marieke and the floating booster station DI 509 are based on the indexed CIRIA valuation for 2017.

Crew costs are based on the 2017 EBA rates and safe manning levels for pumping ashore operations.

The fuel costs are based on the Brisbane Bunker Prices of 13th April 2017, being trending to 600 US$/MT.

The exchange rate € - AUD used in the calculations is set to 0.7

Environmental monitoring has not been incorporated in the scope of work nor in the budget cost estimate.

Dredging of the gross quantities only, no overdredging has been allowed for in the calculations.

No cyclone events or cyclone moorings are part of the budget cost estimate.

5.1. Bed levelling.

The deployment of a bed levelling device will be the prerogative of the dredging contractor and will depend on his selected work method, the equipment deployed and the availability of a bed leveller, also called a sweep bar operation.

The bed leveller will optimise the dredge efficiency, especially when the firmer intermediate Clay layers are dredged with a TSHD, and as an extra will slightly minimise the dredged quantity.

The bed leveller or sweep bar also is essential to move material from the top of the batters to the toe area for further dredging by the TSHD.
Bed levelling will result in transporting material in front of a sweep bar over relatively short distances, in the order of 20 to 100 meter, depending on the soil to be moved and the configurations of the sweep bar arrangement and the power of the tugboat.

The sweepbar operation has been incorporated in the presented production estimate and budget cost estimate.

5.2. Public safety and preparations.

The installation of the delivery pipe for the pumping ashore operations to the Northern Sands Quarry area will require a proper route investigation to define whether there will

be adequate space to install the pipeline. Special attention will have to be given to the public safety, as the pipeline will be infringing on areas open to the public.

No clearing operations have been incorporated in the budget cost estimate.

5.3. Closing remark.

The production and budget cost estimate is based on the data made available and calculations based on this information.

Jack HC Kerklaan

Akuna Dredging Solutions Pty Ltd

Camp Mountain,
17th April 2017

Attachments:

- General Information and Cost Principles
- Production estimates
- Cost estimates

Ports North

AKUNA

CAIRNS SHIPPING CHANNEL

April 2017

GENERAL INFORMATION and COST PRINCIPLES

The cost level of the estimate is based on prices at 1Q2017.

The M&R and D+I calculations for the TSHD and the Booster station are based on the indexed CIRIA valuation for 2017.

Crew costs are based on the 2017 EBA rates and safe manning levels for pumping ashore operations.

The fuel costs are based on the Brisbane Bunker Prices of 13 April 2017, being 600 US$/MT.

The exchange rate € - AUD used in the calculations is 0.7

The mobilisation/ demobilisation costs are based on the following assumptions:
- TSHD from and back to Singapore on own keel
- Booster station from and to Singapore towed by the Multicat/Shoalbuster
- Multicat/shoalbuster from and back to Singapore on own keel and towing the booster station
- Tugboat from and to Brisbane on own keel
- Launch local hire in Cairns or close surroundings
- Pipelines and spreader pontoon from and back to Batam

Costs include preparations, port clearance, transportation and AQIS hull cleaning.

Pipeline, all with a diameter of 900mm, with lengths of:

Floating pipeline, short length for a moored TSHD, being:	200 m
Submerged pipeline, with the booster in the line, being:	3,000 m
Landline, with bends and pipe bridge(s), being:	4,800 m
Floating line, at the Northern Sand area with a small spreader pontoon, being:	300 m

Installation of floating pipeline, submerged pipeline and booster station with the Multicat and Tugboat.
- Assumed sufficient beach space available to weld the various submerged pipeline sections.

Installation of landline.
- Assumed pipeline route is cleared and accessible for installation crew and equipment.

Site establishment and preliminaries
- Documents and approvals by Management Staff only working from their head office

Site and survey staff, partly expat and partly local
- Locally rented office.
- No workshop foreseen due to the small quantity and the soft material.

The following operations of the dredging spread are the bases of this cost estimate:
- TSHD 5,600m5, Marieke type, dredging in channel areas and pumping ashore. Operational 135 hrs/week.
- Booster station, DI509 4,475 kW type, positioned in the submerged line. Operational 40 hrs/week.
- Multicat, 45T Bollard Pull Shoalbuster type, for anchoring and coupling TSHD and bunkering booster. Day and Night shift.
- Tugboat, 25T Bollard Pull type, for sweepbar operations. Dayshift only.
- Launch, 460 kW type, for survey and personnel transport. Dayshift working and standby during nightshift.
- Small spreader pontoon, with 4 shore winches, at the Northern Sands Quarry.

Operational Delays
- Weather delay based on Cairns wave heights and periods, approx. 10% being 12 hrs/week.
- No cyclone delays included nor cyclone moorings in the costs.
- Shipping delays assumed 6 hrs/week. Needs to be checked, no information made available.

Booster location
- Calculations show that the booster needs to be approx. 800 meter offshore. Booster pontoon has sufficient freeboard.

Pumping with 4,050 kW TSHD and 4,475 kW booster result in above critical velocity in the dia 900mm pipeline.
- Small quantities of 300 mu sand can still be transported. No shells.
- Northern Sands pond level assumed at RL 3.5 m AHD.

TSHD pumping ashore mooring location seaward of the - 8m LAT contour line

TSHD sailing speeds
- As per the Port of Cairns speed restrictions: 10 knots seaward of B15, 8 knots inward of B15 and 6 knots in Port.
- Due to squat effect unrestricted full load speed 11 knots and unrestricted empty speed 12 knots.

Pre-sweeping with tugboat is assumed to be 1.5 weeks before operations with the TSHD start.
- According to the cross-sections there is not much depth below the proposed channel design level to sweep material into.
- Majority of material need to be dredged and transport to the Northern Sands Quarry.
- Shallow batters to be swept partly before and during the dredging operations.

LMOB (Lean Mixture Over Board) and sailing to turning areas are incorporated in the production estimate.
- Overflow of 5 minutes at the end of the loading cycle.

Environmental monitoring has not been incorporated in the scope of work nor in the costs.

Dredging of indicated gross quantity only, no overdredging allowed for in the calculations.

Ports North

AKUNA

CAIRNS SHIPPING CHANNEL
DREDGED QUANTITY GROSS 710,000 m3

April 2017

PRODUCTIONS

Service Hours / week		**168**
Delays / week		33
Bunkering		4
Technical		8
Weather		12
Operational		
Shipping		6
Blockage/debris		
Other delays		3
Operational Hours / week		135

Cycle times and weekly production

Dredging area		Smith Creek Swing basin	Crystal Swing basin	Bend						TOTAL
From Chainage		10,800	11,500	13,250	14,500	16,500	18,500	20,500	22,500	
To Chainage		11,500	13,250	14,500	16,500	18,500	20,500	22,500	24,500	
Quantity										
Gross (incl. OD)	situ m3	43,243	36,980	15,284	148,371	259,712	166,709	33,411	6,290	**710,000**
By Sweep bar	%	-	5	5	5	-	-	10	5	
	situ m3	-	1,849	764	7,419	-	-	3,341	315	**13,687**
By TSHD	situ m3	43,243	35,131	14,520	140,952	259,712	166,709	30,070	5,976	**696,313**
Layer thickness	m	0.8	0.8 - 1.3	0.8	0.3	0.3 - 0.5	0.3 - 0.8	0 - 0.8	0.1	
Load in Hopper	situ %	40	42	40	47	48	50	42	38	
	situ m3	2,240	2,352	2,240	2,632	2,688	2,800	2,352	2,128	
Cycle:										
Loading	min	35	35	35	35	35	35	35	35	
Overflow	min	5	5	5	5	5	5	5	5	
Lean Mixture Over Board	min	6	10	55	31	22	16	34	105	
Turning	min	15	11	5	5	5	5	8	5	
Sailing to turning area	min	-	-	7	-	20	28	24	-	
Sailing Loaded	min	95	85	66	58	51	44	38	33	
Anchoring	min	10	10	10	10	10	10	10	10	
Coupling	min	5	5	5	5	5	5	5	5	
Filling pipeline	min	25	25	25	25	25	25	25	25	
Pumping mixture	min	36	37	36	38	38	38	37	35	
Cleaning pipeline	min	20	20	20	20	20	20	20	20	
Sailing Empty	min	92	82	63	55	48	42	35	31	
Total Cycle	min	344	325	332	287	284	273	276	309	
Trips per week		23.5	24.9	24.4	28.2	28.5	29.7	29.3	26.2	
Weekly production										
Hopper m3 /week		52,744	58,619	54,651	74,283	76,665	83,077	69,026	55,783	
Duration	weeks	0.82	0.60	0.27	1.90	3.39	2.01	0.44	0.11	**9.52**
Total munber of loads		19.3	14.9	6.5	53.6	96.6	59.5	12.8	2.8	**266**

Northern Sands Quarry Volume pumped										
Filling pipeline	m3	101,351	78,417	34,031	281,155	507,250	312,579	67,120	14,742	**1,396,646**
Pumping mixture	m3	135,520	106,110	45,504	375,463	671,889	407,246	90,823	19,460	**1,852,015**
Cleaning pipeline	m3	81,081	62,734	27,225	224,924	405,800	250,064	53,696	11,794	**1,117,317**
Total water and mixture	m3	317,952	247,261	106,759	881,542	1,584,939	969,889	211,640	45,996	**4,365,978**
Situ m3 (check)		43,243	35,131	14,520	140,952	259,712	166,709	30,070	5,976	**696,313**
Dilution factor		6.35	6.04	6.35	5.25	5.10	4.82	6.04	6.70	**5.27**

Ports North

AKUNA

CAIRNS SHIPPING CHANNEL
DREDGED QUANTITY GROSS 900,000 m3

April 2017

PRODUCTIONS

Service Hours / week		**168**
Delays / week		33
Bunkering		4
Technical		8
Weather		12
Operational		
Shipping		6
Blockage/debris		
Other delays		3
Operational Hours / week		135

Cycle times and weekly production

Dredging area		Smith Creek Swing basin	Crystal Swing basin	Bend						TOTAL
From Chainage		10,800	11,500	13,250	14,500	16,500	18,500	20,500	22,500	
To Chainage		11,500	13,250	14,500	16,500	18,500	20,500	22,500	24,500	
Quantity										
Gross (incl. OD)	situ m3	54,815	46,877	19,374	188,076	329,212	211,321	42,352	7,973	**900,000**
By Sweep bar	%	-	5	5	5	-	-	10	5	
	situ m3	-	2,344	969	9,404	-	-	4,235	399	**17,350**
By TSHD	situ m3	54,815	44,533	18,405	178,672	329,212	211,321	38,117	7,574	**882,650**
Layer thickness	m	0.8	0.8 - 1.3	0.8	0.3	0.3 - 0.5	0.3 - 0.8	0 - 0.8	0.1	
Load in Hopper	situ %	40	42	40	47	48	50	42	38	
	situ m3	2,240	2,352	2,240	2,632	2,688	2,800	2,352	2,128	
Cycle:										
Loading	min	35	35	35	35	35	35	35	35	
Overflow	min	5	5	5	5	5	5	5	5	
Lean Mixture Over Board	min	6	10	55	31	22	16	34	105	
Turning	min	15	11	5	5	5	5	8	5	
Sailing to turning area	min	-	-	7	-	20	28	24	-	
Sailing Loaded	min	95	85	66	58	51	44	38	33	
Anchoring	min	10	10	10	10	10	10	10	10	
Coupling	min	5	5	5	5	5	5	5	5	
Filling pipeline	min	25	25	25	25	25	25	25	25	
Pumping mixture	min	36	37	36	38	38	38	37	35	
Cleaning pipeline	min	20	20	20	20	20	20	20	20	
Sailing Empty	min	92	82	63	55	48	42	35	31	
Total Cycle	min	344	325	332	287	284	273	276	309	
Trips per week		23.5	24.9	24.4	28.2	28.5	29.7	29.3	26.2	
Weekly production										
Hopper m3 /week		52,744	58,619	54,651	74,283	76,665	83,077	69,026	55,783	
Duration	weeks	1.04	0.76	0.34	2.41	4.29	2.54	0.55	0.14	**12.07**
Total munber of loads		24.5	18.9	8.2	67.9	122.5	75.5	16.2	3.6	**337**

Northern Sands Quarry Volume pumped										
Filling pipeline	m3	128,473	99,404	43,137	356,394	642,992	396,227	85,082	18,687	**1,770,396**
Pumping mixture	m3	171,786	134,508	57,681	475,939	851,689	516,227	115,128	24,666	**2,347,625**
Cleaning pipeline	m3	102,778	79,523	34,510	285,115	514,394	316,982	68,066	14,949	**1,416,317**
Total water and mixture	m3	403,037	313,436	135,328	1,117,448	2,009,075	1,229,435	268,276	58,303	**5,534,339**
Situ m3 (check)		54,815	44,533	18,405	178,672	329,212	211,321	38,117	7,574	**882,650**
Dilution factor		6.35	6.04	6.35	5.25	5.10	4.82	6.04	6.70	**5.27**

Ports North

AKUNA

CAIRNS SHIPPING CHANNEL

DREDGED QUANTITY GROSS 710,000 m3

April 2017

ESTIMATE

	Description	Unit	Qty.	Rate	Amount
	MOBILISATION				
	TSHD Marieke	Lump Sum	1	1,378,227	**1,378,227**
	TSHD Booster DI509	Lump Sum	1	381,428	**381,428**
	MULTICAT	Lump Sum	1	1,304,097	**1,304,097**
	TUGBOAT	Lump Sum	1	185,988	**185,988**
	LAUNCH	Lump Sum	1	43,251	**43,251**
	Pipelines and spreaderpontoon	Lump Sum	1	1,975,762	**1,975,762**
	TOTAL MOBILISATION				**5,268,752**
	INSTALLATION				
	Booster station	Lump Sum	1	315,102	**315,102**
	Pipelines	Lump Sum	1	1,769,458	**1,769,458**
	TOTAL INSTALLATION	Lump Sum			**2,084,560**
	SITE ESTABLISHMENT and PRELIMINARIES				
	Documents and approvals	Weeks	4.0	42,867	**171,469**
	Staff preparations	Weeks	4.0	114,559	**458,238**
	Survey Staff for in-survey	Weeks	3.5	29,399	**102,895**
	Survey launch and equipment	Weeks	3.5	105,850	**370,475**
	Pre-sweeping with sweepbar	Weeks	1.5	142,761	**214,141**
	TOTAL ESTABLISHMENT and PRELIMINARIES	Lump Sum			**1,317,218**
	DREDGING				
	TSHD Marieke	Weeks	9.5	720,041	**6,854,380**
	TSHD Booster DI509	Weeks	9.5	304,730	**2,900,852**
	MULTICAT for TSHD mooring and booster	Weeks	9.5	294,946	**2,807,717**
	TUGBOAT for sweepbar operations	Weeks	9.5	142,761	**1,359,002**
	LAUNCH for survey and personnel transport	Weeks	9.5	93,085	**886,120**
	Pipelines and spreaderpontoon	Weeks	9.5	78,287	**745,243**
	TOTAL DREDGING				**15,553,314**
	DREDGE MANAGEMENT				
	Staff	Weeks	9.5	113,734	**1,082,685**
	Survey	Weeks	9.5	33,930	**322,995**
	TOTAL MANAGEMENT				**1,405,680**
	SITE CLEARANCE				
	Staff site clearance	Weeks	4.0	114,559	**458,238**
	Survey Staff for out survey	Weeks	2.0	29,399	**58,797**
	Survey equipment	Weeks	2.0	105,850	**211,700**
	Post-sweeping with sweepbar	Weeks	1.0	142,761	**142,761**
	Booster station	Lump Sum	1	206,735	**206,735**
	Pipelines dismantling	Lump Sum	1	1,093,695	**1,093,695**
	TOTAL SITE CLEARANCE				**2,171,926**
	DEMOBILISATION				
	TSHD Marieke	Lump Sum	1	790,924	**790,924**
	TSHD Booster DI509	Lump Sum	1	206,932	**206,932**
	MULTICAT	Lump Sum	1	838,475	**838,475**
	TUGBOAT	Lump Sum	1	129,775	**129,775**
	LAUNCH	Lump Sum	1	27,184	**27,184**
	Pipelines and spreaderpontoon	Lump Sum	1	1,555,590	**1,555,590**
	TOTAL DEMOBILISATION	Lump Sum			**3,548,880**
	TOTAL PROJECT ESTIMATE				**31,350,331**

Ports North

AKUNA

CAIRNS SHIPPING CHANNEL

DREDGED QUANTITY GROSS 900,000 m3

April 2017

ESTIMATE

	Description	Unit	Qty.	Rate	Amount
	MOBILISATION				
	TSHD Marieke	Lump Sum	1	1,378,227	**1,378,227**
	TSHD Booster DI509	Lump Sum	1	381,428	**381,428**
	MULTICAT	Lump Sum	1	1,304,097	**1,304,097**
	TUGBOAT	Lump Sum	1	185,988	**185,988**
	LAUNCH	Lump Sum	1	43,251	**43,251**
	Pipelines and spreaderpontoon	Lump Sum	1	1,975,762	**1,975,762**
	TOTAL MOBILISATION				**5,268,752**
	INSTALLATION				
	Booster station	Lump Sum	1	315,102	**315,102**
	Pipelines	Lump Sum	1	1,769,458	**1,769,458**
	TOTAL INSTALLATION	Lump Sum			**2,084,560**
	SITE ESTABLISHMENT and PRELIMINARIES				
	Documents and approvals	Weeks	4.0	42,867	**171,469**
	Staff preparations	Weeks	4.0	114,559	**458,238**
	Survey Staff for in-survey	Weeks	3.5	29,399	**102,895**
	Survey equipment	Weeks	3.5	105,850	**370,475**
	Pre-sweeping with sweepbar	Weeks	1.5	142,761	**214,141**
	TOTAL ESTABLISHMENT and PRELIMINARIES	Lump Sum			**1,317,218**
	DREDGING				
	TSHD Marieke	Weeks	12.1	720,041	**8,688,652**
	TSHD Booster DI509	Weeks	12.1	304,730	**3,677,137**
	MULTICAT for TSHD mooring and booster	Weeks	12.1	294,946	**3,559,078**
	TUGBOAT for sweepbar operations	Weeks	12.1	142,761	**1,722,679**
	LAUNCH for survey and personnel transport	Weeks	12.1	93,085	**1,123,251**
	Pipelines and spreaderpontoon	Weeks	12.1	78,287	**944,674**
	TOTAL DREDGING				**19,715,471**
	DREDGE MANAGEMENT				
	Staff	Weeks	12.1	113,734	**1,372,418**
	Survey	Weeks	12.1	33,930	**409,430**
	TOTAL MANAGEMENT				**1,781,849**
	SITE CLEARANCE				
	Staff site clearance	Weeks	4.0	114,559	**458,238**
	Survey Staff for out survey	Weeks	2.0	29,399	**58,797**
	Survey equipment	Weeks	2.0	105,850	**211,700**
	Post-sweeping with sweepbar	Weeks	1.0	142,761	**142,761**
	Booster station	Lump Sum	1	206,735	**206,735**
	Pipelines dismantling	Lump Sum	1	1,093,695	**1,093,695**
	TOTAL SITE CLEARANCE				**2,171,926**
	DEMOBILISATION				
	TSHD Marieke	Lump Sum	1	790,924	**790,924**
	TSHD Booster DI509	Lump Sum	1	206,932	**206,932**
	MULTICAT	Lump Sum	1	838,475	**838,475**
	TUGBOAT	Lump Sum	1	129,775	**129,775**
	LAUNCH	Lump Sum	1	27,184	**27,184**
	Pipelines and spreaderpontoon	Lump Sum	1	1,555,590	**1,555,590**
	TOTAL DEMOBILISATION	Lump Sum			**3,548,880**
	TOTAL PROJECT ESTIMATE				**35,888,657**