Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 1 – Executive Summary

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1. Executive Summary

1.1 Introduction

Baffinland Iron Mines (BIM) currently operates the Mary River iron ore mine in Nunavut, Canada. Ore is currently mined, crushed, screened and then trucked to Milne Port, where it is stockpiled until it can be shipped off site during the arctic summer. Two product types are produced, a lump ore between 32 mm and 6 mm and a fine sinter-feed ore of 6 mm or less. The ore is one of the highest grade products being produced in the world today and requires no subsequent processing before being fed to sinter plants or blast furnaces.

BIM plans to increase the production rate of the mine to 12 million tonnes per annum (Mtpa), shipping the output through Milne Port. This will be achieved by upgrading the mine fleet, constructing a rail line from the mine to the port, building a new crushing and screening facility at the port, construction of larger ore stockpiles and building a second ore dock and ship loader.

The base cost estimate (US$ 936.7 Million[1]) equates to a capital intensity of US$ 134 t/annum production increase (7Mt); after consideration of lease potential to reduce capital requirements by US$55 Million, the incremental project capital intensity falls to $ 126 t/annum of production increase (7Mt) , and will provide an operation cost of US$ 16.66 /tonne product after initial ramp-up (excluding port operations and shipping). Capital intensity and operating cost relative to similar projects and operations are shown in Figure 1-1 and Figure 1-2.

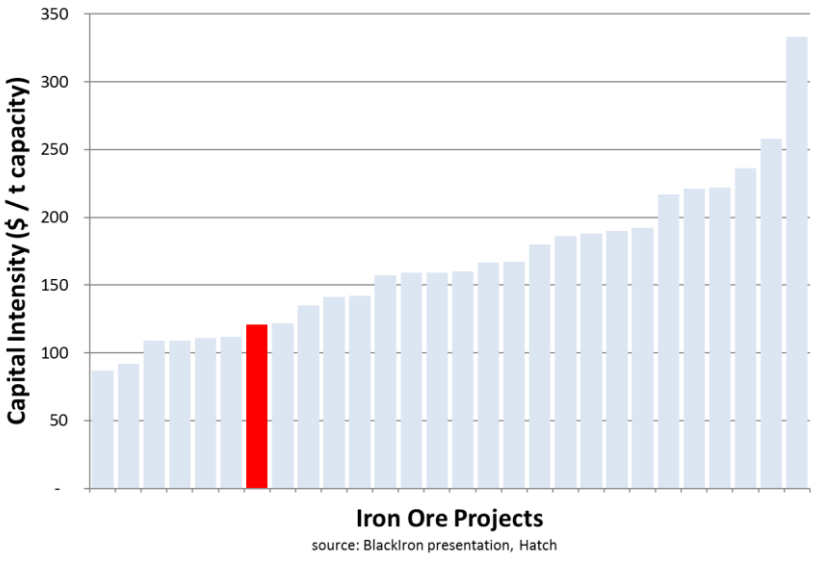

Figure 1-1: Iron Ore Project Capital Intensity (after capture of operating leases)

[1] In line with Arcelor Mittal Guidelines. Arcelor Mittal requires +/-10 to +/- 15% accuracy on the estimate. The estimate is reported to have an accuracy range of -11.6 to +12.2 over a 90% confidence interval around the mean estimate value. The estimate aligns with the requirements of an AACE Class 3 Estimate.

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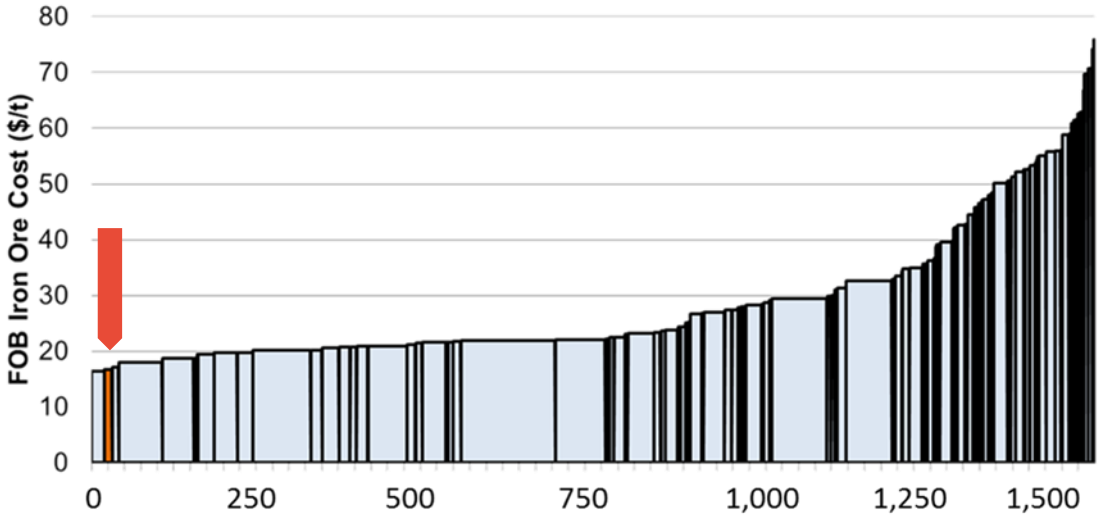

Figure 1-2: 015 SLN Global FOB Iron Ore Cost

The basis of the cost estimate is firm bids received for a substantial portion of the capital cost estimate.

The direct cost (excluding owners cost and contingency) 84% of the estimated capital cost has been obtained from firm market costs won from competitive tenders, see Figure 1-3. Major contracts for Bulk Materials Handling and Earthworks are in final contract negotiations.

The substantial firm (near contract award) pricing contained in the capital cost estimate provides the rationale for determining contingency at a p75 level.

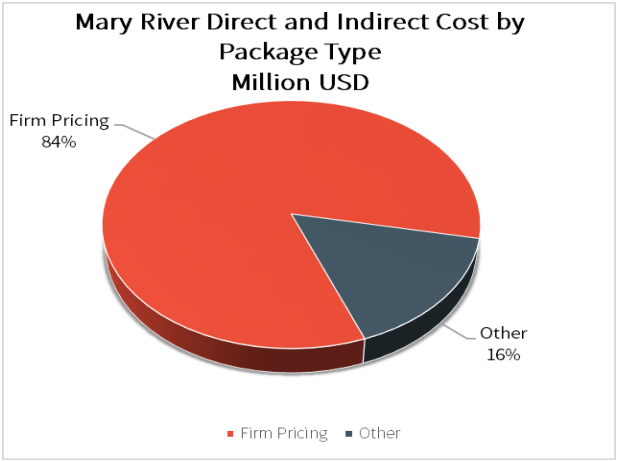

Figure 1-3: Capital Cost - Cost Source

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1.2 Project Objective

The expansion project objective is to increase the volume of iron ore shipped from Milne Port in the defined shipping season each year to 12 million tonnes, maximize the lump product, while minimizing capital expenditure and operating cost, resulting in a low cost sustainable operation.

1.3 Project Summary

The proposed Expansion Project scope developed during the Stage 3 Study includes:

- Expansion of mine equipment fleet with larger haul trucks, drills, shovel(s) and associated support equipment and facilities implemented over a progressive transition period (mine fleet required after 2019 included in the sustaining capital estimate)
- Development of a mine Site primary crushing system and rail loading area (rail car loading with front end loaders).
- Installation of a railway system, rolling stock and associated support equipment and facilities to transport ore from the mine to the port.
- Installation of automated rail ore unloading facility at Milne Port with conveyor discharge to stockpile;
- Installation of a Milne Port secondary crushing and screening plant.
- Development of new lump ore stockpiles,7.8 Mt capacity, with associated stacker-reclaimer which can reclaim at 16,000 t/h and feed the new ore dock and ship loading system.
- Installation of a new ore dock (Ore Dock #2) with a single dual linear shiploader to load both Panamax and Cape size vessels.
- Expansion of existing support infrastructure at Mary River and Milne Port.

Site layouts for the Mine Site, Railway and Milne Port are shown on the following pages in Figure 1-4,Figure 1-5 and Figure 1-6.

Planned production ramp-up for the project, based on existing operations achieving a production rate of 5 Mtpa, is summarized in Table 1-1

Table 1-1: Production Ramp-up by Year

Year	Calendar Year Production (Mt)	Tonnes Shipped Open Water (Mt)
2018	6.0	5.2
2019	8.0	5.5
2020	12.0	11.9
2021	12.0	12.0

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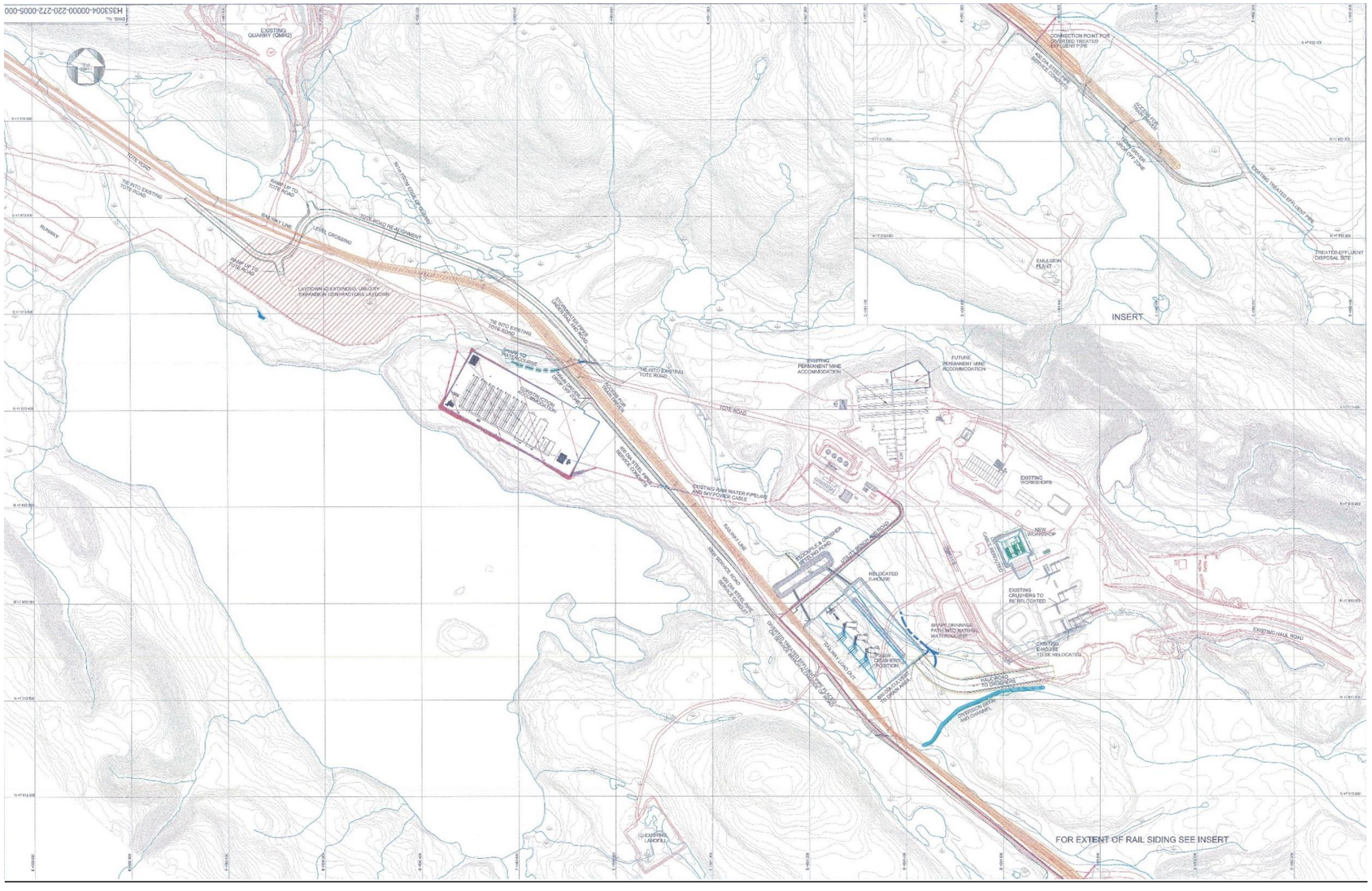

Figure 1-4: Minesite Layout

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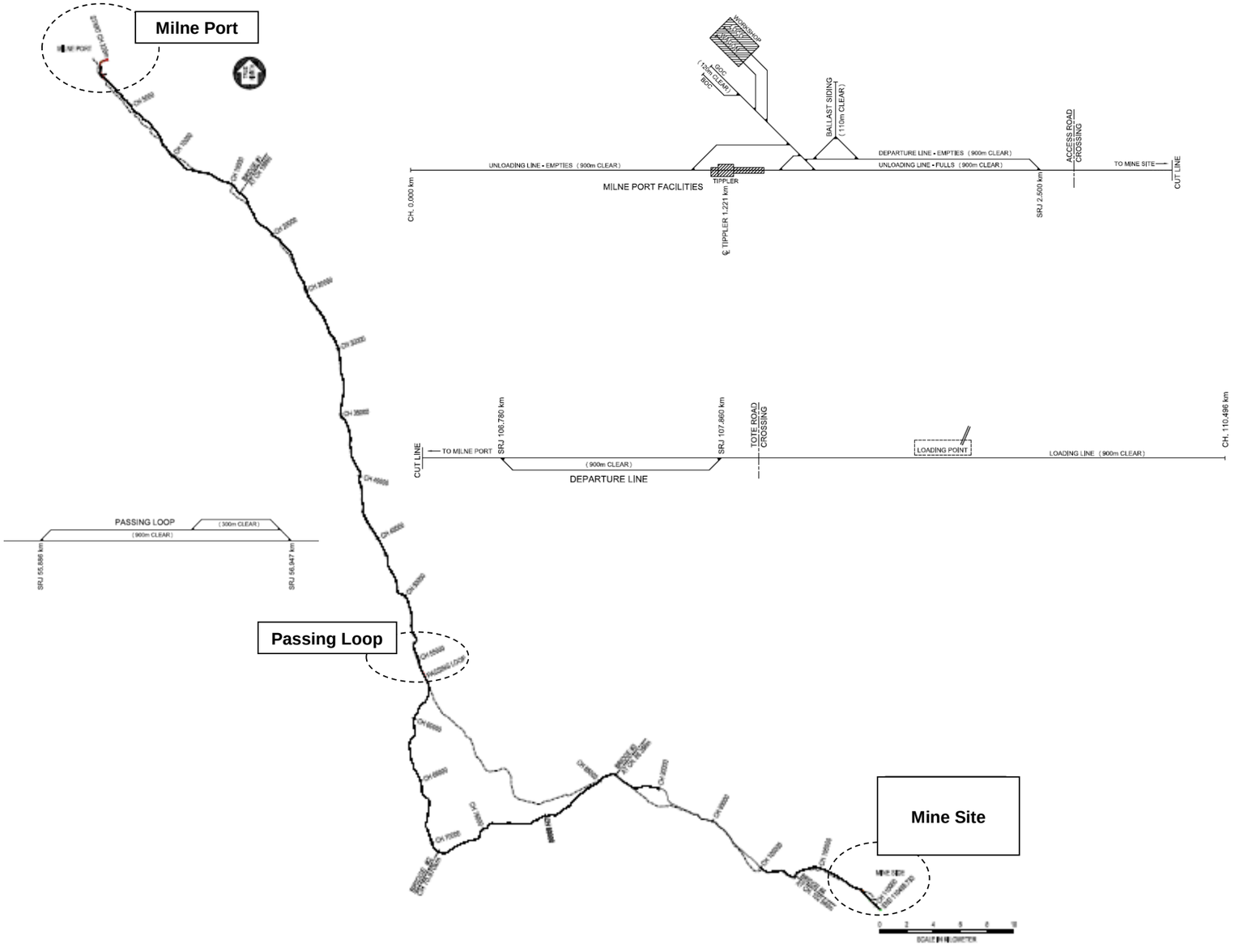

Figure 1-5; Rail Alignment

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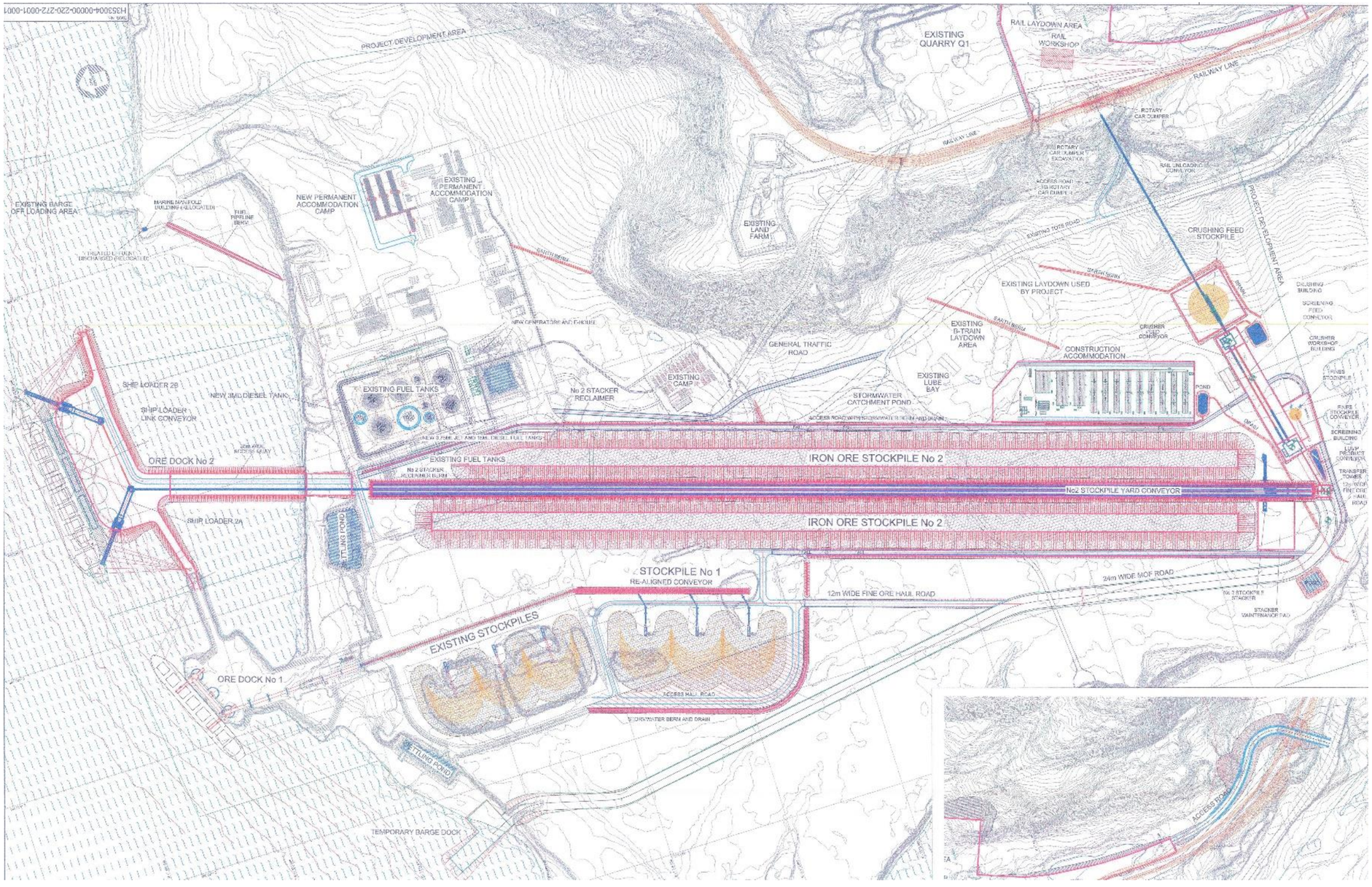

Figure 1-6 Milne Area Layout

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1.4 Resources and Reserves

Mineral Resources in this report were estimated in accordance with NI 43-101 and CIM resource classification definitions. The effective date of this Mineral Resource estimate is December 31, 2016 and the estimate is based on the surveyed open pit topographic surface as at year end (EOY) 2016. The resource estimate incorporates exploration and definition diamond drilling, and channel sampling data up to and including 2014 as well as production blast hole drilling to EOY 2016. RPA is not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that could materially affect the Mineral Resource estimate.

Table 1-2 summarizes the Mineral Resource estimates, exclusive of Mineral Reserves, for the Mary River DSO iron deposits with an effective date of December 31, 2016.

Table 1-2: Summary of Mineral Resources - December 31, 2016

Category	Tonnes (Mdmt)	Tonnes (Mwmt)	Fe %	P %	S %	Mn %	SiO_2 %	Al_2O_3 %
Deposit No. 1								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	117	118	65.3	0.038	0.36	0.22	3.1	1.0
M+I	426	429	65.7	0.031	0.28	0.21	2.8	1.2
Inferred	73	74	65.5	0.036	0.50	0.28	2.5	0.9
Deposit No. 2 – as of Nov. 7, 2013								
Indicated	26	26	65.7	0.021	0.01	0.02	4.5	0.8
Inferred	38	38	63.1	0.031	0.02	0.01	8.5	0.9
Deposit No. 3 – as of Nov. 7, 2013								
Inferred	271	273	66.1	0.035	0.01	0.06	1.9	1.1
Totals Deposit Nos. 1, 2, and 3								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	143	144	65.4	0.035	0.30	0.18	3.4	1.0
M+I	452	455	65.7	0.030	0.26	0.20	2.8	1.1
Inferred	382	385	65.7	0.035	0.10	0.10	2.7	1.0

Notes:

1. Mineral Resources for Deposit No. 1 have been estimated as of Dec. 31, 2016. Estimates for Deposit Nos. 2 and 3 are in progress, and, pending completion, estimates as of Nov. 7, 2013 are listed.
2. CIM Definition Standards are followed for Mineral Resources.
3. Mineral Resources are estimated at a cut-off grade of 55% Fe for Deposit No. 1 and 60% Fe for Deposit Nos. 2 and No. 3.
4. Mineral Resources are estimated using a long-term iron ore price of $70/t Fe, and a US$/C$ exchange rate of 1.28 C$/US$.
5. Bulk density is based on a formula relating bulk density to iron content.
6. Mineral Resources are reported in dry and wet tonnes, and dry grades. In situ moisture is estimated to be 0.7%.
7. Mineral Resources are inclusive of Mineral Reserves.
8. Numbers may not add due to rounding.

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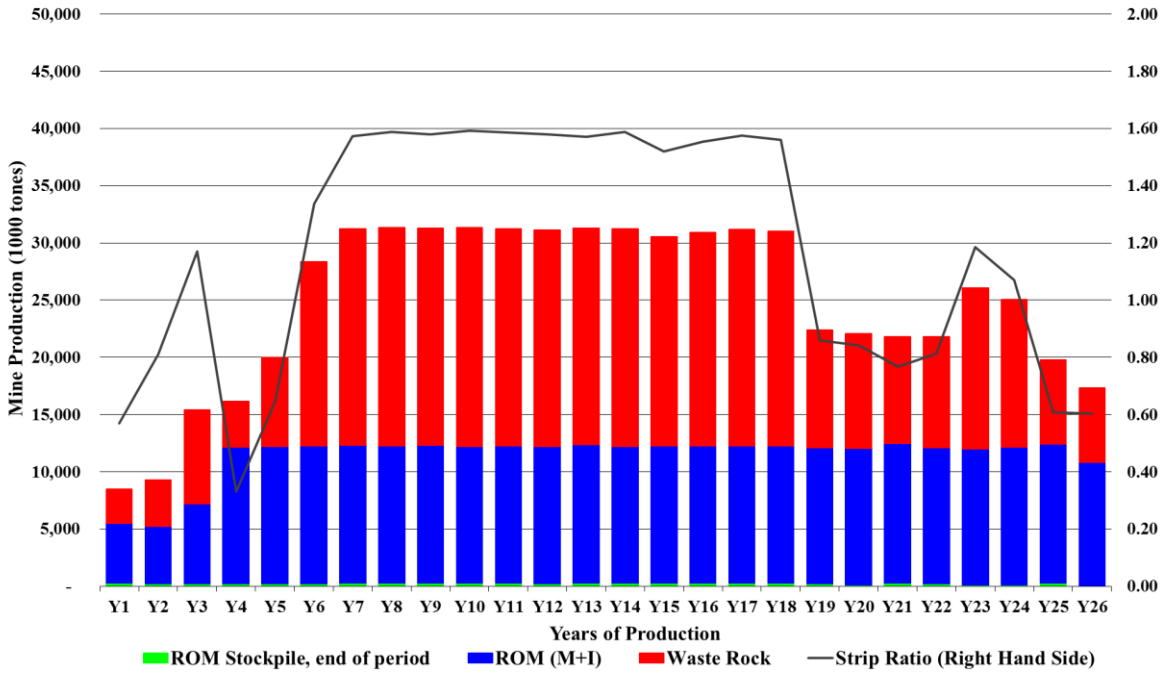
1.5 Mining

The mine plan has been updated. The smoothed production plan is shown in Figure 1-7.

Figure 1-7: Final feasibility study mine plan, Source: RPA



1.6 Railway

A new rail system will transport ore from the Mine Site to Milne Port to support the increased production, improve operational reliability and reduce operating costs. The new rail system, when commissioned, will completely replace the existing truck haul operation.

The rail system generally comprises of:

- Mine loading area located adjacent to the new primary crusher arrangement. Trains will be loaded by front end loader.
- Main line, nominally 110km in length, connecting the Mine Site to Milne Port. One siding will be positioned approximately mid-way along the main line for passing of trains.
- Port terminal with rotary car unloading system for offload of ore and rail operations and maintenance facilities.

Rail system key parameters are summarized in Table 1-3.

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Table 1-3: Rail Alignment Parameters

Item	Value	Comment
Total main line length	110.5 km	
Number of bridges	4	Steel girder type
Number of level crossings	5	Excluding yard track
Maximum gradient – loaded uphill	1.5%	
Maximum gradient – empty uphill	3.0%	
Number of trains	2	
Number of locomotives per train	2	One at each end
Number of wagons per train	72	Up to maximum 80
Length of train	~800 m	
Total payload per train	7,630 t	Weight of iron ore carried
Maximum speed	60 km/h	
Average speed, loaded train	45 km/h	Average from Mine to Port
Operating cycle time	9 hrs	
Number of loaded trains per day	5-6	

Rail gradients of 1.5% loaded and 3.0% empty have been proposed due to the undulating terrain and to minimize disturbance of the ground in areas of permafrost. A benchmarking comparison of these gradients to similar operations is shown in Table 1-4.

Railway support facilities and equipment commensurate with the scale of operation planned will be provided, including rolling stock workshop, mobile servicing and maintenance equipment, and automated equipment to detect rolling stock faults (“wayside equipment”).

Table 1-4: Rail Gradient Benchmarks

Country	Rail Line	Ruling gradient (Loaded)	Ruling gradient (Empty)
Norway	Ofotbanen Ore Line	0%	1.80%
Western Australia	FMG	0.23%	0.50%
Western Australia	BHP- Goldsworthy & Mount Newman	0.33%	1.50%
South Africa	Iron Ore export line	0.40%	1.00%
Western Australia	RIO- Hamersley & Robe Valley	0.40%	0.40%
India	Haryana - Maharashtra	0.50%	0.50%
Western Australia	Roy Hill Railway - Iron ore	0.50%	0.50%
South Africa	Coal Export Line	0.63%	1.52%
Alaska	Fairbanks Railway	1.00%	1.00%
Brazil	MRS	1.00%	1.00%
Canada	Canadian National	1.00%	1.00%
Sweden	Malmbanan Ore Line	1.40%	1.70%
Canada	**Baffinland Iron Mines (Proposed)**	**1.50%**	**2.20%**

1.7 Ore Handling

A block flow diagram summarizing the planned ore handling system is shown in Figure 1-8. The system comprises of:

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- Primary crushing using the existing 3 jaw crushers (with modifications) and train loading at the Mine Site.
- Secondary crushing (a single large cone crusher) and product screening (two triple deck screens) at Milne Port.
- Stockpiling of fines in the existing stockpile area for Ship Loader #1; reclaimed using the existing mobile equipment reclaim.
- Stockpiling of lump in a new stockpile area for Ship Loader #2 using an automated boom stacker; reclaimed with a bucketwheel reclaimer.

The upgraded system will simplify ore transport between sites by rationalizing to a single intermediate product (instead of managing transport of two different products, lump and fines) and will reduce the degradation of the lump ore by reducing handling after final screening.

During the Stage 3 Definitive Study tender packages for the Design and Build of the Ore Handling System which includes facilities to produce lump and fines at Milne from ore dumped into an automated train unloader through to fines stacking, lump stacking and reclaiming and supply of a new shiploader were issued to five international major bulk materials contractors. Firm bids were received from multiple contactors. Bids received supported the viability of the process (contractors agreed to accept performance warranties) and viability of equipment selected and equipment capacities noted in the Stage 2 Study. Capital and operating costs used in this study have been based on firm pricing received. After completion of the capital cost estimate, commercial negotiations have concluded allowing selection of a single vendor. Commercial negotiations have realised a reduced price from the selected vendor. Savings made provide an additional contingency buffer in the CAPEX estimate relative to his package.

In negotiating the Design Build offer for package CM001, the following changes will be incorporated into the equipment supplied by the contractor:

- Two secondary crushers will be provided in place of one. Contractors noted the use of a single crusher will reduce lump production, i.e. increase fines by approximately 6%.
- A single stacker reclaimer will be provided in place of a stand-alone stacker and reclaiming machine for the lump stockpiles. Stacking operations will occur all year except the shipping season. Reclaiming lump at 16,000 tonne per hour will occur during the shipping season with lump or from the screening plant bypassing the stacker for direct shiploading.
- A single dual linear radial shiploader will be provided capable of servicing both Panamax and Cape size vessels from Dock #2.

Modular erection concepts will be applied by the contractor to enable offsite pre-assembly, pre-commissioning and single piece shipment to site, under contractor control of the following:

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- Train unloader barrel, mechanism, bins and feeders
- Crusher Building
- Screening Building
- Stacker/Reclaimer unit
- Shiploader

Pre-assembly of conveyor units into 20m sections will further minimise construction work force size and minimise on site construction risk.

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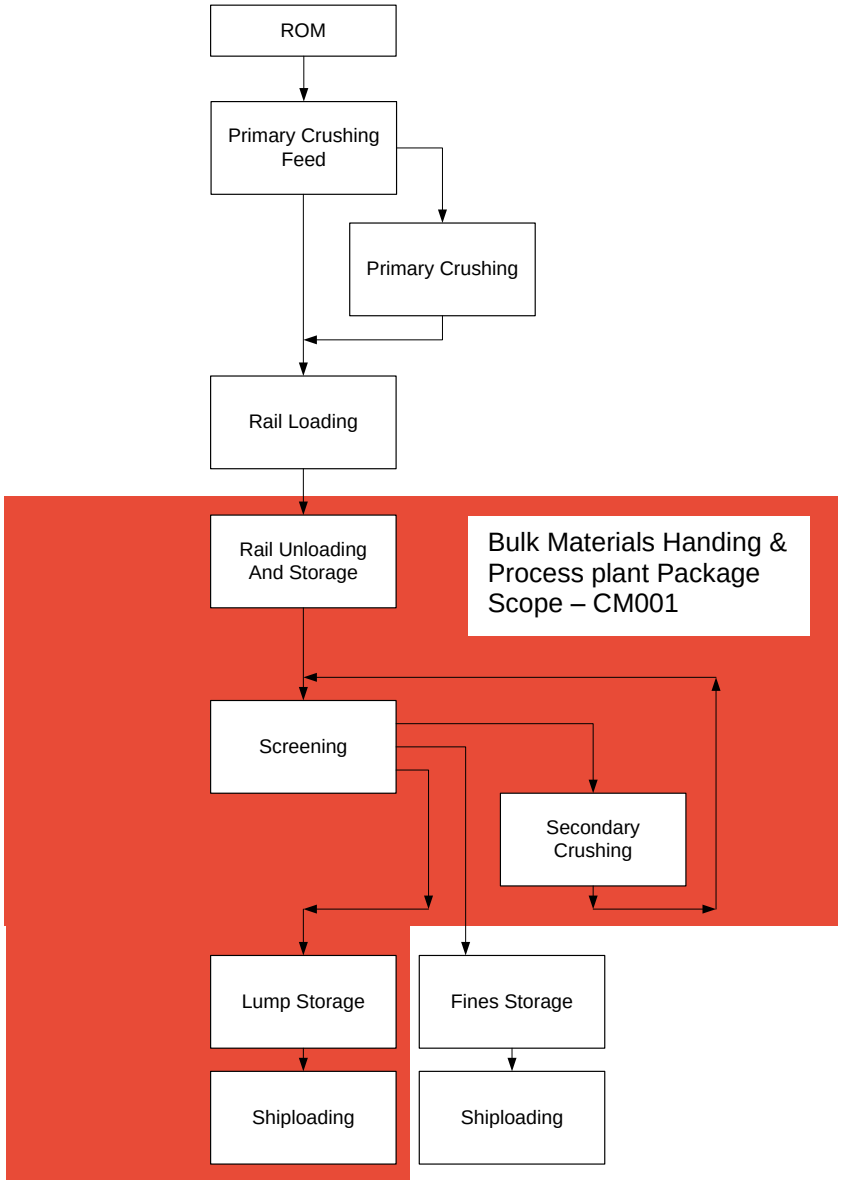

Figure 1-8: 12 Mtpa Simplified Process Block Flow Diagram

1.8 Ship Loading

Increasing annual production with the proposed project configuration requires shipping of 9.2 Mt lump ore and 2.8 Mt fine ore from Milne Port during the “open water” season utilizing market available ships.

To achieve the planned operation a new ore dock capable of berthing Cape Size ships and loading them at a rate of up to 16,000 t/h will be constructed. The existing dock will also remain in operation, loading ships up to Panamax in size.

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The proposed configuration will load all lump ore from the new dock and all fine ore from the existing dock, however the layout is configured in a manner which facilitates loading of either product from both docks utilizing mobile equipment.

Ship loading operation to achieve 9.2Mt lump and 2.8Mt fines shipment, utilizing ships expected to be available on-market, is summarized in Table 1-5.

Table 1-5: Ship Loading Operations Summary

Period	Dates	Ship Type	Ships Loaded Dock #1	Ships Loaded Dock #2
Early Season	Jul 25 – Aug 14	Ice Class	14x Supramax	24x Panamax
Mid-Season	Aug 15 – Sep 20	Non-ice class	22x Panamax	28x Cape Size
Late Season	Sep 21 – Oct 15	Ice Class	8x Supramax*	24x Panamax

*Loading of fines at Dock #1 has been maximized early season during milder weather conditions. There is surplus capacity to load additional Supramax ships Late Season if required.

1.9 Project Schedule

An execution schedule has been developed and validated with schedules included within assessed firm bid proposals for contracts bid during the Stage 3 Study. The schedule is based on phased issue of permits and licences and start of construction work within the ambit of existing permits pending receipt of supplementary permits refer to Figure 1-9.

Since the Stage 2 Study, a revision to dates for receipt of permits has been received. The nature of construction which is tied to material deliveries in short annual shipping windows has allowed for the slippage to be accommodated by absorbing project float. The project schedule captures dates shown in Table 1-6.

Permit	Stage 2 Study	Stage 3 Study Forecast	Permit Enables
Project Certificate	30 Mar ‘18	30 Oct 2018	
Revised Land Lease	30 Apr ‘18	31 Oct 2018	
DFO Authorisation – Ore Dock	30 Jul ‘18	01 Jan 2019	Start of Marine structures
DFO Authorisation – New Water Crossings	30 Jul ‘18	01 Jan 2019	Start of bridges, rail diversion areas
CTA Rail Permit	30 Jul ‘18	28 Feb 2019	Start of rail superstructure

Table 1-6: Project Permit Dates

Schedule analysis indicated achievement of mechanical completion and commissioning work is achievable in 2019. The commissioning of plant late into the 2019 shipping season precludes scheduling of Cape size vessels until the 2020 shipping season. Following commissioning in 2019, land based ramp up of the mine, rail, crushing and screening, and stockpiling work will continue towards the 12mtpa production rate as quickly as possible. Shipping at the 12Mtpa rate will begin in 2020 upon arrival of Cape size export vessels at Dock #2.

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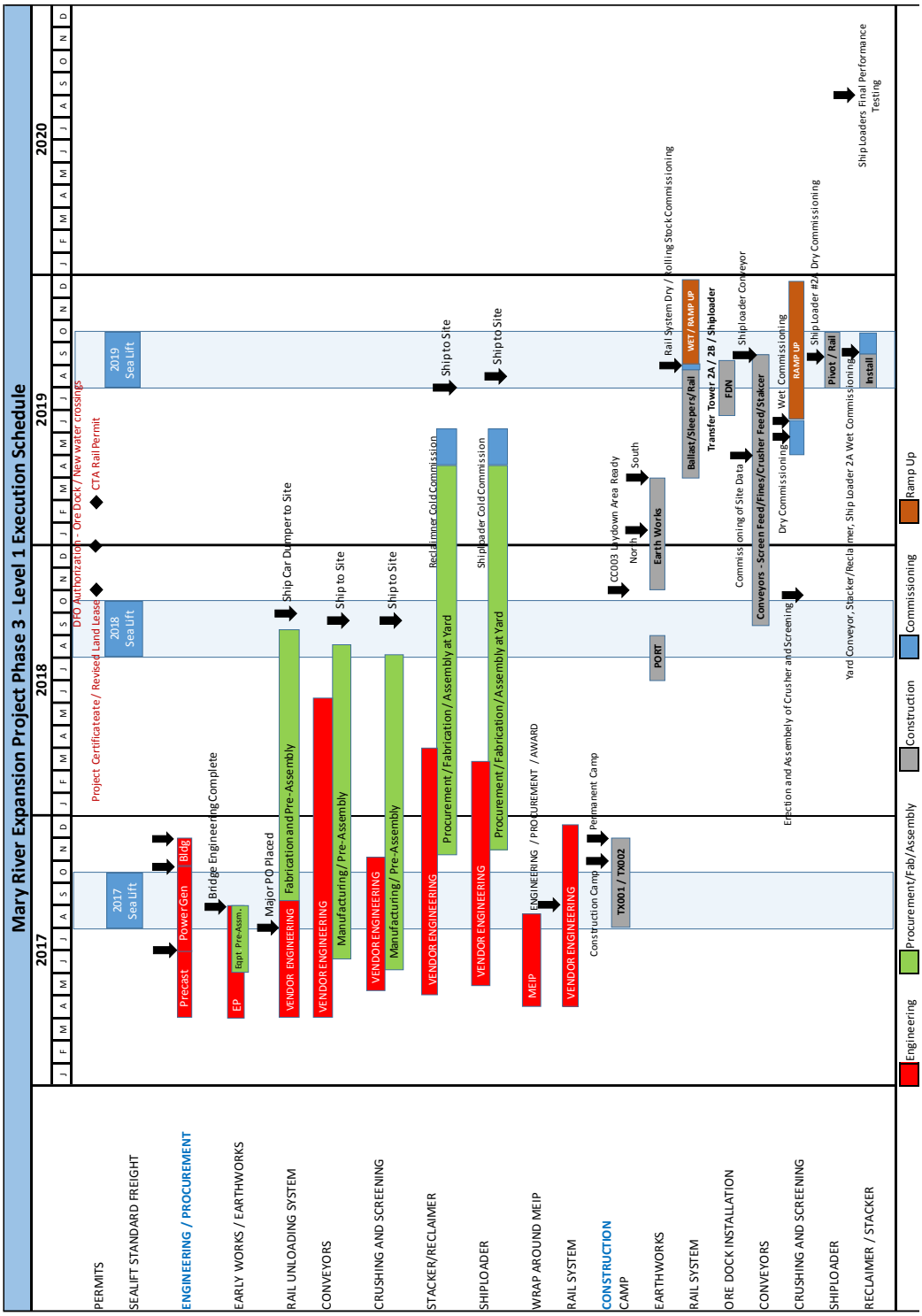

Figure 1-9: Level 1 Project Schedule

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1.10 Project Development and Execution

The project will be executed by a small Owner Team supported by an EPCM contractor. The contractual relationships are shown in Figure 1-10.

The EPCM contractor is responsible for project delivery from receipt of Run of Mine ore (ROM) at the primary crusher pad at Mary River Mine to lump ore discharge onto ships at Milne and fine ore reclaim at the port at Milne.

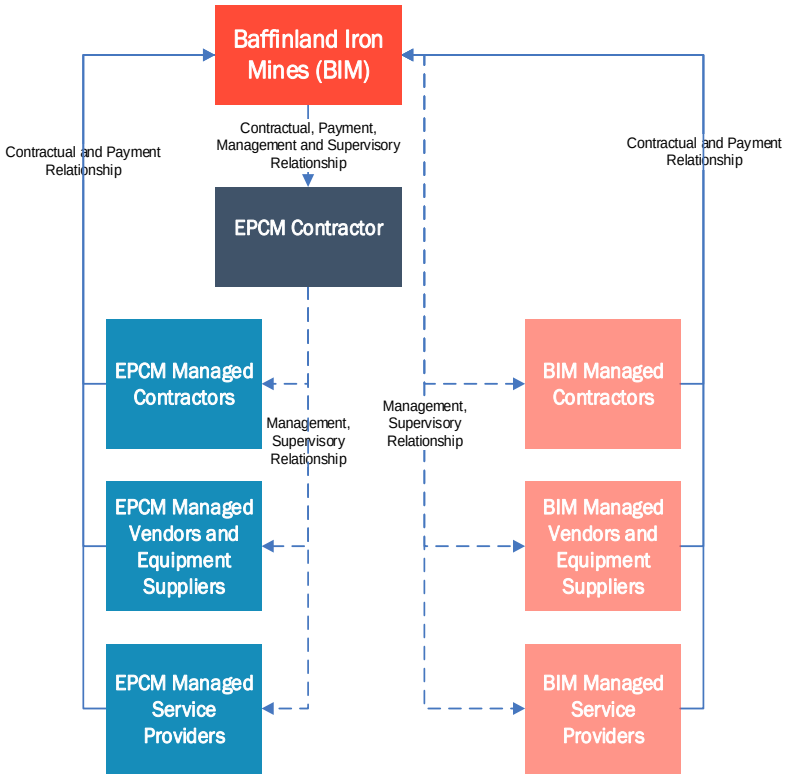

Figure 1-10: EPCM Model

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1.11 Capital Cost Estimate

1.11.1 Capex Summary

The total cost of the project is estimated to be US$ 936.7[2][3] million including a contingency of US$40.3 million. There are opportunities to potentially reduce the projected cost by $54.8 million by replacing some of the capital equipment with operational leases. Further opportunities exist to negotiate contact prices to levels lower than reported in the capital cost estimate; these opportunities will be progressed following submission of this report.

A summary of the capital cost estimate by production area is listed in Table 1-7. The total installed cost summary by WBS and Cost Type is listed in Table 1-7.

Table 1-7: Total Installed Cost by Production Area US$ millions

	Total
1000 - Mine	43.4
2000 - Iron Ore Process Plant And Onsite Infrastructure	39.7
3000 - Rail	282.8
4000 - Port	253.9
5000 - Other Off Site Infrastructure	0
Direct	**619.8**
6000 - Construction Facilities And Support	199.6
7000 - Implementation Contractor's Services	47.5
Indirect	**247.1**
8000 - Owner's Cost	**29.6**
9000 - Contingency / Escalation / Risk[4]	**40.3**
Total before the following	**936.7**
Operating Leases/off-balance sheet arrangements[5]	**(62)**
Total	**874.7**

[2] Estimated at exchange rates 0.7355 USD:CAD and 1.0867 USD:EUR (April 27, 2017)
[3] In ljne with Arcelor Mittal Guidelines. Arcelor Mittal requires +/-10 to +/- 15% accuracy on the estimate. The estimate is reported to have an accuracy range of -11.6 to +12.2 over a 90% confidence interval around the mean estimate value.
[4] Contingency assessed by BIM at the P75 level from the QRA model. In anticipation of expected further savings to be negotiated in major construction contracts CM001, CC002, CC003 and CG001 plus other smaller contracts, BIM has assessed this level of contingency to be appropriate.
[5] It is expected that in the normal course, operating leases or other off-balance sheet arrangements will be put in place for supply of locomotives, wagons, certain mining equipment, construction equipment, rail maintenance equipment, power generating sets and fuel tanks required for the project.

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Table 1-8: Total Installed Cost by WBS and Cost Type (USD Millions)

	Equipment	Material	Labour	Freight	Sub-Contract	Total
1000 - Mine	17.9	1.2	1.3	0.0	23.1	43.4
2000 - Iron Ore Process Plant And Onsite Infrastructure	31.9	1.5	0.1	0.0	6.2	39.7
3000 - Rail	30.9	0.0	0.3	0.3	251.3	282.8
4000 - Port	79.1	13.7	65.7	0.1	95.2	253.9
5000 - Other Off Site Infrastructure	0.0	0.0	0.0	0.0	0.0	0
Direct	**159.7**	**16.3**	**67.5**	**0.4**	**375.9**	**619.8**
6000 - Construction Facilities And Support	4.4	4.1	5.0	80.7	105.4	199.6
7000 - Implementation Contractor's Services	0.2	0.0	3.5	0.0	43.8	47.5
Indirect	**4.7**	**4.1**	**8.5**	**80.7**	**149.2**	**247.1**
8000 - Owner's Cost	0.0				**29.6**	**29.6**
9000 - Contingency / Escalation / Risk[6]	0.0				**40.3**	**6.34**
Total before the following	**164.4**	**20.5**	**75.9**	**81.1**	**594.9**	**936.7**
Operating Leases/off-balance sheet arrangements	(62)					**(62)**
Totals						**874.7**

The accuracy level established for the estimate over a 90% confidence interval over the mean project cost (p50=US$879m) is -14.2% and +15.6%.

Opportunities and risks exist which may influence the capital cost estimate. During the next stages of the project opportunities to further refine pricing and optimize the scope and project definition will be pursued.

The estimate excludes allowances for foreign exchange variation; import duties and customs clearance charges; working capital; cost of finance; cost of feasibility study and permitting; sunk costs; taxes; and owners management reserve.

[6].Contingency set at the value required for the project to realise a 75% chance of underrun, value set by BIM.

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1.11.2 Direct Cost

The direct cost is summarized in Table 1-9 below.

Table 1-9: Direct Cost Summary by WBS

Description	WBS	USD Millions	% of Direct Cost
Mine	**1000**	**43**	**7%**
Site Development	1500	4.5	1%
Services & Utilities	1600	1.4	0%
Mobile Equipment	1700	10.1	2%
Mine Ancillary Facilities	1800	17.1	3%
Mine Materials Handling	1900	10.3	2%
Iron Ore Process Plant And Onsite Infrastructure	**2000**	**40**	**6%**
Process Plant	2300	36.3	6%
Utilities & Onsite Infrastructure	2800	0.7	0%
Process Ancillary Facilities	2900	2.8	0%
Rail	**3000**	**283**	**46%**
Terminals / Yards	3100	35.7	6%
Mainline CN 2.80 km to 90.00 km	3200	152.8	25%
Mainline Ch 90.00 km to CH 106.00 km	3300	33.4	5%
Sidings	3400	2.9	0%
Bridges	3500	21.0	3%
Locomotives & Rolling Stock	3600	29.7	5%
Services & Utilities	3700	0.0	0%
Rail Ancillary Facilities	3900	7.1	1%
Port	**4000**	**254**	**41%**
Port terminal	4100	80.6	13%
Ore Handling	4200	62.2	10%
Wharf & Marine Structures	4600	34.2	6%
Loadout	4700	44.3	7%
Utilities & On-site Infrastructure	4800	32.6	5%
Port Ancillary Facilities	4900	0.0	0%
Total Direct Costs		**620**	**100%**

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1.11.3 *Indirect Costs*

Indirect costs include items that are necessary for the completion of the project, but are not directly related to the direct construction costs.

The Indirect cost estimate has been reviewed area by area and adjusted based on duration, effort and weightage against overall project duration. See Table 1-10 below:

Table 1-10: Indirect Cost Summary

Description	WBS	USD Millions
Construction Facilities And Support	**6000**	**200**
Construction Facilities	6100	4.9
Construction Support	6200	36.6
Construction Equipment, Tools And Supplies	6300	31.1
Material Transportation to Site (if not included in the direct costs)	6400	80.8
Project Accommodation	6700	46.2
Implementation Contractor's Services	**7000**	**48**
EPCM - Labour & Expenses	7100	47.5
Owner's Cost	**8000**	**30**
Owner's Cost During Implementation Phase	8100	29.6
Contingency / Escalation / Risk	**9000**	**6.34**
Contingency / Escalation / Risk	9100	6.34
Total Indirects, Owner's Cost, Contingency		**284**

1.11.4 *Owner's Costs*

An estimate, defined by BIM, has been included to cover those tasks that will be managed directly by the Owner.

Quarry royalties have been directly calculated.

1.11.5 *Project Contingency*

Contingency is a provision for unknown project costs increases, which may occur, but which cannot be accurately quantified for estimating purposes due to the lack of complete, and detailed information, as well as limited engineering development of the current PFS Phase. For the purpose of this study a contingency factor has been recommended based on the experience of the study team, developed by evaluating project maturity the level of engineering.

Project contingency has been selected by BIM from outputs arising from a Quantitative Risk Analysis and Monte Carlo simulation of expected final capital cost. Contingency has been

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selected as being the amount that will provide a 75% probability of project underrun which equates to a sum of US$40.3m. The level of contingency has been set, taking into account the following;:

- The very high proportion of cost (84% of costs excluding owners cost and contingency) is based on firm bids capable of being rendered to lump sum contracts.
- Post estimate closure negotiations for with contractor CM001 have realised further cost savings of approximately 6%, relative to the estimate.
- Contract negotiations for packages CC002 and CC003 for earthworks and EPCM are showing downward cost trends relative to the estimate.

With these factors in mind, BIM has confidence that a P75 contingency level for this project is appropriate.

1.11.6 Project Cash Flow

	Total Capital Cost	Cash Flow Typle	Total 2017	TOTAL 2018	TOTAL 2019	TOTAL 2020	TOTAL
Capital Cost $US millions	936,838	Commitment	853,944	62,525	15,498	4,871	936,838
		Incurred	275,919	407,845	237,253	15,821	936,838
		Invoiced	223,635	391,747	280,515	40,941	936,838
		Cashflow	146,393	413,274	310,912	66,259	936,838
Cumulative Cost $US millions	936,838	Commitment	853,944	916,469	931,967	936,838	936,838
		Incurred	275,919	683,764	921,017	936,838	936,838
		Invoiced	223,635	615,382	895,897	936,838	936,838
		Cashflow	146,393	559,667	870,579	936,838	936,838

Table 1-11: Capital Cost Flow

1.12 Operating Cost and Sustaining Capital Estimate

The estimate has been compiled utilizing information from the project team and Baffinland. The coordination and compilation of information, assumptions and inputs from multiple contributors is a key component of this estimate. Client Standards and the practices and procedures have been used where applicable.

Estimated average life of mine unit operating costs are approximately $16.66 per tonne product[7]. As shown in Figure 1-11.

[7] Estimated at exchange rate 0.7355 USD:CAD

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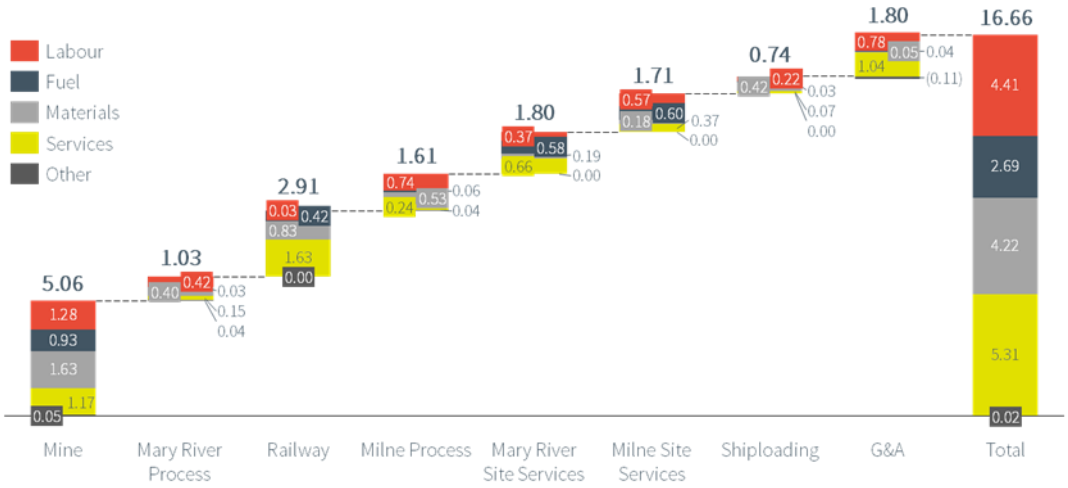

Figure 1-11: Operating Costs Averaged Over the Period 2019 to 2041, $US/tonne

Variation in operating cost year to year are largely driven by changes in the stripping ratio that occurs within the mine.

1.12.1 Operating Cost Estimate Basis

The estimate has been based on 12Mtpa operating rate of product shipped.

The operating cost has been estimated to a level of appropriate for this stage of engineering. This Study is intended to produce a capital estimate roughly equivalent to an AACE Class 3 capital spending estimate of +/-15% with 10-15% contingency. This operating cost estimate aims to achieve a similar level of accuracy, and can be considered to have an Canadian Dollar accuracy of -5% to +15%. At the time this report was prepared, Stage 3 mine plan was not yet complete, therefore the mine plan and associated mining costs are based on the previous Stage II mine plan. Operating costs for shipping and navigational support are not included.

The estimate has been assembled in Canadian dollar terms. Overall costs will be converted to United States Dollars using the average exchange rate of 0.7355 USD per CAD for the month August 2016.

1.12.2 Labour

Labour quantifications has been based on the organization structure and workforce numbers provided by BIM with adjustments to reflect the additional equipment operations.

1.13 Risk Management

During the Study risk reviews were carried out including informal risk identification. Key risks identified include:

- Capital cost increase due to:
  - Schedule Delay

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- Rail Earthworks Cost (quantity and/or unit cost variations).

The receipt of lump sum bids for major contracts with liquidated damages provisions for performance and schedule provide a substantial mitigation to this risk element. Aggressive pursuit of permits remains the mitigation to ensure permit approvals do not slip beyond provisions contained in the schedule.

- Project schedule delay possible due to:
  - Project Certificate and Associated Environmental Permit Delay's
  - Project Funding Release
  - Major Equipment Lead Times
  - Ship Loader Installation and Commissioning.

  Firm bids received for the supply of the majority of the equipment supply along with liquidated damages terms provide strong risk mitigation measures put in place during the Study.
- Operations cost/production impact due to:
  - Iron Ore Market Price
  - Product Quality
  - Unable to Achieve Design Capacity
  - Rail Tie Replacement.
- Health and Safety risk from:
  - Plane Crash
  - Rail Collision.

As the project advances through the next stage, increased definition will change the project risk profile and allow the project team to develop appropriate treatment plans for all key project risks to a higher level of detail. Opportunities to improve project economics and parameters even further will also be considered in the next phases.

1.14 Financial Analysis

The following summarises the financial performance of the project to increase production from 5 Mtpa (currently) to 12 Mtpa (planned) for the Mary River Project.

Average, undiscounted average unit cash flows for the life of mine are shown below. Working capital is excluded as it is negligible over the life of mine.

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Table 1-12: Cash flow summary over life of mine

Cash flow summary, $US/t	Average, LoM
Revenue	$71.62
Operating costs	(18.06)[8]
Freight and port charges	(6.14)
Royalties and overheads	(1.82)
EBITDA	45.60
Capital spending	(5.12)
EBITDA less Capital Spending	40.48

The resulting project net present value (NPV) is summarized in the tables below. NPVs include impact of pre-existing selling price, tax, royalties and financing supplied by Baffinland and included in their financial model.

Table 1-13: NPV summary, $US millions (excluding sunk costs)

Discount rate	Pre-tax unlevered	After-tax levered
7%	5,869	3,549
8%	5,233	3,156
10%	4,201	2,513

A sensitivity analysis was performed to examine the impact to after tax, levered NPV from changes in forecast benchmark price, exchange rate, capital costs and operating costs.

[8] Operating costs averaged over the period 2017 to 2041

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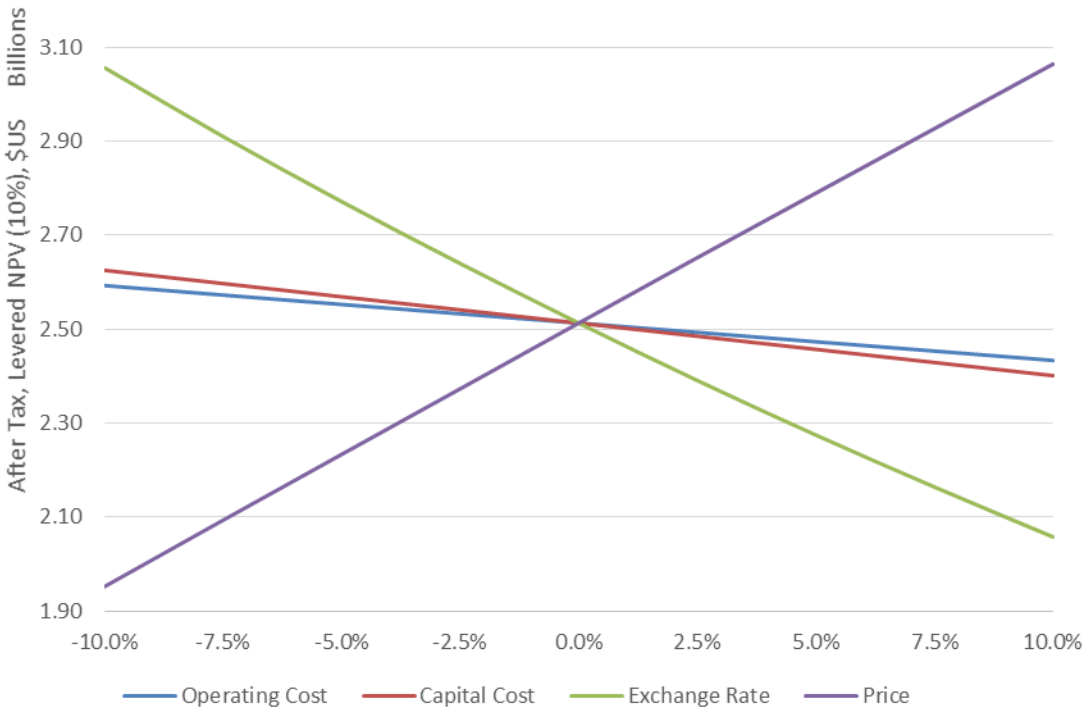
Figure 1-12: Net Present Value Sensitivity at 10% of After Tax, Levered Cash Flow



Benchmark prices which directly impact revenue are the largest sensitivity. Capital costs and operating costs are largely denominated in Canadian Dollars, while revenues are in US Dollars. Exchange rate showing the second largest sensitivity is therefore expected.

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 2 – Project History

2017-05-01	0	Approved for Use	N Mason	J. Cleland	S Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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Disclaimer

This report has been prepared by Hatch Ltd. ("Hatch") for the sole and exclusive benefit of Baffinland Iron Mines Corporation (the "Client") for the sole purpose of assisting the Client to identify potential options to increase production from the Mary River mine, and may not be provided to, used or relied upon by any other party for financing purposes without receipt of a copy of the attached waiver and release executed by such third party.

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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2. Project History

2.1 Location

The Mary River mine is located at the northern end of Baffin Island in the Qikiqtaaluk Region of Nunavut, Canada. The site is approximately 550 km north of the Arctic Circle.

Figure 2-1: Mary River Location Map

Baffin Island presents a unique and challenging environment displaying extreme conditions much of the year. Specific project planning is required to mitigate the associated risks:

- Sub-zero temperatures for at least 9 months of the year, with temperatures reaching as low as -54°C. Requires arctic class winterized equipment, temporary heated shelters, careful work planning and specific scheduling of temperature critical construction activities.
- Conditions during the summer period are relatively mild with an average daily maximum temperature of 10°C. Rainfall, which generally occurs during summer but can extend from April to November, averages approximately 260 mm per year.
- Significant changes in daylight hours during the year, including two months of near total darkness and a two month duration “polar day”. Construction activities scheduled to leverage summer 24-hour sunlight working full “night” shift and to minimize outdoor work during periods of near complete darkness.
- Cold permafrost ground conditions with, in places, significant soil ice content and large ice lenses. Earthworks design and construction to minimize disturbance of existing

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permafrost; and activities planned to leverage hard frozen ground conditions during winter including the option to construct ice roads and access over water.

- Ship passage by conventional (non-ice breaking) ships in or out of Milne Port is only possible from late July to mid-October due to ice coverage of the shipping routes. This provides a limited window to ship in supplies and the project must rely solely on air transport for resupply when ships cannot get to Milne Port. Detailed logistics planning, construction and contracting strategy and project scheduling to mitigate impacts on the project schedule.

2.2 Background

Prospector Murray Watts discovered the Mary River iron ore deposit in 1962. The following year Baffinland Iron Mines Ltd. (BIML) was established as a private company to develop the Mary River claims and leases. Over the next three years BIML built a 100 km tote road from Milne Inlet to the Mary River camp; constructed gravel airstrips near the Mary River camp, at Milne Inlet and at Katiktok Lake (near Deposit No. 4); and conducted additional metallurgical tests.

Exclusive rights to the Mary River ore deposits are now held by Baffinland Iron Mines Corporation. Baffinland Iron Mines Corporation's major shareholders include Nunavut Iron Ore and ArcelorMittal.

In 2013 Baffinland Iron Mines (BIM) developed an open-pit iron ore mining operation at Mary River. Mining commenced in August 2014 and BIM shipped its first iron ore to European Markets in July 2015.

Product from the Mary River mine is high grade direct shipping iron ore, both lump (approximately 75% of product) and sinter fines (approximately 25% of product). Crushing and screening of the ore is carried out on site at Mary River, no additional ore processing is required.

2.3 Current Operations

BIM's existing "Early Revenue Phase" operation is approved to mine, crush, stockpile and ship up to 4.2 Mtpa of iron ore lump and fines through Milne Port. Existing equipment and facilities include:

- Open pit mine with associated haul road and waste rock dump at Deposit No. 1.
- Mine equipment fleet based around use of 90t class mine haul trucks (CAT 777's).
- Mobile crushing and screening equipment located at Mary River.
- Ore Haul Trucks (OHT's) for transport of ore from Mary River to Milne Port.
- Lump and fines stockpiles with mobile stacking and reclaim equipment at Milne Port.
- Ore dock with ship loader suitable for loading Panamax vessels.

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- Mary River support infrastructure, including mine truck and general mobile maintenance workshops, central warehouse, gravel runway suitable for jet aircraft, accommodation, utility systems, waste management facilities, power generation and fuel storage tank farm.
- Milne Port support infrastructure, including mobile maintenance workshops, warehouse, accommodation, utility systems, waste management facilities, power generation and large capacity fuel tank farm.

Additional support infrastructure includes soft walled (Weatherhaven) camps and established rock quarries at both sites.

2.4 Expansion Project Objectives

The expansion project objective is to increase the volume of iron ore shipped from Milne Port in the defined shipping season each year to 12 million tonnes. Maximize the lump product, while minimizing capital expenditure and operating cost, resulting in a low cost sustainable operation. The proposed expansion project shall:

- Comply with the Nunavut Mine Health & Safety Act and Regulations, requirements defined in BIM's licences and permits, and BIM Safety Standards.
- Be constructed with minimal impact on existing ongoing operations.
- Achieve an annual production rate of 12 Mtpa transported off site during the defined shipping season using available market ice-class and non-ice-class ships up to Cape Size capacity.
- Be designed for operation 24 hours per day, 365 days per year; with the exception of the ship loading operations which are constrained by the available shipping season.
- Produce lump and fines product complying with BIM's specifications, maximizing the proportion of lump product.

2.5 Expansion Study Work Undertaken

2.5.1 High Level Option Study (Q2 2016)

During March and April 2016 Hatch developed a high level option study to determine the optimum project configuration for increasing production from 4.2 Mtpa to 12 Mtpa including rail transport of ore from Mary River to Milne Port. The proposed project configuration included:

- Mine fleet expansion using additional 90t class trucks (CAT 777).
- Primary crushing at the mine site using new and existing equipment.
- Rail transport of ore from the mine to the port. Rail alignment generally following existing Tote Road with specific approved deviations. Rail car loading using front-end-loaders. Rail car unloading using Kiruna Helix system.

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- Secondary crushing at the Port using three (3) 1000 hp cone crushers.
- Existing ship loader stockpile expanded to 5.2 Mt. Existing Ship loader utilized without modification.
- New 5.0 Mt lump stockpile with stacker/reclaimer. New ore dock, Panamax size located east of existing dock. Dock constructed from repurposed ship hull with single quadrant ship loader.
- Support infrastructure upgrades necessary for upgrade operations.

2.5.2 Stage II Study (Q3 – Q4 2016)

Based on the results of the High Level Option Study, Hatch was engaged by Baffinland in June 2016 to conduct an updated study to further develop options to increase production to 12 Mtpa, reduce unit operating costs and minimize the associated capital investment.

The Stage II Study was completed in October 2016.

The Stage II Study defined the scope of facilities to be provided to lift the production of iron ore from the Mary River Mine to achieve shipment of 12 Mtpa of iron ore.

The Stage II Project considered:

- Continued mining of Deposit No.1.
- Use of a mining fleet based around 90t class mine haul trucks (CAT 777) augmented with 220t class trucks (CAT 793).
- Conversions of existing crushing and screening plant to be able to produce a primary crushed ore with a nominal top size of 100mm, as averse to production of lump and fines at Mary River.
- Maintaining the Front End Loader (FEL) feeding of Run of Mine (ROM) ore to the crushers.
- Development of ROM stockpiles ahead of the crusher circuit and primary crushed ore stockpiles for reclaim and loading onto trains by FEL.
- Development of a single track, standard gauge rail track with associated locomotives and ore wagons to transport -100 mm ore from Mary River to the port at Milne.
- Unloading trains using an automated rotary car unloaders coupled to a primary crushed ore stockpile at Milne.
- Reclaim of primary crushed ore and feed to a single cone crusher and two multi deck screens to produce separate lump and fines product.
- Conveying lump product to be stacked in new lump ore stockpiles using an automated rail mounted stacker machine.

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- Trucking fine ore from the screening plant to be stockpiled within the existing stockpile area with existing stackers being engaged to stack the ore.
- Installation of a single automated bucket wheel reclaimer for lump reclaim
- Installation of a new dock mounted with two radial arm shiploaders capable of loading Cape size and Panamax vessels.
- Use of existing conveyors (reconfigured) and mobile equipment to reclaim fine ore and load onto Panamax sized vessels using the existing ship loader.
- Upgrading Mine and Milne Port infrastructure to provide for additional accommodation units (construction and operations), maintenance facilities (truck shop at Mary River, Rail workshop and Crusher Workshop at Milne), utility, power generation and distribution facilities as well as increases in fuel storage volumes.
- Shipping lump and fines ore from two docks during the defined summer shipping season.
- Recommendations to further define the project using and executions strategy based around;
    - Offsite modular construction for process and bulk materials handling equipment and as many other facilities suited to this construction approach.
    - Use of Design Build (D&B) contracts for development of the rail and the Milne bulk materials handling system.

The Stage II Study defined the capital requirements as shown in Table 2-1.

Table 2-1: Stage II Report Capex Estimate

Production Area	Capital Cost (USD Millions[3])
Mining / Mine site	30.6
Port Site / Bulk Materials Handling	209.9
Railway	276.3
Indirect Costs	247.3
Owners Costs	26.4
Contingency	158.1
Total Estimated Cost	**948.7**
Potential Operating Lease Reduction	(60.0)
Potential Capital Cost Savings (Market Conditions)	(35.0)
Potential Project Capex with Savings	**853.7**

2.6 2016 – 2017 Geotechnical Investigation

In parallel with the Stage II Study, investigations were initiated to generate geotechnical information to confirm Stage II scope, where possible, and to develop a body of data to

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support rapid progression of Study and detailed design work in subsequent phases of the Project. The programme included:

- 2016 work completed:
  - Boreholes at the Milne Port infrastructure were drilled.
  - Bridge abutment at the existing Tote Road km 17, km 80 and km 97 were drilled.
  - Accessible boreholes on the rail alignment in cut locations between km 0 to km 58 and km 78 to km 108 were drilled.
  - A sample of the Granitic Gneiss was cored near the existing quarry at Milne Port. Samples of the Dolomitic Limestone were cored along the existing Tote Road near km 63.
- 2017 work completed – Marine Study:
  - Offshore investigations related to placement of Dock 2 including:
    - 5 Piezo cone penetration tests.
    - Drilling five locations for the new dock and collection of soil samples for analysis.
    - Seismic surveys at 12 locations within the rail alignment, outside current permit boundaries to allow assessment of bed rock depth.
- 2017 work completed or currently being completed – Rail Study:
  - Boreholes between km 78 and km 70 has been drilled
  - The bridge abutments at km 70 has been drilled.
  - GPR surveys will be completed at km 26 and km 46 where substantial ice formations have been found during the 2016 borehole drilling program.
  - Geophysical investigations will be completed between km 70 and km 58 as this section is not accessible with the borehole drilling equipment.
  - One new boreholes was drilled along a potential alternative alignment to avoid the ice formation at km 26.
  - Additional geotechnical testing is being completed on the ballast samples from the quarries at the mine and port to ensure material properties meet the requirements for railway ballast.

Full details of the geotechnical program and its results are detailed within Section 7 of this report. Further geotechnical work may be required in the execution phase of the project to confirm design baseline data for detailed design purposes.

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2.7 Stage III Study Objectives

Minimising capital requirements during the construction period, 2017 to 2020, obtaining a higher level of cost certainty and mitigating risks, relative to the Stage 2 Study result is required for BIM to make a final commitment to project execution.

A number of optimisation elements were recognised in Stage II work requiring further development in Stage III.

2.7.1 Optimization Potential For Subsequent Phases

During the completion phase of the Stage 2 Study a workshop convened between Hatch and BIM identified a number of vectors for improving project cost projections and cost certainty. The major cost and delivery improvement vectors are:

- To reinforce the viability of the project, commissioning and project ramp up planning to ensure production and shipping a total of +12 Mt of DSO in the shipping season of 2020, is required.
- Detailed planning to ensure minimal interruption to existing operations and product shipping during the construction period.
- Detailed planning to ensure a robust operations readiness plan is developed and implemented to ensure smooth transition to new operating methods and a sustained ramp up to 12 Mtpa of DSO shipped.

Specific optimisation targets were identified as:

- Optimisation of rail earthworks design arising from:

  Receipt of a consistent set of Lidar information for the entire alignment length of the railway. Such data became available after completion of cost estimates underpinning the Stage II Study.

  Completion in January 2017 of a field geotechnical program to confirm assumptions about soil and rock conditions used within the Stage II Study. Completion of the geotechnical program will also provide information to confirm and upgrade (where supported by data) assumptions made with respect to the amount of material from rock and other cuts, which may be re-used as construction materials.

  Further optimization of the rail alignment and railway rolling stock requirements arising from completing a software optimization of the rail alignment and operating regime using Trimble optimization software, including:

  - Improving alignment near km 97.
  - Optimization of culvert designs to where possible allow for standard designs.
  - A review of the use of spoil materials as construction material.
  - Optimization of the rolling stock and locomotive requirements.

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- Optimisation of project costs;

  Recognizing the depressed global market for equipment and materials supply, there may be the likelihood of commercial competition to secure material, equipment and construction contracts, which may result in reduced pricing relative to the Stage II Study.

  - Sourcing equipment from known low cost countries such as in China.
  - Optimization of mobile equipment costs through competitive bidding in the Stage 3 Definitive Study of contracts for supply, maintenance and operation of mobile equipment on a contract basis. This is approach is applicable to mining equipment and railway maintenance equipment.
  - Optimization of freight costs through packaging freight within major design supply contracts to simplify the freight and logistics train, where this is to the advantage of the project.
  - Optimizing supply and construction cost by packaging work into larger vertically integrated packages on a design, supply and construct basis, to obtain economies of scale and systems integration through provision of complete systems by a single party.
  - Competitive bidding for design during the Stage 3 Definitive Study (using a FIDIC contracting platform), supply and install contracts, may result in vendors offering optimized equipment selections and designs, further driving the cost of the project down. Optimizations expected include:
    - Optimized foundation designs to minimize concrete use and need for site poured contract.
    - Optimized steelwork designs for plant and buildings to minimize project cost.
  - Use of modular concepts to minimize requirement for a site construction workforce and commissioning efforts, through pre-commissioning off site.

An assessment of the risk of delay in placement of contracts, release of permits and mobilisation within shipping windows that may result in shipping windows being missed with consequent risk of substantial project delay is required to balance optimisation concepts.

2.7.2 Stage III Definitive Study – Study and Report Preparation Responsibilities

In October 2016 BIM launched a Stage III Study due for completion in April 2017.

The table below summarises the organisations contributing to the development of this Stage III report.

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Table 2-2: Study Report Contributors

Study Report Section	Study Element	Report Contributor
1	Executive Summary	Hatch
2	Project History	Hatch
3	Geology	BIM / Roscoe Postle Associates, Inc (RPA)
4	Mineral Resources	BIM / Roscoe Postle Associates, Inc (RPA)
5	Mining	BIM / Roscoe Postle Associates, Inc (RPA)
6	Process Definition	Hatch
7	Engineering Development	Hatch
8	Project Layout	Hatch
9	Facilities Description	Hatch
10	Business Systems	BIM
11	Project Schedule	Hatch
12	Capital Costs	Hatch
13	Human Resources	BIM
14	Operating Costs	Hatch
15	Market Analysis	BIM
16	Legal and Fiscal	BIM
17	Health Safety, Environment and Community	Hatch
18	Sustainable Development	BIM
19	Financial Analysis and Evaluation	BIM/Hatch
20	Project Risks and Opportunities	Hatch
21	Execution Plan	Hatch
22	Operations Readiness	Hatch

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Baffinland Iron Mines LP

Mary River Expansion Stage 3

Definitive Study Report

Section # 3 - Geology

April 28 /17	A		Review	PC	DR	JC	Name
May 1/17	C		For use	PC		JC	
Date	**Rev.**		**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
	RPA						**Employer**

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1. information available to RPA at the time of preparation of this report,
2. assumptions, conditions, and qualifications as set forth in this report, and
3. data, reports, and opinions supplied by the Client and other third party sources.

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1.0 Summary

Regional Geology

The Mary River Group is part of the Committee Bay Belt, an assemblage of granite-greenstone terrains, rift basin sediments and volcanic rocks which lie within the northern Churchill Province and extend from southwest of Baker Lake for over 2,000 km to northwestern Greenland. Mary River Group greenstone belts form isolated remnants in a roughly 65 km long stratigraphically coeval volcanic series, which has been highly contorted, deeply eroded and forms a discontinuous series of volcanogenic units within older gneiss and migmatite formations, The iron formations, of varied types and quality, occur discontinuously within the metasedimentary mid-section units of the Mary River Group.

Local Geology

High-grade iron deposits were discovered in 1962 within a deformed granite-greenstone terrain at Mary River on northern Baffin Island, about 160 km south of Pond Inlet. Initial fieldwork from 1962 to 1965 outlined four exposed deposits (Deposit Nos. 1, 2, 3, and 4) of high-grade hematite-magnetite mineralization hosted within extensive belts of banded iron formation. The Mary River iron ore deposits represent high-grade examples of Algoma-type iron formation. The deposits are characterized by zones of massive, layered to brecciated hematite and magnetite, variably intermixed with banded oxide to silicate facies iron formation.

Property Geology

DEPOSIT NO. 1

Deposit No. 1 is currently the largest defined iron ore deposit in the Mary River area. The deposit has a total strike length, as defined by outcrop and magnetic anomalies, of about 3,800 m. Outcrops of high-grade iron oxides consisting of hematite and magnetite in various proportions and of specularite are exposed along the margin and crest of Nuluujaak Mountain at elevations ranging from 250 m to 700 m, over a strike length of 2,500 m. A possible additional strike of 550 m is suggested by magnetic surveys and outcrop to the south. Magnetic survey data also indicate the continuation of the iron formation for about 750 m to the north.

DEPOSIT NO. 2

Deposit No. 2 outcrops on a ridge located 2.6 km east of Deposit No. 1. The deposit consists of dark steel to blue-grey weathered high-grade specularite iron formation outcropping up to 40 m in width and 90 m in length. The deposit has been traced for over 600 m along strike. The deposit strikes west-

southwest and grades into a south to south-southeast dipping belt of banded oxide facies iron formation up to 100 m wide. The zone of high-grade iron formation outcrops from 610 m to 670 m in elevation.

DEPOSIT NO. 3

Deposit No. 3 is situated on the crest and lower slope of a ridge 670 m south of Deposit No. 2. The deposit consists of high-grade hematite and specularite iron formation outcropping at an elevation of 490 m to 530 m and has a drilled strike extent of approximately 2.5 km. High-grade iron formation outcrops and float associated with a belt of Mary River Group metasedimentary and metavolcanic rocks can be traced along strike and in aeromagnetic anomaly patterns intermittently for more than 9 km east-northeast and northeast to the Glacier Lake area.

DEPOSIT NO. 4

High-grade iron formation of Deposit No. 4 outcrops on a low ridge 27 km northwest of Deposit No. 1 and three km west of the Central Borden Fault zone. In this area, exposures of high-grade magnetite and specularite iron formation occur as a series of elongated lenses or bands, 5 m to 75 m wide that outcrop intermittently over a strike length of 2,800 m within the mine lease boundary. Due to the predominantly narrow widths encountered in Deposit No. 4 and presence of high sulphur and high phosphorus, little potential for additional tonnage is anticipated in the immediate Deposit No. 4 area. The deposit is open at depth, however the potential in-pit waste rock contains high sulphur values.

DEPOSIT NO. 5

The 2008 airborne magnetic survey outlined an anomaly extending 21 km southeast from Deposit No. 4. Deposit No. 5 was discovered in 2009 within this magnetic anomaly and is located approximately four kilometres southeast of Deposit No. 4. Deposit No. 5 is comprised of two main hematite enriched lenses within a broader regionally continuous banded iron formation. The largest outcrop of high grade mineralization associated with the main Deposit No. 5 lens can be traced for approximately 700 m in strike length and has an exposed width of 70 m. Three additional narrow exposed intervals of enriched iron formation occur to the southeast of Deposit No. 5.

Mineralization

The Mary River deposits comprise a number of iron formations which have been enriched and altered to varying degrees. Original banded iron formations comprised of alternating layers of magnetite and hematite are preserved in several locations along strike of existing high grade deposits. The regional metamorphism and folding associated with the Hudsonian Orogeny resulted in significant crustal

thickening. This period also resulted in zones of weak to very efficient leaching of silica. Subsequent hypogene and metamorphic events led to the alteration of magnetite to hematite and specular hematite. Surface outcrops differ in iron, silica, and sulphur content and in the proportions of their main oxide minerals – hematite, magnetite, and specularite.

3.0 Geological Setting and Mineralization

The following is taken from RPA Inc. (2013b)

3.1 Regional Geology

The Mary River Group is part of the Committee Bay Belt, an assemblage of granite-greenstone terrains, rift basin sediments and volcanic rocks which lie within the northern Churchill Province and extend from southwest of Baker Lake for over 2,000 km to northwestern Greenland (Jackson and Berman, 2000). The Committee Bay Belt is joined to the south by the approximately 1.9 Ga to 1.8 Ga Baffin Orogen. The Committee Bay Belt has been divided into major assemblages, which include the following:

a) Archean-age banded granite migmatites and three or more phases of gneissic granitic intrusions, traversed by deformed amphibolite dikes. Ages to 2.85 Ga, are unconformably overlain by the Mary River Group. The units are strongly metamorphosed.

b) Late-Archean Mary River Group; a diverse assemblage of metasedimentary and metavolcanic rocks, preserved in narrow, folded greenstone belts. Ages 2.76 Ga to 2.72 Ga. Belts generally show a lower sequence of varied metavolcanics, overlain by metasedimentary- metavolcanic sequences including iron formation, succeeded by an upper group of metavolcanic and metapelitic clastic sedimentary units with high- level metamorphism.

c) Paleoproterozoic Piling Group; metasedimentary/metavolcanic sequence including quartzites, marble, sulphidic iron formation, black schists, mafic metavolcanics. Ages 1.9 Ga to 1.8 Ga with medium-level metamorphism.

d) Mesoproterozoic Bylot Supergroup, in the Borden Rift Basin; siliciclastic and carbonate sedimentary rocks, some mafic volcanic units. Age 1.27 Ga with low-level metamorphic facies.

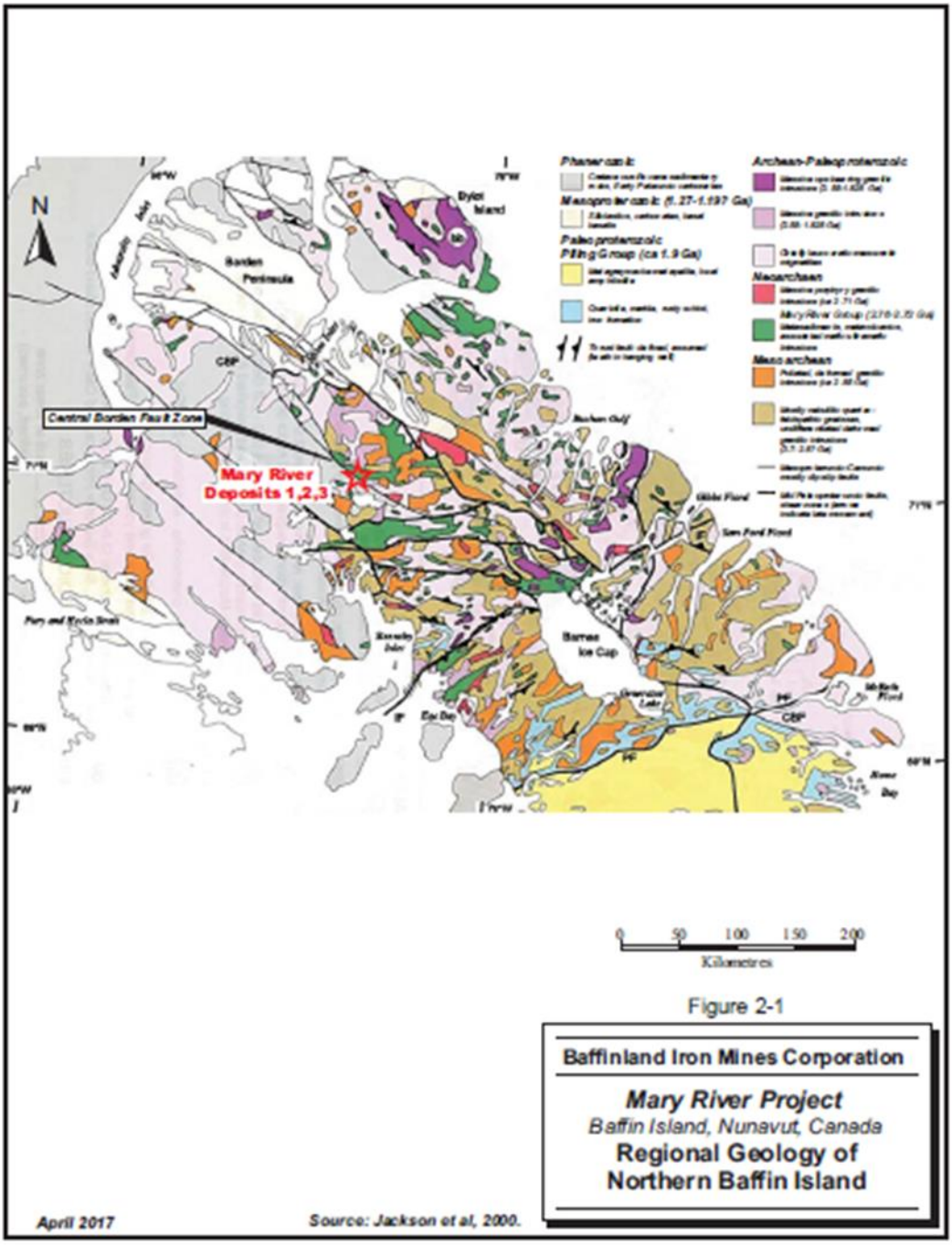
e) Early Paleozoic Cambro-Ordovician (Turner Cliffs-Ship Point Formation); unmetamorphosed clastic and carbonate sedimentary rocks, locally preserved in northwesterly-trending grabens. Age 400 Ma to 500 Ma.

Mary River Group greenstone belts form isolated remnants in a roughly 65 km long stratigraphically coeval volcanic series, which has been highly contorted, deeply eroded and forms a discontinuous series of volcanogenic units within older gneiss and migmatite formations (Figure 3-1). The belts consist most commonly of a lower sequence of felsic to mafic metavolcanic rocks and an upper sequence of turbiditic pelite-greywacke. The stratigraphic position of iron formation, quartzite, conglomerate, minor marble and volcanic breccia may vary on a regional scale (Jackson and Berman, 2000).

The iron formations, of varied types and quality, occur discontinuously within the metasedimentary mid-section units of the Mary River Group. Their outcrop patterns are interrupted and truncated by original local sedimentary facies variations and by post-depositional folding, faulting, and erosion. Only in a few locations, such as Mary River, do the iron formations have the required thickness, quality, and continuity sufficient to be of potential economic interest.

The regionally-extensive Franklin dolerite dike swarm generally follows the direction of major northwest-trending fault sets. These major fault systems persist for hundreds of kilometres and are marked by fault-line valleys and scarps, and show evidence of very large vertical and horizontal displacements. One of these, the Central Borden Fault Zone, passes about one kilometre to the south of the Mary River iron deposits. The fault separates the Mary River Group rock (~2.75 Ga age) on the northeast from the early Paleozoic formations (Turner Cliffs and Ship Point formations) to the southwest.

Figure 3-1 Regional Geology



3.2 Local Geology

The local geology is presented on Geological Survey of Canada Map 1451A "Geology of Icebound Lake, District of Franklin, 1:250 000 (Jackson et al., 1978a). Closed-file maps of the geology at 1:50,000 scale are presented by Geological Survey of Canada, Geology of NTS Sheets 37G/5 and 37G/6 (1965) by G.D. Jackson. The geology of the Mary River area has been synthesized by BIM's senior geologist, T. Iannelli (Iannelli, 2005).

High-grade iron deposits were discovered in 1962 within a deformed granite-greenstone terrain at Mary River on northern Baffin Island, about 160 km south of Pond Inlet. Initial fieldwork in from 1962 to 1965 outlined four exposed deposits (Deposit Nos. 1, 2, 3, and 4) of high-grade hematite- magnetite mineralization hosted within extensive belts of banded iron formation (Figure 3-2). Deposits No. 1 to 3 occur within a single 30 km^2 area, while Deposit No. 4 is situated 27 km to the northwest. The sedimentary-volcanic succession in which the iron formations are hosted was designated as the Mary River Group by Jackson in a 1966 paper (Geology and Mineral Possibilities of the Mary River Region, Northern Baffin Island, Canadian Mining Journal, 87, No. 6, 57-61).

The complexly folded Mary River Group greenstone belt, in the Mary River area, has a strike length of about 65 km and an inferred width of up to six kilometres (Jackson et al., 1978a). Rocks of the Mary River Group in the Project area include banded oxide and silicate facies iron formation, high-grade iron formation (hematite, magnetite and mixed hematite-magnetite-specularite varieties), and mixed metasedimentary rocks (quartzite, metaconglomerate, metapelites, metagreywacke and related derived cordierite-staurolite-garnet-mica to quartz-feldspar-biotite schists and gneisses) (WGM, 1964, 1965; Jackson et al., 1978a; Jackson, 2000).

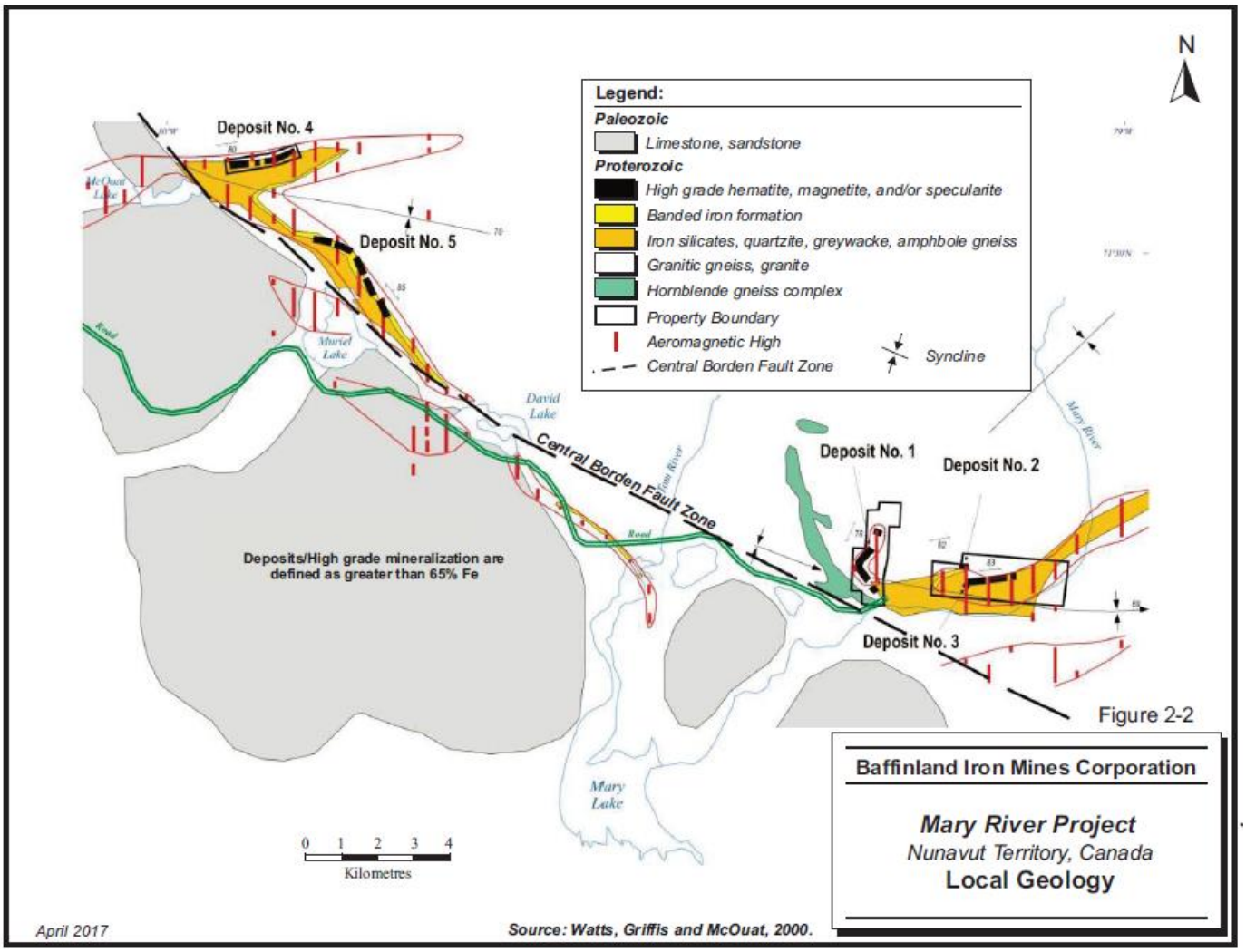
The iron formation-bearing assemblage, as outlined at Deposit No. 1, is stratigraphically underlain (to the west) by quartz-feldspar-mica gneiss (i.e., "quartz augen gneiss") with minor interleaved bands of quartz-mica schist and quartzite, and overlain (to the east) by chlorite-actinolite schist and garnetiferous amphibolite. Thin bands of chlorite-actinolite schist, staurolite-garnet-mica schist, amphibolite, and banded iron formation occur interlayered within the high-grade iron formation across the width of the high-grade iron deposits (WGM, 1964, 1965). The iron formation assemblage may be as much as 400 m thick (Iannelli, 2005).

The Mary River iron ore deposits represent high-grade examples of Algoma-type iron formation (Gross, 1996). The deposits are characterized by zones of massive, layered to brecciated hematite and magnetite, variably intermixed with banded oxide to silicate facies iron formation. They are spatially associated with a major northwest-trending discontinuity - the Central Borden Fault Zone. This crustal scale structure extends more than 200 km northwest from Angajurjualuk Lake to Milne Inlet and southern Borden Peninsula (Figure 3-2). The iron formation assemblage formed during the accumulation of the late Archean (2.76 to 2.72 Ga) Mary River Group – a diverse assemblage of originally volcanic flows, volcaniclastic, greywacke, conglomeratic and turbiditic sediments.

Field investigations by Duke (2010) suggests evidence for post-collisional extensional unroofing of the Hudsonian metamorphic terrain in north central Baffin, with keels of the Mary River Group bordering flow folded high grade gneissic domes. Duke and McCleod (2009) describe the cores of domes as interfolded Mesoarchean and Neoarchean granite-greenstone metamorphic assemblages refolded during the Hudsonian. Near contacts with the Mary River supracrustal rocks, the gneiss is interleaved with melt sheets of Hudsonian augen granite. On the contact with the Mary River lithologies these augen granite sheets exhibit strong mylonitic foliation.

Duke (2010) indicates that the high-strain mylonitic boundary conditions between the domal gneisses and keels of the Mary River metavolcanics and metasediments are attributed to extensional unroofing of the Hudsonian gneisses, facilitated by domal rises and suprastructural sinks. The flow-folding within the domes is related to Hudsonian collision which ended around 1850 Ma. The development of mylonitic fabrics post-date collision, but predate the injection of non-mylonitized pegmatite bodies that probably date about 1,780 Ma. Duke (2010) suggests a potential role for the mylonitic schist boundary in the secondary enrichment of the Mary River iron ores.

Figure 3-2 Local Geology



3.5 Property Geology

Deposits Nos. 1 through 5 are described below. Mineral resources and mineral reserves are reported in Deposits Nos. 1 through 3 only.

DEPOSIT NO. 1

Deposit No. 1 is currently the largest defined iron ore deposit in the Mary River area. The deposit has a total strike length, as defined by outcrop and magnetic anomalies, of about 3,800 m. Outcrops of high-grade iron oxides consisting of hematite and magnetite in various proportions and of specularite are exposed along the margin and crest of Nuluujaak Mountain at elevations ranging from 250 m to 700 m, over a strike length of 2,500 m. A possible additional strike of 550 m is suggested by magnetic surveys and outcrop to the south, and magnetic data indicate the continuation of the iron formation for about 750 m to the north (WGM, 1964, 1965).

Deposit No. 1 can be divided into an approximately 1,300 m long northern portion (North Limb), which strikes at 041° and dips at -77˚ to the southeast, and an approximately 700 m long southern portion (South Limb) which strikes at 316˚ and dips at -65˚ to the northeast (Figures 7-3 and 7-4). Minor extensions to the northeast and southeast vary locally in strike and dip. The limbs occupy the flanks of a steep northeasterly plunging syncline. Four stratigraphic lenses of high-grade mineralization are located within the fold hinge. These include from footwall to hanging wall the 100, 200, 300, and 400 zones (Figures 3-3 and 3-4).

The high-grade lower zone of oxide iron formation (coded as 100 in block model) forms a tabular 105 m to over 150 m thick body with chlorite-actinolite schist and/or garnetiferous amphibolite at the hanging wall and quartz-mica schist and quartz-feldspar-mica gneiss at the footwall. Bands of chlorite-actinolite schist with garnet and/or magnetite, banded oxide facies iron formation, and staurolite-cordierite-mica schist are rarely interlayered within the iron deposit particularly with the high-grade magnetite of the north limb. The bands are laterally continuous and average one metre to 15 m in thickness and separate the lower, middle, and upper zones. High-grade hematite-dominated iron formation predominates along the south limb and core of the synformal structure, while specularite occurs adjacent to the site where the north limb is disrupted by a north-northwest trending fault.

The iron formation along the south limb forms a 290 m thick assemblage consisting of two major sequences comprised of a lower high-grade iron formation band (up to 120 m in true thickness) overlain by a mixed zone of variably alternating high-grade iron formation, banded oxide iron formation, chlorite-actinolite schist, amphibolite and cordierite-staurolite-mica schist layers 2 m to 18 m thick. The lower high-grade iron formation band forms the surface outcrop along the crest of Nuluujaak Mountain.

DEPOSIT NO. 2

Deposit No. 2 outcrops on a ridge 2.6 km east of Deposit No. 1 (Figure 3-2). The deposit consists of dark steel to blue-grey weathered high-grade specularite iron formation outcrops up to 40 m in width and 90 m in length and can be traced for over 600 m along strike. The deposit strikes west-southwest and grades into a south to south-southeast dipping belt of banded oxide facies iron formation up to 100 m wide (Figures 3-5 and 3-6). The high-grade iron formation zone at Deposit No. 2 outcrops over an elevation of 610 m to 670 m.

Mapping, drilling results and correlation with the Mary River Group assemblage at Deposit No. 1, suggests that high-grade specularite iron formation at Deposit No. 2 stratigraphically overlies light grey pink-grey-brown weathered quartz- feldspar-mica gneiss and quartz-sericite to chlorite-amphibole-mica schist to the north and northwest.

The iron formation is overlain by a sequence of green-grey-brown to dark green weathered chlorite-amphibole-mica schist with subordinate serpentinized mafic intrusive bands and banded oxide facies iron formation, in turn overlain by banded oxide facies iron formation (with minor high-grade magnetite plus specularite iron formation; upper banded iron formation zone) which is in turn overlain by chlorite-mica-quartz-feldspar schist (to the south and south-southeast).

The strike extent of the main Deposit No. 2 appears drilled off towards the east and west. Based on occurrences of high-grade float along strike towards the west, potential exists for additional lenses of high grade along this trend for at least another 300 m.

Deposit No. 2 appears to be more complex than Deposit No. 1, in terms of continuity of high-grade iron formation and continuity of thickness. The high-grade zone reaches a maximum (true) thickness of 90 m at drill hole MR2-06-82 and grades into banded iron formation below the required DSO grade to the east and west.

DEPOSIT NO. 3

Deposit No. 3 is situated on the crest and lower slope of a ridge 670 m south of Deposit No. 2 (Figures 3-5 and 3-7). The deposit consists of high-grade hematite and specularite iron formation at an elevation of 490 m to 530 m and has a drilled strike extent of approximately 2.5 km. High-grade iron formation outcrops and float associated with a belt of Mary River Group metasedimentary and metavolcanic rocks can be traced along strike and in aeromagnetic anomaly patterns intermittently for more than 9 km east-northeast and northeast to the Glacier Lake area (Baffinland Iron Mines Ltd., 1964, 1965; Jackson et al., 1978a).

Foliation in gneiss and schist and foliation plus relict banding in high-grade iron formation at Deposit No. 3 strikes east-west and at its western extent dips -88º to the north, while at its eastern extent the dip decreases to -67º towards the north. Drilling at Deposit No. 3 has shown that at the footwall contact, high-grade specularite iron formation is in contact with chlorite-amphibole to mica-sericite-chlorite schist which in turn is in contact with a thick sequence of quartz-feldspar-mica gneiss. Comparison with the correlative stratigraphic sequence noted at Deposit No. 2 suggests that the Mary River Group succession is overturned at Deposit No. 3. Thus, the high-grade iron formation assemblage is stratigraphically overlain by silicate and/or banded oxide facies iron formation with minor chlorite-amphibole schist, which is in turn overlain by amphibolite (Jackson, 2000, 2006; Baffinland Iron Mines Ltd., 1964, 1965).

A 2006 drill hole (MR3-06-108) intersected homogeneous high grade specularite iron formation with an estimated true thickness of approximately 140 m at the western most extent of Deposit No. 3 (Figure 3-7).

Drilling in 2007, on 450 m spaced drill sections, indicated a strike length of at least 2,450 m of high grade iron formation, with the high-grade zone pinching out in thickness towards the east. At its western extent, the Deposit is interpreted to be terminated by a southwest-trending fault which is also interpreted to limit the eastern extension of Deposit No. 2 (Figure 2-5). Potential exists beyond the eastern-most extent of Deposit No. 3 for the discovery of additional targets of high-grade iron formation.

DEPOSIT NO. 4

High-grade iron formation of Deposit No. 4 outcrops on a low ridge 27 km northwest of Deposit No. 1 and three km west of the Central Borden Fault zone. In this area, exposures of high-grade magnetite and specularite iron formation occur as a series of elongated lenses or bands, 5 m to 75 m wide, that outcrop intermittently over a strike length of 2,800 m within the mine lease boundary. Due to the predominantly narrow widths encountered in Deposit No. 4 and presence of high sulphur and high phosphorus, little potential for additional tonnage is anticipated in the immediate Deposit No. 4 area. The deposit is open at depth, however, the potential in-pit waste rock contains high sulphur values.

DEPOSIT NO. 5

The 2008 airborne magnetic survey outlined an anomaly extending 21 km southeast from Deposit No. 4. Deposit No. 5 was discovered in 2009 within this magnetic anomaly and is located approximately four kilometres southeast of Deposit No. 4. Deposit No. 5 is comprised of two main hematite enriched lenses within a broader regionally continuous banded iron formation. The largest outcrop of high grade mineralization associated with the main Deposit No. 5 lens can be traced for approximately 700 m in strike length and has an exposed width of 70 m. Three additional narrow exposed intervals of enriched iron formation occur to the southeast of Deposit No. 5.

Figure 3-3 Deposit No. 1 Geology

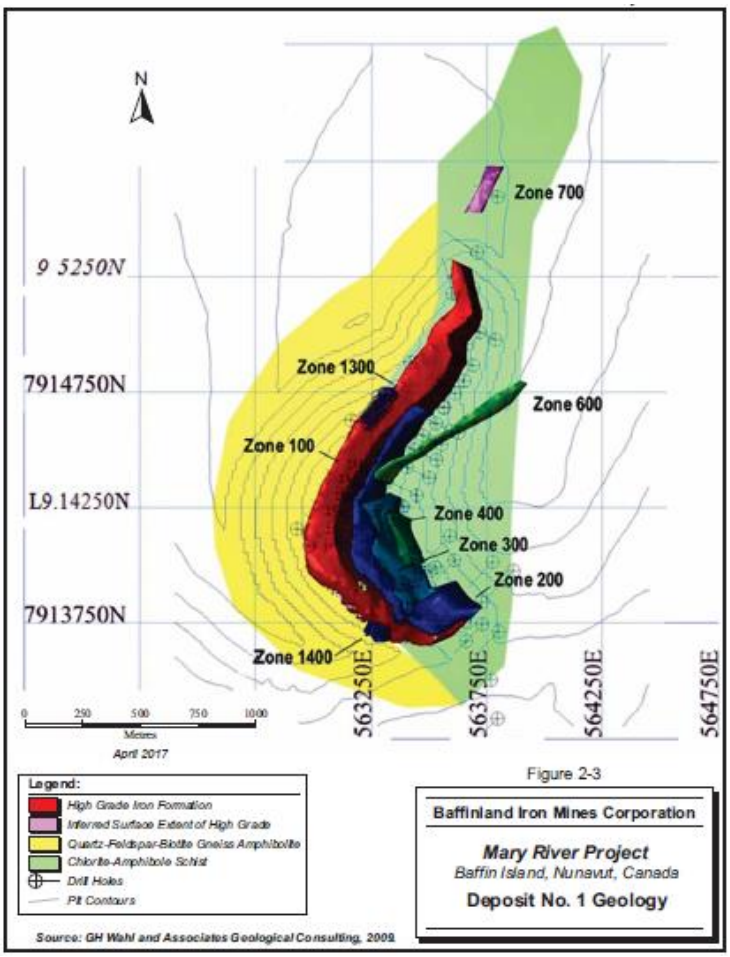


Figure 3-4 Deposit No. 1 Vertical Section

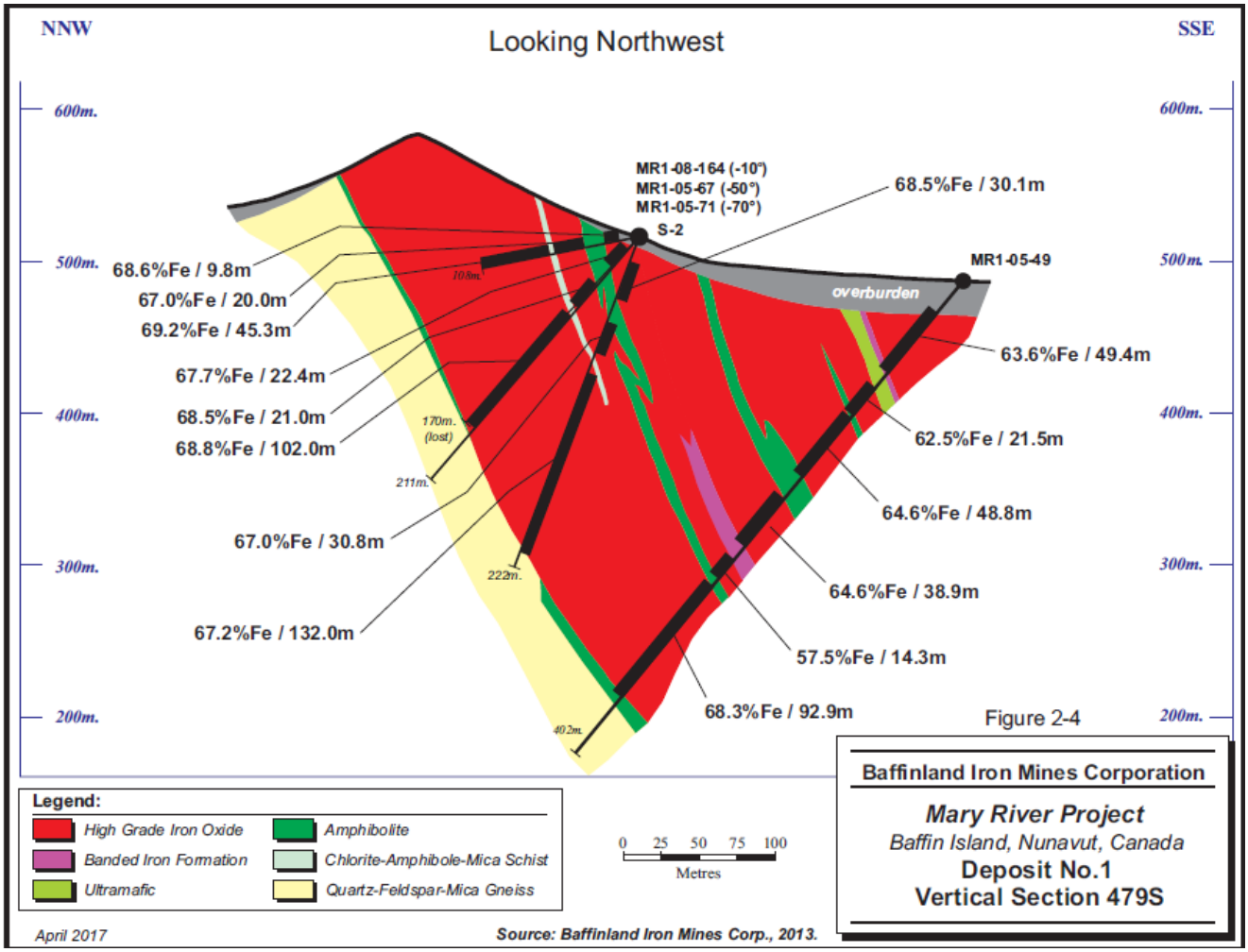


Figure 3-5 Deposit No. 2 and 3 Geology

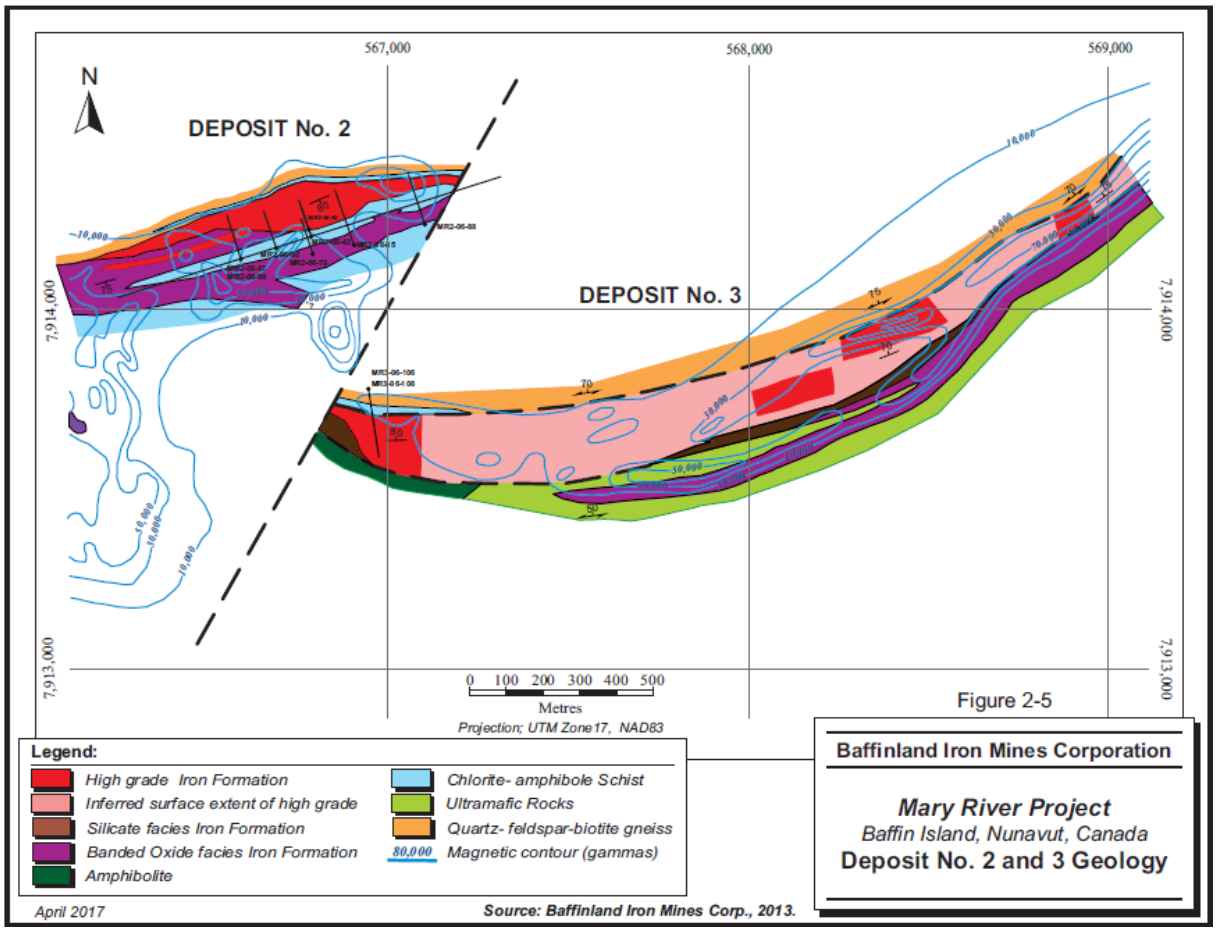


Figure 3-6 Deposit No. 2 Vertical Section

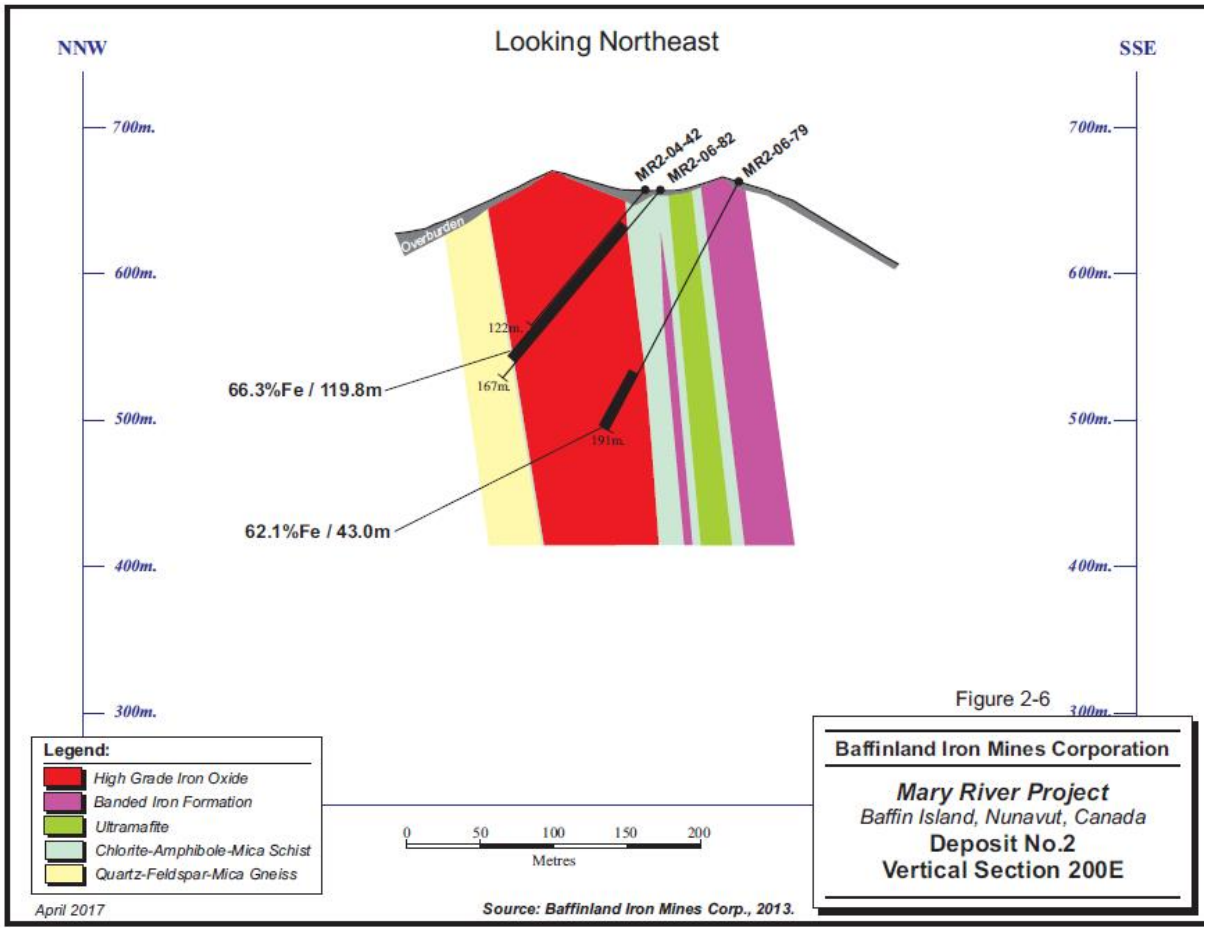
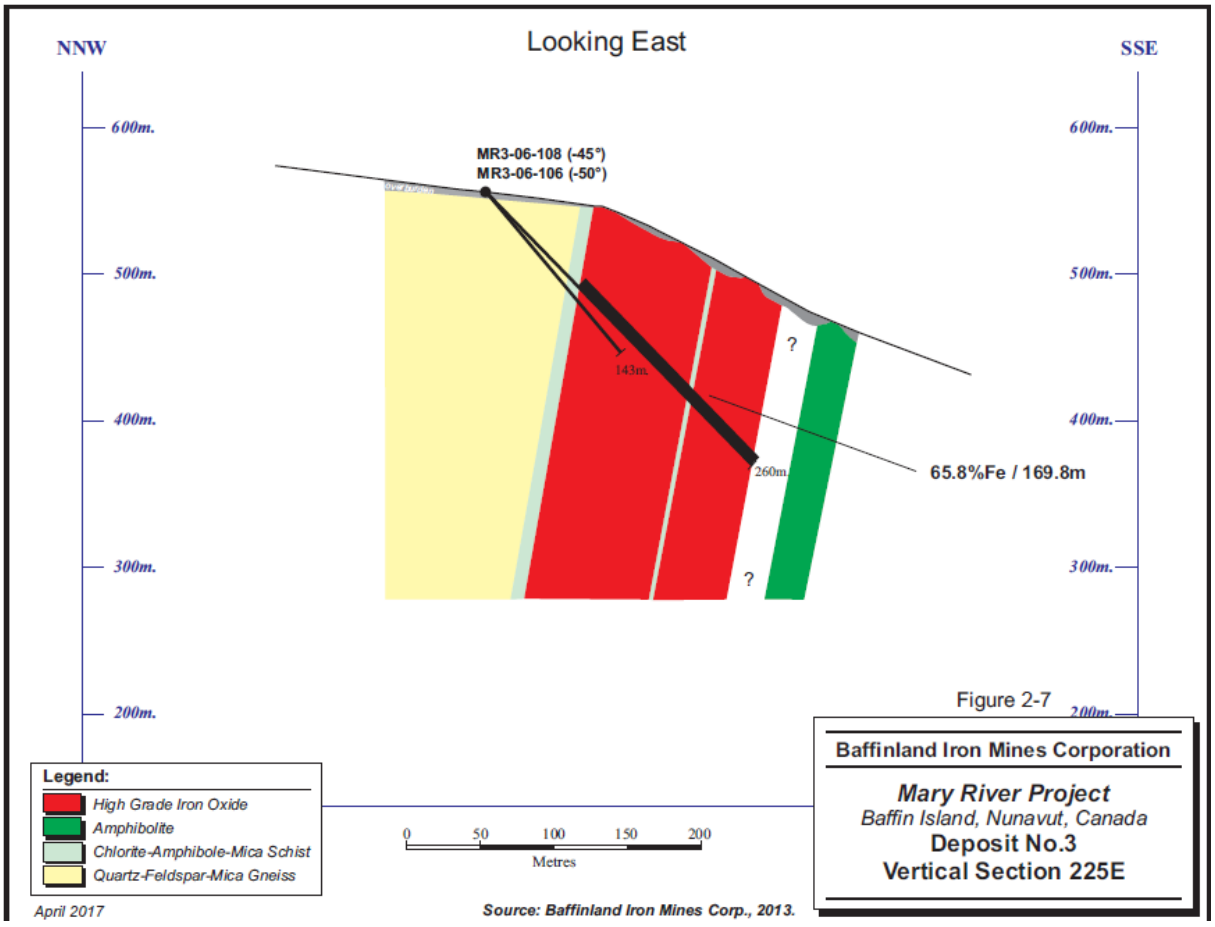


Figure 3-7 Deposit No. 3 Vertical Section



4.0 Mineralization

The Mary River deposits comprise a number of iron formations which have been enriched and altered to varying degrees. Original banded iron formations comprised of alternating layers of magnetite and hematite are preserved in several locations along strike of existing high grade deposits. The regional metamorphism and folding associated with the Hudsonian Orogeny resulted in significant crustal thickening. This period also resulted in zones of weak to strong leaching of silica. Subsequent hypogene and metamorphic events led to the alteration of magnetite to hematite and specular hematite. Surface outcrops differ in iron, silica, and sulphur content and in the proportions of their main oxide minerals – hematite, magnetite, and specularite.

The microscopic examination of drill core specimens by R.A. Blais (1964) suggested that magnetite was the stable mineral of the iron formations during metamorphism (amphibolite facies), and was replaced to various degrees by hematite (martitization), resulting in a range of hematite-magnetite (martite) compositions. This alteration process had occurred during a late stage of metamorphism, under conditions of localized stress and high oxygen pressure, and may have been associated with folding and faulting of the tabular high-grade magnetite iron formation.

The strong structural influence on channeling of oxidizing solutions is supported by the alignment of lineations produced by tubular pores in the hard, high-grade hematite iron formation (i.e., parallel to the axial plane and plunge of the synform) and the concentration of high-grade hematite at the core of the fold.

Euhedral specularite crystals in magnetite rock indicate that specularite did not form by a process similar to martitization, but through the possible metamorphic replacement of magnetite. It is also possible that the specularite and other hematite mineralization formed as a primary rather than secondary mineral. What caused the crystallization of flaky, course-grained specularite as compared to fine-grained massive hematite, however, is not fully understood. Field evidence suggests that higher fluid or vapour pressures in zones of shearing may have facilitated the growth of specularite.

4.1 Deposit Types

The Mary River deposits can be described by the depositional model proposed for Algoma-type iron formation. The characteristic stratigraphy for Algoma-type iron formations consists of a lower succession of typically intermediate volcanic rocks interbedded with acid volcanic rocks, volcaniclastic sedimentary rocks, and their sedimentary derivatives. These units are followed by banded iron formation comprised of alternating cherty bands and iron oxides or bedded or banded pure oxides ranging from metres to hundreds of metres in thickness depending on depths of original basins. The iron formation is then overlain by a sequence of volcanic and volcaniclastic sedimentary rocks commonly intruded by ultramafic and granitic intrusive bodies.

Mary River Group greenstone belts across northern Baffin Island consist of variable amounts of banded iron formation associated with metasedimentary, metavolcanic, and meta-igneous rocks (Jackson et al., 1978a, b, c; Jackson and Morgan, 1978). The banded oxide and silicate facies iron formations comprise the lateral equivalents of the high-grade Mary River deposits, which are almost entirely composed of iron oxides suggesting a significant enrichment of iron through secondary processes.

Duke (2010) indicates growing evidence for a secondary iron enrichment mechanism associated with widespread retrograded mylonitic detachment faults along the base of the high grade and enriched BIF across north central Baffin Island in places such as the Mary, Turner, Cockburn, and Rowley River areas. These detachment faults are marked by a chlorite retrograded mylonitic structural contact between underlying ductile rising domes of poly-deformed mafic-felsic gneisses and overlying supracrustal sinking keels which host the Mary River iron deposits (Duke and Macleod, 2009). These detachment faults are thought to be post regional folding of the Hudsonian orogeny around 1,850 Ma (Duke, 2010).

The high grade massive and enriched iron oxide deposits occur where Mary River BIF borders directly on detachment schist that separates the mylonitic roof of infrastructural domes from the high strained keels of Mary River Group. At detachment schist contacts, magnetite BIF shows evidence of having undergone extreme pressure solution resulting in the highly efficient leaching of quartz from quartz-magnetite BIF. In large deposits, the primary banding defining early isoclinal folding is completely destroyed by metamorphic differentiation and recrystallization, resulting in greater than 100 m thicknesses of massive magnetite/hematite. On the flanks of the high-grade iron deposits, iron enrichment is marked by various degrees of silica loss due to continued silica removal.

Several regional examples of exposed giant quartz veins occurring along detachment schist boundaries adjacent to high grade magnetite zones account for the removal of silica from the banded iron formations. Duke (2010) suggests that the hydrothermal removal of silica was likely facilitated by dewatering of the nearby footwall serpentinized komatiites.

5.0 Exploration

The following is taken from the Wahl and Gharapetian reports (2009 and 2011).

Commencing in 2002, the newly formed BIM group reassembled and reviewed all available data and made plans for the 2004 summer season.

In 2004, equipment was moved to site and a new camp was established. Drilling by BIM in 2004 focused on extending the northern and southern extents of mineralization previously defined by WGM drilling on Deposit No. 1. A total of 2,813 m of drilling in 15 holes produced 832 assay samples or 1,497 m of split core samples. The 2004 drill program increased the explored length of the Deposit No. 1 to over 2,700 m and confirmed a vertical extent to 400 m. A new northeastward trending limb was discovered above the hanging wall.

The first drill hole (MR2-04-42) drilled into Deposit No. 2 intersected approximately 85 m true width of high-grade iron formation indicating that further drilling on Deposit No. 2 was warranted. A further seven metallurgical samples were collected from core and two metallurgical samples from outcrop in Deposit No. 2 were forwarded to Studien-Gesellschaft für Eisenerz-Aufbereitung (SGA) in Germany for testwork.

In 2004, a total of 68 composite samples (60 kg to 120 kg) were collected from the remaining drill core and forwarded for metallurgical testwork at SGA in Germany. Each composite represented approximately a 14 m to 16 m drill core interval. Results of this testwork are discussed in later sections of this report.

In 2005, 34 holes were completed for a total of 8,073 m. On Deposit No. 1, a total of 2,621 samples representing 5,216 m of split core were sent for assay. The drill program was largely aimed at testing the depth extent of Deposit No. 1 to delineate the footwall contact. Drilling in Deposit No. 1 demonstrated that the surface widths encountered by WGM extended to approximately 600 m in depth with no indication of pinching out at depth. An additional 135 metallurgical composites collected from Deposit No. 1 drill core were dispatched to SGA in Germany for metallurgical testwork.

Another 15 metallurgical samples from surface outcrops on Deposit No. 1 were also forwarded to SGA in Germany. An aerial topographic survey was completed by Eagle Mapping Services to produce a digital terrain map of the area covering Deposit Nos. 1, 2, and 3.

A resource estimate was prepared in 2006 as part of a scoping study completed by Aker Kvaerner. The resource estimate incorporated the WGM drilling results along with BIM's 2004 and 2005 drilling results. A total of 309 Mt of Indicated Mineral Resources at a grade of 66.1% Fe and 28 Mt of Inferred Mineral Resources at a grade of 65.9% Fe were estimated. This resource estimate is now superseded as a result of infill and extension exploration drilling completed since 2005.

Exploration work in 2006 included drilling on Deposit Nos. 1, 2, and 3. A total of 4,135 m in 22 holes were drilled on Deposit No. 1 which included exploration, infill drilling, as well as geotechnical drilling for pit walls. Thirteen holes were focused on the north limb, one on the south limb, four on the fold hinge and the remaining four holes were comprised of geotechnical pit wall holes. A total of 1,276 samples were collected representing 2,513.70 m of sample from 18 exploration drill holes. Channel sampling in 2006 comprised of 12 samples or 67 m on Deposit No. 1. Metallurgical mapping of Deposit No. 1 continued with a combined total of 209 samples forwarded to Germany by the end of 2006.

In 2006, 1,172 m were drilled in seven holes on Deposit No. 2 and 118 samples were collected from 232 m of split core from three drill holes. One of these three holes, MR3-06-108, intersected 169.8 m of massive high grade specular hematite, suggesting a true thickness of at least 140 m at the western extent. A total of 636 m were drilled in three holes on Deposit No. 3. Seventeen core samples were submitted from Deposit No. 2 and an additional 10 core samples from Deposit No. 3 were submitted for metallurgical testwork.

In 2007, BIM completed 4,392 m of drilling on Deposit No. 1, which includes both geotechnical and exploration drilling. This drill program was comprised of three bulk sample pilot test holes on the north limb, a further three infill holes on the north limb, three holes on the south limb infill, ten holes into the fold hinge and three geotechnical-specific holes. An additional 87 core samples from 2006 were submitted for metallurgical testwork.

In 2007, eight additional holes were drilled at Deposit No. 3 for a total of 1,918 m on 450 m step outs. A total of 578 m of core was sampled representing 293 samples. A further eight channel samples for a total of 82 m were collected in 2007. The drill program was successful in defining an inferred resource over a 2,450 m strike length.

Geotechnical drilling was also undertaken at the Milne Inlet and Steensby port sites, as well as along the Steensby railway alignment, intended to support project permitting and basic engineering, which was a new focus of the 2007 drilling program.

Exploration drilling in 2007 and 2008 on Deposit No. 1 targeted the upper 250 m of the deposit, in order to provide metallurgical material, upgrade inferred resources and to obtain a more complete deleterious database for the upper portion of deposit. This program was only partially completed in 2008 and continued in 2009.

In 2008, a total of 5,071 m were drilled in 27 infill holes. This program was to improve the confidence level of the upper 250 m of the Deposit No. 1. Drill results indicated a more localized control on deleterious elements and also indicated in some locations a greater thickness of near surface high grade iron formation than had been previously interpreted.

The 2008 geotechnical drilling included 315 holes along the railway corridor, 64 holes at the Steensby port location, 33 holes at quarry and tunnel locations along the railway corridor, and 30 infrastructure holes at the proposed Mary River mine site location.

For the 2008 metallurgical testwork program, a further 54 metallurgical samples from 2007 drill core were sent to SGA for Deposit No. 1 and another 23 core and outcrop samples for Deposit No. 3 from the 2007 exploration program.

In February 2008, BIM announced an updated mineral resource and mineral reserve statement for the Mary River Property. Deposit No. 1 was estimated to contain approximately 160 million tonnes of proven reserves at an average grade of 64.4% iron, plus probable reserves of approximately 205 million tonnes at an average grade of 64.9% iron. Mineral resources totalled 400,000 tonnes of Measured Mineral Resources, 52 million tonnes of Indicated Mineral Resources, and 448 million tonnes of Inferred Mineral Resources (all exclusive of mineral reserves) on Deposit Nos. 1, 2, and 3. These estimates have been superseded by subsequent estimates.

In February 2008, the results of a definitive feasibility study, managed by Aker Kvaerner E&C, on Deposit No. 1 (the DFS) were released. The DFS is a detailed study of the technical and economic feasibility of Deposit No. 1 and was based on proven reserves of 160 million tonnes and probable reserves of approximately 205 million tonnes. The DFS indicated that, based on the shipment of 18 million tonnes of ore per year to the European market, the proven and probable reserves could sustain a mine life of over 20 years. Assuming CFR Steensby Inlet and average sale prices of US$67 per tonne for lump ore and US$55 per tonne for fines, the DFS indicated that the mine could generate a pre-tax internal rate of return of 20.5%, with a payback period of 3.7 years, and an after-tax internal rate of return of 15.9%. The DFS forecasted pre-tax cash flow over the life of the mine to be $18.1 billion, with after-tax cash flow of $11.2 billion.

The DFS estimated the initial capital costs for the project to be $4.1 billion, including all direct and indirect costs, contingencies and owner's costs. Sustaining capital was estimated to be $400 million over the life of the project, including project reclamation and closure costs. Operating costs for all of the facilities were estimated to be $14.62 per tonne, excluding taxes and financing costs.

In July 2008, the company revised its bulk samples targets from 250,000 tonnes to a range of 120,000 to 150,000 tonnes. This target was revised due to the advent of an earlier than anticipated spring melt combined with severe rainfall in the later part of June resulting in a need for extensive construction and maintenance work along the full length of the 100 km tote road to the shipping site at Milne Inlet. Haulage of the bulk sample on this road at the time had been interrupted for approximately nine weeks and resumed in late July 2008.

By November 2008, three shipments of the iron ore bulk sample arrived in Europe. The first trial cargo of lump iron ore was shipped to the port of Vlissingen in the Netherlands for ThyssenKrupp. The trial cargo weighed approximately 54,464 tonnes by draft survey at the discharge port and the lump iron ore graded more than 68% iron with low moisture content of 1.28% and low levels of deleterious elements. The undersize (less than 6.3 mm) portion of the cargo was 3.4% of the cargo weight.

The second trial cargo of lump iron ore discharged approximately 31,050 tonnes at the port of Bremen, Germany for ArcelorMittal Bremen. This trial cargo also graded more than 68% iron with low moisture of 1.26% and low deleterious elements. The undersize portion of the cargo was 4.2%.

The third and final trial cargo was discharged at the port of Vlissingen in the Netherlands for ThyssenKrupp. This trial cargo weighed approximately 27,701 tonnes and graded more than 66% iron with moisture content of 3.32%.

The bulk sample open pit was selected to mine and ship lump iron ore that was representative metallurgically of what would be shipped in the initial 10 to 15 years of production. The three trial cargos of Mary River iron ore were consumed in the blast furnaces of ArcelorMittal and ThyssenKrupp in 2009.

In October 2008, 18 mineral claims totalling approximately 32,016 acres (12,956 ha) were staked. The claims surround Deposit No. 4 and cover prospective stratigraphy to the southeast.

In November 2008, New-Sense Geophysics Ltd released results from a high resolution magnetic airborne geophysical survey. The survey was based on 200 m spaced regional traverses with 100 m infill lines surrounding the known deposit areas. A total of 6,184.9 line km of survey were flown. The survey outlined additional stratigraphic targets in the vicinity of Deposit No. 4 as well as targets to the east and west of Deposit No. 3.

In 2009, enriched iron oxide mineralization was identified on the recently staked claims southeast of Deposit No 4 forming what is now referred to as Deposit No. 5.

During the summer of 2009, BIM drilled another 2,317 m on the south limb of Deposit No. 1 to better define the southeastern extent of mineralization. The previously interpreted extent of mineralization was confirmed with a decrease in thickness and a gradational increase in banded iron formation with depth.

In 2010, BIM drilled three holes for a total of 483 m on Deposit No. 2, 162 m in two holes on Deposit No. 3, a total of 3,165 m in 17 holes on Deposit No. 4, and 2,662 m in 20 holes on Deposit No. 5. An additional three holes were drilled to determine waste rock acid generation properties on Deposit No. 1.

In 2010, Baffinland was acquired by ArcelorMittal and Iron Ore Holdings. Since that time, various technical and economic studies have been completed, including:

- Mary River Project – Early Revenue Report (ERP); BIM; December 24, 2012
- Baffinland Mary River Trucking Feasibility Study; AMEC; December 2010
- Mary River Iron Ore Trucking Feasibility Study Update; AMEC; March 21, 2013
- FEL 3 Report for Mary River Project; Hatch; April 30, 2012

Work in the 2010 field season included diamond drilling on Deposit Nos. 1, 2, 3, 4, and 5. Regional exploration led to the discovery of Deposits 6, 7, 8, and 9. In 2010, BIM also completed an updated resource estimate on Deposit No. 1.

5.1 Drilling

The BIM exploration drill hole database comprises WGM exploration data completed in the 1960s as well as several years of exploration by BIM. Tables 5-1, 5-2, 5-3, 5-4, and 5-5 summarize the exploration database completed on Deposit Nos. 1, 2, 3, 4, and 5 to the end of 2010. For type of sampling, DDH refers to diamond drill core holes and CHA refers to trench channel sampling.

Table 5-1 Drilling and Channel Sampling at Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Year	*Company*	*Type*	*No. of Holes/Channels*	No. of Metres
1964	WGM	DDH	26	3,318
2004	Baffinland	DDH	12	2,350
2005	Baffinland	DDH	34	8,393
2006	Baffinland	DDH	22	4,136
2007	Baffinland	DDH	22	4,492
2008	Baffinland	DDH	27	5,071
Total			**143**	**27,760**
1963	WGM	CHA	208	1,023
2006	Baffinland	CHA	12	67
Total			**220**	**1,090**

Table 5-2 Drilling and Channel Sampling at Deposit No. 2
Baffinland Iron Mines Corporation – Mary River Project

Year	*Company*	*Type*	*No. of Holes/Channels*	No. of Metres
2004	Baffinland	DDH	1	122
2006	Baffinland	DDH	7	1,193
2010	Baffinland	DDH	3	483
Total			**11**	**1,798**
1963	WGM	CHA	22	130

Table 5-3 Drilling and Channel Sampling at Deposit No. 3
Baffinland Iron Mines Corporation – Mary River Project

Year	*Company*	*Type*	*No. of Holes/Channels*	No. of Metres
2006	Baffinland	DDH	3	636
2007	Baffinland	DDH	8	1,918
2010	Baffinland	DDH	2	162
Total			**13**	**2,716**
1963	WGM	CHA	19	97
2007	Baffinland	CHA	8	82
Total			**27**	**179**

Table 5-4 Drilling and Channel Sampling at Deposit No. 4
Baffinland Iron Mines Corporation – Mary River Project

Year	Company	Type	No. of Holes/Channels	No. of Metres
2010	Baffinland	DDH	17	3,165
1963	WGM	CHA	32	191
2010	Baffinland	CHA	43	91

Table 5-5 Drilling and Channel Sampling at Deposit No. 5
Baffinland Iron Mines Corporation – Mary River Project

Year	Company	Type	No. of Holes/Channels	No. of
2010	Baffinland	DDH	20	2,662
2010	Baffinland	CHA	87	185

The BIM drilling was completed using mainly HQ (core diameter 63.5 mm). Drill hole collars were surveyed on an ongoing basis. Down hole surveys are completed using a Maxibor instrument which collects direction and inclination data for the entire length of the hole. Where drilling became difficult, holes were reduced to NQ equipment (core diameter 47.6 mm). Drilling was completed using Longyear L-38 and LM-30 modular rigs.

Drill core recoveries generally ranged from 92% to 99% for the BIM drilling (Table 5-6) and were found to be appropriate for resource estimation. Occasional intervals of poor recovery were a result of broken or fragmentary hematite or magnetite generally related to apparent zones of faulting or shearing; friable, porous hematite within the fold axis; or fractured or brecciated waste rock above the hanging wall.

Table 5-6 Average Drill Core Recoveries
Baffinland Iron Mines Corporation – Mary River Project

Year	Company	Recovery %
2004	Baffinland	99
2005	Baffinland	96
2006	Baffinland	95
2007	Baffinland	92
2008	Baffinland	98
2010	Baffinland	98
1964	WGM	88
1965	WGM	70

5.2 Sample Preparation, Analyses and Security

5.3 Sampling Method and Approach

WGM 1964-1965

The notes on WGM sampling are adapted from von Guttenberg and Farquharson, 2003.

Core from the WGM 1964-65 drilling programs at Deposit No. 1, with visible iron oxides, was split longitudinally with one-half stored at Mary River and the other half shipped for assaying to Technical Service Laboratory (TSL) in Toronto, or to Warnock Hersey Company Limited in Montreal. Initially, core containing little waste material was sampled and assayed in six metre lengths. Later the sample length was reduced to three metres and different types of iron ore and bands of waste were sampled and assayed separately. A total of 701 samples with a combined length of 2,728.57 m from 25 drill holes were assayed, with lengths of individual samples varying from 0.3 m to 16.8 m, with an average of 3.9 m. The core samples show no bias and reflect the entire iron ore zone thickness.

Surface chip and trench samples collected during the 1964 to 1965 WGM programs were taken on sections perpendicular to the strike of the deposits. The sample weight was approximately 0.5 lb/ft (745 g/m).

Deposit No. 1 was channel sampled at approximately 150 m sectional spacing. Deposit No. 2 was channel sampled at approximately 50 m intervals where outcrops permitted over a strike length of 335 m. Deposit No. 3 was channel sampled in only two general areas of outcrops spaced approximately 1.5 km apart.

The surface samples at Mary River provide a limited representation of the composition and distribution of iron oxides in the underlying deposits. Surface sampling is limited by outcrop exposure which only provides a limited exposure of the true thickness of the cross strike extent of the iron formation.

BIM 2004-2010 EXPLORATION CAMPAIGNS

The principal sampling method employed in 2004 to 2010 by BIM was core drilling which was contracted to Boart Longyear Inc. Drilling on Deposit No. 1 was designed to achieve a drill hole spacing of 75 m along strike and down dip. Deposit No. 2 is currently drilled at 100 m spacing, while drilling on Deposit No. 3 is up to 450 m spacing between drill sections.

The HQ-sized drill core was logged and two metre sample lengths were marked for sampling and assaying. Sample lengths were less than two metre when intervals were encountering changes in lithology. The core was cut using a diamond saw. In addition to sampling the mineralization, samples were also collected for internal waste, hanging wall and footwall zones, and adjacent banded iron formation to assess the grade impacts of waste deleterious elements and dilution. Remaining core samples were stored in core boxes on site for future reference or for metallurgical testwork. Sample mass for HQ sized core ranged from 11 kg to 15 kg. Sample mass for NQ sized core ranged from 6 kg to 7 kg.

Drill core logging captured major and minor rock types, core recovery, rock quality distribution, presence of sulphides and structure. Geological core logging entered directly using laptops. Core was photographed prior to sampling.

Channel samples were cut with a diamond saw and sample volume per metre roughly equated that of HQ diameter core. A limited amount of surface channel sampling was completed on Deposits No. 1, No. 2 and No. 3 by BIM. Some channel sample composites weighing approximately 200 kg each were sent for metallurgical testwork.

5.4 Sample Preparation and Analysis

WGM 1964-1965

The following descriptions of WGM sample preparation and assaying were adapted from von Guttenberg and Farquharson (2003) and from Wahl and Gharapetian (2009).

In 1964, assays on chip and trench samples from the Mary River deposits for total iron, phosphorous and sulphur were completed by standard wet chemical procedures. Silica, alumina, manganese, and titanium were determined by spectrochemical methods with an accuracy of ±5%.

Samples of half core were crushed to -6 mm in a steel-plate crusher, a 300-g split of the crushed sample was pulverized to -10 mesh (1.7 mm), and 5 g was assayed for soluble iron, silica and sulphur by wet chemical methods. For an accurate identification of ore types, a 100 g split of the -10 mesh material was used for standard Davis Tube analysis, which was the main analytical procedure used to classify the samples based on their hematite-magnetite content.

To chemically characterize the iron ore types separated by core logging and Davis Tube tests, 45 composite samples from 10 holes drilled in 1964 were analyzed for soluble Fe and for SiO_2, Al_2O_3, MnO, TiO_2, CaO, MgO, S, P, and loss on ignition (LOI). Composites of these samples were analysed for 50 elements by spectrography.

Based on composite samples, assays from the 1964-65 drilling programs by spectrography and whole-rock analysis by Technical Services Laboratories (TSL) and Superior Laboratories (SL), and other elements or oxides, such as Al_2O_3, Cu, Pb, Zn, Mn, Ti, V, Na, and K all occur in amounts which would not affect the marketability of the iron ore.

The analytical work showed that iron levels and accessory elements generally fell within acceptable limits for lump iron ore in all composites, except waste-rock units. Sulphur in five composites exceeded 0.05%, and four magnetite-rich composites carried phosphorus in excess of 0.04%.

Comparative assaying was the only quality control measure discussed in the reports, from 1963 to 1965, describing the assaying of core and surface samples, and no original laboratory reports for that period are available. The laboratories used for assaying of core, surface and metallurgical samples in 1963 to 1965 were not certified which was not unusual at that time.

The areas of concern related to the analytical work from that period, which may influence the quality of the resource, are the accuracy of the sulphur assays and the determination of the magnetite content by the Davis Tube magnetic separator.

In general, the sampling methodology, sample preparation, and analytical procedures were adequate for the definition of the Mary River mineralization.

BIM 2006 TO 2010

Sample preparation of split core was completed at SGS laboratories in Sudbury, Ontario. Prepared pulps were then forwarded to SGS in Lakefield for assay.

Preparation of samples included a primary crush of the sample to -43 mm. This was followed by a secondary crush to -34 mm. Samples were then screened at 6.3 mm, weighed and recombined.

Samples were then riffle split to 500 g for tertiary grinding and pulverizing. A tertiary crush of the 500 g split to -3 mm completed the assay preparation.

In 2005, the secondary crush to -34 mm was eliminated since analysis of screened fractions completed by SGA in Germany showed little or no variance. The elimination of the secondary crush also provides a more representative assessment of the lump ore percentage.

Analytical procedures were as follows:

- H_2O Determination of moisture content by heat and weight loss
- Fe Total iron by potassium dichromate titration
- FeO Non-oxidation leach, followed by dichromate titration
- Cl UV spectrophotometry
- S Total sulphur by Leco carbon sulphur analyser

Whole rock analysis was carried out to determine SiO_2, Al_2O_3, P_2O_5, Na_2O, TiO_2, V_2O_5, CaO, MgO, K_2O, and MnO. The method was borate fusion followed by X-ray fluorescence. The detection limit for all elements was 0.01%, except for Na_2O and K_2O which was 0.05%.

Loss on Ignition (LOI) was determined by high temperature weight loss.

Minor and trace element determinations were made by inducted coupled plasma (ICP) spectrometry, using acid digestion. A suite of ICP analyses was also evaluated to see if any elements were potentially problematic. Table 5-7 of raw assay data from the 2004 and 2005 drill program indicate that most of these deleterious elements are either below the detection limit or proximal to the detection limit, suggesting that they are not present in sufficient quantities to negatively affect ore quality.

Table 5-7 Detection Limits and Mean Grades of Deleterious Elements
Baffinland Iron Mines Corporation – Mary River Project

Grade Parameter	Units	Detection Limit	Mean
As	g/t	<40	BD
Ba	g/t	<.5	5.84
Bi	g/t	<60	BD
Cd	g/t	<10	BD
Co	g/t	<10	25.16
Cr	g/t	<4	18.12
Cu	g/t	<0.5	15.1
Mo	g/t	<10	BD
Sn	g/t	<20	BD
Tl	g/t	<30	BD
Zn	g/t	<50	BD
Na_2O	%	<0.002	0.007
TiO_2	%	<0.01	0.04
V_2O_5	%	<0.01	BD
CaO	%	<0.01	0.4
K_2O	%	<0.003	0.01

BD = Below Detection Limit

Elements and oxides that are analyzed at elevated quantities locally within the Mary River deposits include MnO, MgO, P_2O_5, S, and Al_2O_3.

For the purposes of resource estimation, MnO% and P_2O_5% in the assay certificates were recalculated by Wahl and Gharapetian (2011) to provide Mn% and P% values in the BIM database.

5.5 Quality Control and Quality Assurance

SGS is accredited by the Standards Council of Canada (SCC) for specific mineral test listed on the scope of accreditation to the ISO/IEC 17025 standard. ISO/IEC 17025 addresses both the quality management system and the technical aspects of operating a testing laboratory.

Quality control procedures by SGS include duplicate samples, replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis and instrument control samples.
After analysis, results were sent electronically by SGS to BIM offices in Toronto. Signed certificates were later forwarded by mail. Pulps were retained in storage at SGS for future reference as required.

5.6 Sample Security

Sample security was achieved by BIM by restricting access to samples on-site, by carrying out rigorous sample tracking, and by using tamper-proof packaging and secure shipment routes. All samples were air-shipped in sealed containers to SGS laboratories in Sudbury. No evidence of tampering of samples was encountered. Sample assay values forwarded to different laboratories returned similar values.

5.7 Data Verification

WGM 1964-65 DATA

Only limited assay and database verification work was completed by WGM during its exploration programs in 1964 and 1965.

Previous validation of the WGM assay database was comprised of sending a small number of samples to external laboratories. Table 5-8 shows seven results from this WGM duplicate testwork program. Although too few samples to reliably reflect the quality of the WGM assay database, the results suggest that the WGM Fe and SiO_2 grades for the seven samples could be reasonably reproduced at external laboratories.

Table 5-8 WGM Comparative Analysis
Baffinland Iron Mines Corporation – Mary River Project

Sample No.	Tech Serv. Lab.		Lakefield		Steep Rock		Superior	
	Fe (total)	SiO_2	Fe (total)	SiO_2	Fe (sol.)	SiO_2	Fe (sol.)	SiO_2
14	69.97	0.13	68.65	0.78	70.68	0.24	69.46	0.51
24	70.17	0.20	68.88	0.07				
35	70.87	0.54	69.67	0.88				
42	71.26	0.09	70.18	0.30	70.05	0.20	71.30	0.20
47	69.48	0.22	68.82	0.52				
54	71.93	0.15	70.69	0.24	72.17	0.21	71.42	0.31
57	70.06	0.11	69.33	0.46				

(Source: WGM Engineering Report #3 Volume 1, 1965)

To check the quality of assaying by TSL, a set of length-weighted composite samples of minus 10-mesh rejects from the same 10 drill holes that were re-assayed by TSL and SL for Fe, P, SiO_2, Mn, Al_2O_3, CaO, MgO, S, TiO_2 and LOI.

The TSL and SL composite assays showed generally good agreement for most elements with TSL reporting generally slightly higher values, and phosphorous having the largest variation.

The iron assays compared reasonably well, with some negative bias seen in the composite averages for SiO_2. Sulphur had a significant amount of scatter in the individual assays. Of more concern was the lack of standards which would allow an assessment of the accuracy of the assay methods. This particularly affects sulphur, which can occur at levels critical for the marketability of the iron ore, although its absolute concentrations are low. There is also concern regarding the phosphorous precision and accuracy.

In order to address the shortcomings of the 1960s era deleterious dataset, BIM commenced a drill program in 2005 to entirely replace this dataset.

BIM 2004- 2010 DATA

Data verification completed by Wahl and Gharapetian (2009 and 2011) consisted of data entry validation, analysis of available external duplicate data, analysis of twinned holes, checking the results of SGS's internal quality control, checking the quality of core logging and sampling protocols, comparisons of drill campaign results via quantile plots, and validating of drill hole collar locations.

The drilling/sample database used for resource estimation was obtained from BIM as MS Excel files that were imported in Surpac Mining software. These data files were examined both visually and statistically. Any issues that arose during data import were raised with BIM personnel, corrected, and rechecked.

A variety of adjustments were made as data was imported into Surpac. Collar file coordinates were cross-checked with recent drill-hole collar survey files provided by BIM. WGM drill-hole location maps were imported and cross-referenced with the most recent survey data as a secondary check. Drill-hole collar elevations were also cross-referenced against the most recent Lidar topographic survey.

Approximately 5% of the electronic drill-hole assay database was checked against original assay records for data entry errors. Although assay certificates for the WGM drilling were no longer available, original assay tables were used to check data entry.

Drill logs and drill core from the WGM drill campaign were no longer available for verification

purposes. During data input, assay intervals were checked and corrected for overlapping samples, and data entry errors.

SGS completed all of BIM's primary assay work for the 2004 to 2010 exploration programs. SGS is accredited by the Standard Council of Canada (SCC) for specific mineral tests listed on the scope of accreditation to the ISO/IEC 17025 standard. ISO/IEC 17025 addresses both the quality management system and the technical aspects of operating a testing laboratory. SGS documentation provided by BIM indicates that SGS also participates in round robin reference material certification programs.

SGS INTERNAL BLANK, DUPLICATE PULP AND STANDARD RESULTS

SGS's internal quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples.

Duplicate pulp assay results taken by SGS as part of its in-house quality assurance/quality control (QA/QC) program were collected for the BIM drill program and were reviewed by Wahl and Gharapetian (2009 and 2011). Results of the SGS duplicate pulp testwork for all major grade and deleterious grade attributes were evaluated for each year. No contamination issues were noted with blanks. SGS's internal standard results were within two standard deviations of the population mean with no anomalous values. Regressions of duplicates indicated good correlation coefficients with the only issues pertaining to those samples assayed near their detection limit which is expected and not an issue of concern.

QUANTILE PLOTS

In order to verify the quality of the WGM assay database, a quantile-quantile plot was generated for the WGM and BIM five metre composited datasets (Wahl and Gharapetian, 2009). The results indicated a reasonable correlation for percentage of iron.

The percentage of sulphur quantile plot indicates that the BIM drill campaign encountered a significant population of higher grade sulphur results. It is possible that the difference is based on localised geological variations, based on where these samples were taken. The WGM drilling was relatively near surface, while the 2004 and 2005 drilling campaigns were deeper and spread along a greater strike length of the deposit. The percentage of sulphur data anomalies may also be the result of laboratory errors or differences in analytical methodologies. The problematic WGM sulphur results reflect the

Strathcona (2003) observation that metallurgical testwork in 1971 highlighted similar sulphur grade uncertainties.

TWINNED DRILL HOLES

Three sets of WGM holes were twinned by BIM in order to further assess the quality of the WGM database (Tables 5-9 to 5-11). In order to extract comparable data from the variable sample length dataset, the assay data which fell within the interpreted iron formation solids was composited into two metre lengths. Grade attributes common to both datasets included Fe%, SiO_2% and S%.

Table 5-9 compares WGM hole S-2 with BIM MR1-05-67 and indicates that there was a significantly high variability in minimum and maximum Fe%, SiO_2%, and S% grades, resulting in a larger discrepancy in average Fe% and SiO_2% grades. These min/max outliers impact the overall mean grade of the iron formation interval.

All twinned intervals show a slightly higher Fe% grade in the BIM holes compared to the WGM holes. As well, SiO_2% and S% mean grades are consistently higher in the WGM drilled intervals. The difference in sulphur content over a 58 m interval for the WGM and BIM holes in Table 5-9 cannot be explained. The apparent high S% bias in the WGM holes is also not consistent with the sulphur quantile plot results. It is not clear whether this is a result of contamination in the WGM drilling, lower core recovery, actual geological features or as a result of sampling or laboratory error.

Table 5-9 Comparison of Twin Drill Holes S-2 and MR1-05-67
Baffinland Iron Mines Corporation – Mary River Project

	WGM S-2			BIM MR1-05-67		
	Fe%	SiO_2%	S%	Fe%	SiO_2%	S%
Average	66.09	1.84	0.04	68.55	0.73	0.03
Minimum	8.44	0.18	0.00	64.31	0.13	0.01
Maximum	70.72	33.03	0.13	70.62	3.46	0.37
25th Percentile	68.40	0.27	0.02	68.18	0.28	0.01
50th Percentile	68.77	0.45	0.03	68.96	0.49	0.02
75th Percentile	69.54	0.81	0.04	69.50	1.01	0.04
Tri Mean	68.90	0.51	0.03	68.88	0.59	0.02

Comprising 29 composites or 58 m of continuous mineralization.

Table 5-10 Comparison of Twin Drill Holes S-5 and MR1-05-63

Baffinland Iron Mines Corporation – Mary River Project

	WGM S-5			BIM MR1-05-63		
	Fe%	SiO_2%	S%	Fe%	SiO_2%	S%
Average	68.09	0.53	0.07	68.62	0.41	0.01
Minimum	64.40	0.30	0.02	66.74	0.21	0.01
Maximum	69.12	1.19	0.11	69.40	1.41	0.02
25th Percentile	67.78	0.40	0.04	68.37	0.27	0.01
50th Percentile	68.63	0.44	0.07	68.74	0.31	0.01
75th Percentile	68.80	0.48	0.08	69.05	0.39	0.01
Tri Mean	68.09	0.53	0.07	68.62	0.41	0.01

Comprising 29 composites or 58 m of continuous mineralization.

Table 5-11 Comparison of Twin Drill Holes S-6 and MR1-05-60
Baffinland Iron Mines Corporation – Mary River Project

	WGM S-6			BIM MR1-05-60		
	Fe%	SiO_2%	S%	Fe%	SiO_2%	S%
Average	67.57	0.97	0.03	68.30	0.80	0.02
Minimum	64.94	0.25	0.01	61.99	0.14	0.01
Maximum	68.90	2.08	0.05	70.29	3.89	0.08
25th Percentile	66.92	0.61	0.02	67.62	0.27	0.01
50th Percentile	67.72	0.64	0.03	69.18	0.32	0.02
75th Percentile	68.31	1.51	0.04	69.58	0.59	0.04
Tri Mean	67.65	0.92	0.03	68.79	0.39	0.02

Comprising 23 composites or 46 m of continuous mineralization.

External BIM Duplicate Samples

Approximately 5% of the 2004, 2005, 2006, 2007, and 2008 assays were sent to the SGA laboratory in Germany for duplicate pulp analysis. Regressions for each element assayed for each year were run to assess for any persistent or incremental laboratory error. All regressions returned good coefficients of correlation. SGS Lakefield, however, indicates a slight and consistent bias toward higher Mn grades over SGA.

Certified Reference Materials

In 2007, BIM contracted SGA of Germany to create six standards representing a range of Fe, SiO_2, Al_2O_3, FeO, P, and S grades. The standards were generated from Mary River metallurgical samples, in order to provide reference material consistent with the Mary River ore types. Standards were inserted at a rate of 1 in 20 within the BIM sample stream. Standard results from the 2007 and 2008 exploration program were analyzed and plotted for various elements. A total of 60 plots were generated to assess for laboratory drift. No significant assay quality issues were identified.

RPA Conclusions

The analyses of the various QA/QC data indicate that the current BIM drill hole assay database is appropriate for resource estimation.

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 4 – Mineral Resources

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4. Mineral Resources

The Mineral Resource estimate for Mary River Deposit Nos. 1, 2 and 3 was carried out by RPA, using Geovia GEMS 6.7.4 mining software by Dassault Systemes Inc.

4.1 Previous Resource Estimates

Several recent NI 43-101 Technical Reports and resource estimates have been completed from 2009 to 2013 incorporating exploration and drilling data up to and including 2009. The generation of newer drilling data in 2010, 2012 and 2014 renders the earlier estimates out of date.

George H. Wahl, P. Geo., completed two estimates in 2009 and 2011 (Wahl and Gharapetian, 2009, 2011). RPA reviewed and audited the Mineral Resource estimate by Mr. Wahl, including his database validation, resource estimation parameters and assumptions, methodology and classification and prepared a Technical Report (David A. Ross et al, 2013). RPA accepted most attributes of the Wahl block models at that time including the grade estimates but made minor modifications to the Mineral Resource classification, adjusted the block size, and developed a new preliminary Whittle open pit shell to constrain the 2013 Mineral Resources. The BIM database used to estimate Mineral Resources in 2009 and 2011 had been previously audited and found acceptable by Mr. Wahl and RPA found the geological interpretations and grades to be appropriate for resource estimation. Methodologies used by BIM to generate its database were reviewed by Mr. Wahl and generally found to be appropriate.

Mineral Resources in this report were estimated in accordance with NI 43-101 and CIM resource classification definitions. The effective date of this Mineral Resource estimate is December 31, 2016 and the estimate is based on the surveyed open pit topographic surface as at year end (EOY) 2016. The resource estimate incorporates exploration and definition diamond drilling, and channel sampling data up to and including 2014 as well as production blast hole drilling to EOY 2016. RPA is not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that could materially affect the Mineral Resource estimate.

Table 4-1 summarizes the Mineral Resource estimates, inclusive of Mineral Reserves, for the Mary River DSO iron deposits with an effective date of December 31, 2016.

Table 4-1 Summary of Mineral Resources – December 31, 2016

Baffinland Iron Mines Corporation – Mary River Project

Category	Tonnes (Mdmt)	Tonnes (Mwmt)	Fe %	P %	S %	Mn %	SiO_2 %	Al_2O_3 %
Deposit No. 1								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	117	118	65.3	0.038	0.36	0.22	3.1	1.0
M+I	426	429	65.7	0.031	0.28	0.21	2.8	1.2
Inferred	73	74	65.5	0.036	0.50	0.28	2.5	0.9
Deposit No. 2								
Indicated	23	23	67.1	0.014	0.01	0.02	3.3	0.5
Inferred	14	15	65.3	0.027	0.01	0.02	4.7	1.1
Deposit No. 3								
Inferred	252	254	66.2	0.035	0.02	0.09	1.9	1.1
Totals Deposit Nos. 1, 2, and 3								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	140	141	65.6	0.034	0.30	0.19	3.1	0.9
M+I	449	452	65.8	0.030	0.27	0.20	2.8	1.1
Inferred	339	342	66.0	0.035	0.12	0.13	2.2	1.1

Notes:
1. CIM Definition Standards are followed for Mineral Resources.
2. Mineral Resources are estimated at a cut-off grade of 55% Fe for Deposits No. 1 and 3 and 62% Fe for Deposit No 2.
3. Mineral Resources are estimated using a long-term iron ore price of $70/t Fe, and a US$/C$ exchange rate of 1.28 C$/US$.
4. Bulk density is based on a formula relating bulk density to iron content.
5. Mineral Resources are reported in dry and wet tonnes, and dry grades. In situ moisture is estimated to be 0.7%.
6. Mineral Resources are inclusive of Mineral Reserves.
7. Numbers may not add due to rounding.

4.2 Resource Database

The exploration database provided to RPA by BIM for Deposit Nos.1 to 3 includes 232 drill holes totalling 37,952.70 m and 61 channel samples totalling 381.06 m. Six WGM holes, and one BIM hole, in Deposit No. 1 were removed for resource estimation purposes where these holes were twinned by more recent BIM drilling, or in the case of the BIM hole, was short and provided less Fe data than the WGM hole. The database also includes three ARD series holes drilled in waste for acid rock drainage testing. Some 25 holes proposed for drilling in 2013 in Deposit Nos. 2 and 3 and elsewhere to the northeast were provided in the database, however, these were not drilled and are not included in the RPA's reporting of the exploration database statistics. A total of 153 drill holes (27,739.54 m) were used to estimate resources for Deposit No. 1. A total of 10 drill holes (1,597.70 m and 22 channel samples over 130.19 m

were used to estimate resources for Deposit No. 2 and a total of 11 drill holes (2,658.70 m) and 27 channel samples over 183.01 m were used to estimate resources for Deposit No. 3. Table 4-2 summarizes the databases.

RPA notes that only 10% of the resource drill holes (15% by length) were surveyed downhole. RPA reviewed the impact of the lack of survey and notes that the difference in toe position for a long hole (>300 m) is about 12 m with a maximum difference of 16 m in the down hole trace. With respect to the drill hole spacings and step outs, the potential error in assay location arising from a lack of downhole surveying has only minor impact on resource estimation.

The blast hole database provided by BIM contains 14,231 holes totalling 100,835.40 m dating from 2001 to 2016. Toe and burden of the blast holes is variable at approximately 4 m to,5.5 m. RPA review of the blast hole database has disclosed that there are 86 pairs (521.02 m) with duplicate collar locations, 310 holes lacking dates and a number of erroneous dates ranging up to 2027. Some of the duplicated holes appear to be randomly distributed but a significant number are area specific and appear to have been miss documented as a batch(s). The duplicated holes were flagged by date, with earlier dates taking precedence, and disregarded for resource estimation.

The blast holes were used in part to wireframe and estimate Fe grade for Deposit No. 1 mineralization near surface and those contained within the resource wireframe were coded. Blast holes used for resource estimation total 10,937 over 80,751.81 m. These holes range in length from 2.5 m to 18.58 m and average 7.38 m.

Table 4-2 Drilling and Channel Sampling Database
Baffinland Iron Mines Corporation – Mary River Project

Exploration Database

Year	Company	DDH	Metres	BS*	Metres	Channels	Metres
1963	WGM					52	290.70
1964	WGM	10	1,540.50				
1965	WGM	16	1,777.56				
2004	BIM	13	2,471.50				
2005	BIM	34	8,393.20				
2006	BIM	32	5,964.50			1	4.00
2007	BIM	27	6,344.80	2	173.00	8	86.36
2008	BIM	28	5,179.40	37	378.00		
2009	BIM	13	2,666.50				
2010	BIM	8	963.00				
2012	BIM	6	1,312.74				
2014	BIM	6	788.00				
Total		193	37,401.70	39	551.00	61	381.06

Resource Estimation Database

Deposit No.1	Company	DDH	Metres	BS*	Metres	Channels	Metres
1964	WGM	6	878.82				
1965	WGM	12	1,327.38				
2004	BIM	6	1,341.10				
2005	BIM	28	8,086.70				
2006	BIM	18	3,396.80				
2007	BIM	18	4,135.70	2	173.00		
2008	BIM	27	5,030.40	22	183.00		
2009	BIM	10	2,257.50				
2012	BIM	3	828.14				
2014	BIM	1	101.00				
Total		129	27,383.54	24	356.00		

Deposit No. 2	Company	DDH	Metres	BS*	Metres	Channels	Metres
1963	WGM					22	130.19
2004	BIM	1	122.00				
2006	BIM	7	1,192.70				
2010	BIM	2	283.00				
		10	1,597.70			22	130.19

Deposit No. 3	Company	DDH	Metres	BS*	Metres	Channels	Metres
1963	WGM					19	96.65
2006	BIM	2	403.00				
2007	BIM	8	2,104.70			8	86.36
2010	BIM	1	151.00				

Total	11	2,658.70			27	183.01
Resource Total	**150**	**31,639.94**	**24**	**356.00**	**49**	**313.20**

*DDH-diamond drill hole; BS-short grade control DDH; Channels-surface channel sampling

4.2.1 Assay Database

The drill hole data base for BIM drilling in deposits 1 to 3 contains 10,549 sample intervals variously tested/analyzed for Fe, FeO, Lump, MAG, P, MnO, SiO_2, Al_2O_3, CaO, K_2O, MgO, Na_2O, P_2O_5, H_2O and LOI. The BIM exploration drilling accounts for 9,591 sample intervals over 18,937.73 m. Analyses for samples are almost complete except for MAG and LOI (Table 4-3), The BS series holes have 127 sample intervals over 332.35 m for which analyses for samples are complete except for only 59.8% analyzed for FeO, Lump, MAG, MgO, Na_2O, K_2O, H_2O and LOI.

Whole rock analyses for MnO and P_2O_5 were converted to Mn and P in the sampling databases.

Core samples from 25 of the 26 WGM holes in the database were analyzed only for Fe, P, S and SiO2. Analyses total 701 over 2,728.09 m.

The drill hole database includes 67 channel samples totalling 260.29 m which were obtained at bedrock surface from deposits 1, 2 and 3.. Samples range in length from 1.52 m to 21.69 m. Channel samples were used in resource estimation for deposits 2 and 3, however, those from Deposit 1 were not used for estimation since the channel sampled area was subject to close-spaced grade control and short hole drilling. Samples (41) were analyzed for Fe, Al_2O3, MnO, P_2O_5, S, SiO_2 in the WGM channels and Fe, FeO, Lump, MAG, P, MnO, SiO_2, Al_2O_3, CaO, K_2O, MgO, Na_2O, P_2O_5, and H_2O for 89 samples in the eight BIM channels.

The production blast holes totalling 14,231 over 100,835.40 m, were all drilled in the footwall of Deposit 1 Lower Zone. The samples were analyzed variously for Fe, FeO, MAG, P, Mn, SiO_2, Al_2O_3, C, CaO, K_2O, Na_2O and LOI. Qualitative entries, indicating the presence of magnetite, hematite, and specularite were variously included in the assay intervals. Sample intervals ranged from 2.5 m to 18.58 m.

The metallurgical testwork database contains 369 samples taken over 13,155.90 m from 92 holes within the resources outlined for the five zones of Deposit 1. Samples consisted of drill core composites ranging in length from 7.6 m to 191.2 m. The composites were tested for apparent density, moisture%, tumble abrasion, tumble strength, reduction index and reduction under load index.

TABLE 4-3 BIM EXOLORATION DDH ANALYSES
Baffinland Iron Mines Corporation – Mary River Project

Attribute	No. Analyzed	Length (m)	Non-Analyzed	% Analyzed
Al_2O_3	9,585	18,924.63	6	99.9%
CaO	9,584	18,922.63	7	99.9%
Fe	9,585	18,924.63	6	99.9%
FeO	9,585	18,924.63	6	99.9%
H_2O	9,584	18,922.63	7	99.9%
K_2O	9,585	18,924.63	6	99.9%
LOI	9,311	18,384.63	280	97.1%
LUMP	9,582	18,918.63	9	99.9%
MAG	9,392	18,538.63	199	97.9%
MgO	9,585	18,924.63	6	99.9%
Mn	9,584	18,922.63	7	99.9%
Na_2O	9,585	18,924.63	6	99.9%
P	9,584	18,922.63	7	99.9%
S	9,585	18,924.63	6	99.9%
SiO_2	9,585	18,924.63	6	99.9%

4.3 Solids Modelling

4.3.1 Deposit No. 1

For Deposit No. 1, the hanging wall and footwall outlines of high grade iron formation were interpreted for each drill section spaced at approximately 75 m. RPA notes that a number of BIM drill holes were terminated in iron mineralization and did not reach the Lower Zone footwall on the west side of the zone and thus leaving the width of the zone open to interpretation. Wireframe solids were then prepared from the sectional interpretation. All wireframe polylines were snapped to drill hole assay intercepts. A cut off of 55% Fe over a minimum horizontal width of five metres was used to define hanging wall and footwall solid boundaries, however, where the massive iron formation grades along strike into banded iron formation, a lower cut-off was used to allow grade interpolation parameters to define gradational extent of lower grade mineralization along strike between drill sections. A majority of the cross-strike contacts were defined by very sharp declines in high grade iron content. The Lower Zone wireframe on the North Limb was extended to depth some 100 m to 175 m from the deepest drilling to the 95 m and 25 m elevations respectively, which is up to 675 m depth from surface. The narrower Middle, Upper and NE zones on the North Limb were extended 75 m to 80 m to depth beyond the deepest drill intercepts. The depth extents of the zones on the South Limb are constrained by drilling.

Plots of production blast hole assays and midpoints of the assay composites were used to model the near surface extents of the Lower zone. A polygon containing the assays above

the 55% Fe cut-off was built and used to clip the top of the Lower zone solid to model level 13 at the 620 EL bench. This solid was used for blast hole Fe grade interpolation in an independent partial model which subsequently replaced the drill hole interpreted portion of the block model for Fe. Other attributes in this upper portion of the Lower Zone were estimated based on the exploration drilling composites only.

In order to manage the impact of highly skewed deleterious grades during grade interpolation, two high deleterious zones with grades >1% S and >1% Mn were solid-modeled separately. These zones occur over a limited distance along the South Limb footwall (rock code 1400) and the North Limb footwall (rock code 1300). S and Mn grades were estimated independently of the North and South limbs only using samples contained within the deleterious zone solids.

High phosphorus was not solid modeled separately since its distribution is far more random from hanging wall to footwall. Two small, poorly defined areas of elevated phosphorus occur within Deposit No. 1 and both have a limited extent. Higher grade phosphorus (0.1% to 0.3%) is concentrated in the extreme north end of the main rock code 100 solid representing approximately 300 m of strike extent and within portions of the two solids located in the inner hanging wall portion of the fold hinge (rock codes 300 and 400).

High K2O (1% to 6%) occurs predominantly along the waste rock hanging wall and footwall contacts with the iron formation solids and should be avoided during mining. Otherwise only rare isolated two metre to four metre wide intervals of high K2O were noted within the iron formation zone solids and would be easily diluted during normal mining conditions.

Three internal waste zones (1000, 1100, 1200) were also solid modelled inside the iron formation wireframe solids. The waste zones were at least eight metres wide, and are either chlorite schist, amphibolite, volcanic tuff or low grade banded iron formation. These zones had been modelled in the previous resource estimates. RPA noted that projection of the waste zones between drill hole intercepts and extrapolation past the drill hole limits was inconsistent with respect to projections for the mineral zones. The greater extent of waste zones with respect to the previous estimates was borne out by blast hole results which were not available for previous estimates. Waste zone extents for this 2017 estimate have been modified accordingly. Other minor waste zones and discontinuous waste intercepts less than five metres horizontal width were incorporated in the mineral solids as internal waste. The modelled waste zones were used to clip voids into the mineral solids under the premise that such waste can be separated from the ore in the pit.

A specularite sub-zone (150) was also modelled at the north end of the Lower zone (100) in Deposit No. 1. The sub-zone was polylined on cross section based on lithology from core logging and where information was available in blast hole logs. The assay/composite grades for the specularite zone were included in the overall iron and other grade attribute estimates for the Lower Zone (100). The specularite zone was coded as “oretype 2” in the grade model used for the Whittle open pit design with the objective of estimating lump/fines production and for stock pile planning.

A digital terrain model (DTM) derived from Lidar topographic surveying by Terrapoint with a 30 cm resolution was created by BIM, merged with an overburden depth surface and used to clip the upper surface of Mineral Resource solids where appropriate. The initial bulk sampling bench is reflected in the DTM. Open pit production benches, mined in the Deposit No. 1 Lower Zone footwall on its west side, have been surveyed and the end of year 2016 (EOY2016) surface integrated by BIM with the LIDAR-overburden topographic surface for reporting of the EOY2016 resources and reserves. This surface was modified and validated by RPA.

A total of five mineralized solids were modelled for Deposit No. 1. Within the main mineralized zone, four stacked stratigraphic zones were modelled. The Lower Zone represents the highest grade, most continuous and thickest zone. The overlying Middle and two upper zones are limited in thickness, lateral extent, and confined largely within the fold hinge. Finally, a narrow mineralized zone (600), striking northeast and diverging from the hanging wall of the Lower Zone, was modelled where defined by drilling at its southern extent. Airborne geophysics defines a continuous anomaly over several hundred metres to the northeast of this zone, however, this portion of the zone is not included in resources because it lacks drilling. Airborne magnetic information aided in defining the width extents of mineralization in the South Limb.

4.3.2 Deposit Nos. 2 and 3

A main zone and hanging wall zone solid were defined for Deposit No. 2. These are labelled as rock codes 2000 and 2010. A single main zone (rock code 3000) was interpreted for Deposit No. 3.

For the 2009-2011 resource estimates (Wahl and Gharapetian, 2009, 2011), wireframe boundaries for Deposit Nos. 2 and 3 had been snapped to GPS locations of high grade extent in surface outcrops as well as to the drill hole traces. RPA maintained these boundaries where practicable. Iron grades at 55% cut-off were to define boundaries with the objective of achieving an iron product grade greater than 65% with a minimum horizontal

mining width of five metres. Lateral extents of solids were limited by either lack of high grade Fe in surface outcrops or by the lack of assays meeting cut-off in step out drill holes.

Iron mineralization in Deposit Nos. 2 and 3 is dominated by specular hematite and as such no sub-zoning for specularite was undertaken.

The iron formation solids were used to constrain grade interpolation. The internal waste solids were used to clip/remove material from the iron formation solids. The deleterious zone solids were used to independently estimate the higher S and Mn grades within the iron formation resource solids. The volumes for each of the solids developed by RPA are listed in Table 4-4.

With respect to the solids used in the previous 2009-2013 resource estimates, total volume of the solids increased 3.5%. The differences are summarized as follows:

- The Lower Zone (zone 100) was thickened near surface as per the blast hole results, and thickened at fold hinge owing to results from the 2009 drilling.
- Specular hematite (zone 150) occurring within the Lower Zone modelled as a sub-zone.
- Some redistribution between zones 200 and 300 occurred where they merge in the South Limb.
- The depth projection of zones 200 to 400 was modified.
- The strike extent of Zone 600 strike was reduced.
- The depth project of Deposit No. 2 (zone 2000) was limited to 200 m RL.
- Internal waste zones in the Lower Zone (zone 100) were extended as dictated by blast hole results and for consistency.
- Internal waste zones in Deposit Nos. 2 and 3 modelled.

Drill hole intersections in the mineralization and deleterious wireframe solids were used to identify enclosed sample intervals which were flagged in the assay and composite databases.

Table 4-4 Zones and Other Solids Used to Constrain Grade Interpolation
Baffinland Iron Mines Corporation – Mary River Project

Zone	Geology Solid			Rock Code	Volume m³ (000's)	Tonnes[1,2] (000's)
Deposit No. 1 Lower	RT100	RPA	Allclip	100	101,252	455,633
Deposit No. 1 Middle	RT200	RPA	Topoclip	200	14,776	66,491
Deposit No. 1 Upper 1	RT300	RPA	Topoclip	300	7,851	35,331
Deposit No. 1 Upper 2	RT400	RPA	Topoclip	400	1,158	5,209
Deposit No. 1 NE	RT600	RPA	Topoclip	600	1,981	8,915
	Subtotal				**127,018**	**571,579**
Deposit No. 2	RT2000	RPA 2017	Topoclip	2000	15,270	68,715
Deposit No. 2	RT2010	Hanging Wall Lens	Topoclip	2010	944	4,248
	Subtotal				**16,214**	**72,963**
Deposit No. 3	Deposit 3	RPA 2107	Topoclip	3000	**99,933**	**449,699**
	Total Resource Solids				**243,165**	**1,094,240**
Internal Waste/Deleterious						
Specularite	Specularite	Final	Clipped	150	5,881	26,466
North Waste 1	RT1000	Internal Waste		1000	348	1,567
North Waste 2	RT1100	Internal Waste		1100	1,074	4,833
South Waste	RT1200	Internal Waste		1200	136	612
North Deleterious	RT1300	S&Mn	deleterious	1300	2,152	9,684
South Deleterious	RT1400	S & Mn deleterious	RT100clip	1400	2,375	10,687

1) Bulk density generalized at 4.5 t/m³

2) Waste tonnes represent loss in pre-clipped Lower Zone mineral solid

4.4 Dry Bulk Density

Density data comprised of 387 metallurgical drill core samples from Deposit No. 1 was used to derive a grade-based regression formula for estimating dry bulk density. For material within the iron formation solids, dry bulk density was calculated as: 2.65 t/m3 + (0.0288 * Fe%). This formula applies only to Fe mineralized material, not waste.

For waste rock outside the iron formation wireframe solids, dry bulk density was assigned a value of 2.82 t/m3 based on the average bulk density of 72 measurements on samples collected in 2010.

Knight Piésold provided density data for three overburden samples in the vicinity of the Deposit No. 1 open-pit location. The average density was estimated at 2.24 t/m3. Knight

Piésold cautions that given the characterization of these samples, the results should be considered approximate. RPA used a rule of thumb overburden bulk density of 2.0 t/m3 for pit design in this report. RPA recommends that additional density measurement of overburden samples be carried out.

4.5 Resource Assay Database

Assays in the resource database were coded by zone through drill hole intersection of the solids in GEMS. Figure 4-1 show resource assay sample length statistics and Tables 4-5 to 4-10 present summary assay statistics by zone for Deposit No. 1.

Figure 4-1 Assay Sample Length Statistics

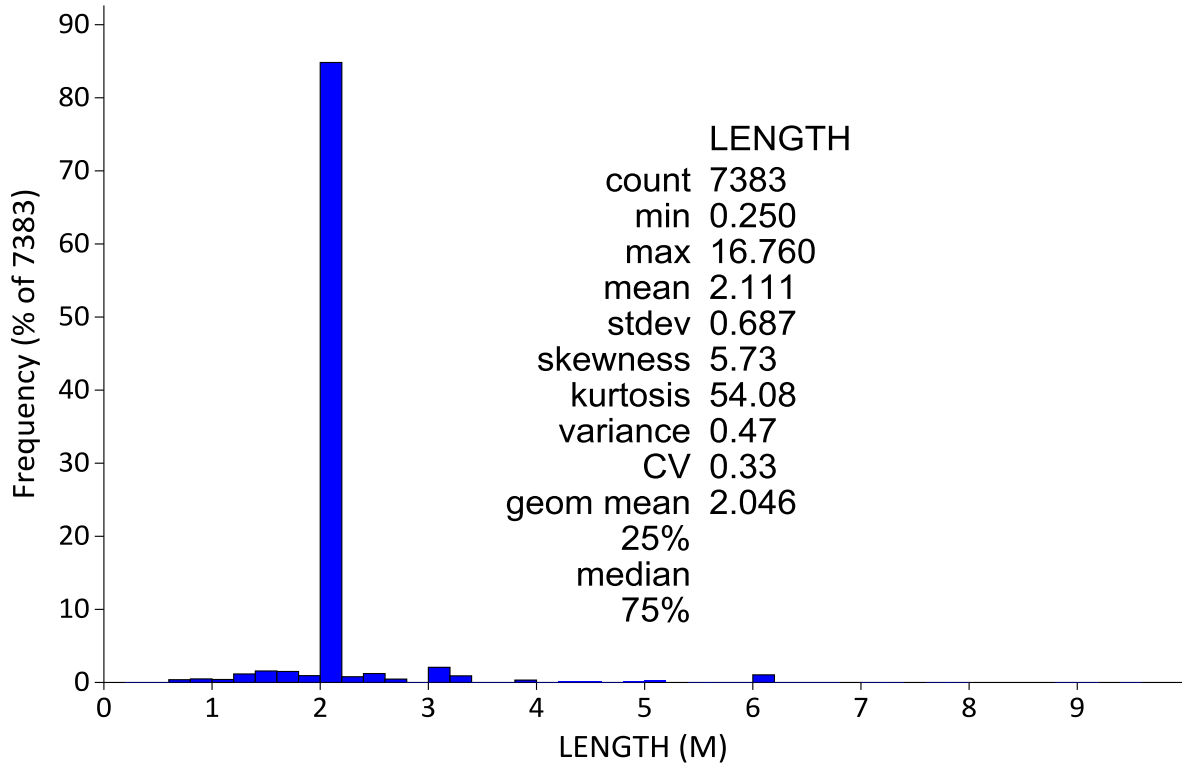


Table 4-5 Assay Statistics for Lower Zone (100) Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Assays							
Al_2O_3 %	5,577	0.00	25.10	1.31	8.49	2.91	2.22
CaO	5,577	0.00	14.70	0.17	0.28	0.53	3.17
Fe %	5,577	0.00	72.17	65.79	71.07	8.43	0.13
FeO %	5,577	0.00	n	12.96	131.10	11.45	0.88
H_2O %	5,577	0.00	14.00	0.00	0.66	1.00	1.69
K_2O %	5,577	0.00	3.92	0.03	0.02	0.15	5.87
LOI	5,577	-3.49	19.00	0.40	5.17	2.27	5.65
LUMP	5,577	0.00	1.00	1.00	0.07	0.00	0.35
MAG	5,577	0.00	112.79	41.77	1363.00	36.91	0.88
MgO	5,058	0.00	19.00	1.00	4.56	2.00	2.14
Mn %	5,577	0.00	5.72	0.21	0.15	0.38	1.79
Na_2O %	5,577	0.00	0.14	0.01	0.00	0.01	1.26
P %	5,577	0.00	2.33	0.03	0.01	0.08	3.06
S %	5,577	0.00	12.20	0.28	0.53	0.73	2.63
SiO_2 %	5,577	0.00	64.90	2.52	31.11	5.58	2.22
Metallurgical Testing Assays							
Apparent Density	244	3.96	5.05	4.63	0.05	0.22	0.05
Moisture%	244	0.01	6.63	0.77	0.89	0.94	1.23
RI	244	10.80	58.00	38.29	100.20	10.01	0.26
RUL	244	0.26	1.33	0.85	0.05	0.22	0.25
TA	244	0.00	40.60	12.98	53.07	7.29	0.56
TS	244	0.00	91.90	76.85	183.80	13.56	0.18

Table 4-6 Assay Statistics for Middle Zone (200) Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Assays							
Al_2O_3 %	1,161	0.00	17.40	1.21	3.46	1.86	1.54
CaO	1,161	0.00	7.28	0.29	0.44	0.66	2.30
Fe %	1,161	19.92	71.27	63.80	50.07	7.08	0.11
FeO %	1,161	0.00	30.70	12.84	101.70	10.08	0.79
H_2O %	1,161	0.00	7.00	1.00	0.81	1.00	1.11
K_2O %	1,161	0.00	0.42	0.01	0.00	0.02	1.76
LOI	1,161	-2.96	25.30	0.08	3.69	1.92	22.83
LUMP	1,161	0.00	1.00	1.00	0.02	0.00	0.20
MAG	1,161	0.00	98.94	41.39	1056.00	32.50	0.79
MgO	1,142	0.00	17.00	1.00	4.85	2.00	1.56
Mn %	1,161	0.00	1.16	0.11	0.02	0.13	1.21
Na_2O %	1,161	0.00	0.08	0.01	0.00	0.01	0.87
P %	1,161	0.00	1.47	0.06	0.01	0.10	1.81
S %	1,161	0.00	4.43	0.13	0.09	0.29	2.23
SiO_2 %	1,161	0.15	42.10	5.58	36.20	6.02	1.08

Metallurgical Testing Assays							
Apparent Density	62	3.64	4.80	4.26	0.06	0.25	0.06
Moisture%	62	0.05	4.36	1.21	1.04	1.02	0.84
RI	62	14.20	61.10	41.16	99.54	9.98	0.24
RUL	62	0.44	1.21	0.90	0.02	0.16	0.17
TA	62	0.00	47.40	20.82	106.20	10.31	0.50
TS	62	0.00	86.60	66.27	371.20	19.27	0.29

Table 4-7 Assay Statistics for Upper 1 Zone (300) Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Assays							
Al_2O_3 %	494	0.07	16.30	1.46	8.06	2.84	1.95
CaO	494	0.01	5.94	0.44	0.68	0.82	1.88
Fe %	494	13.30	71.24	61.89	121.20	11.01	0.18
FeO %	494	0.23	29.81	10.66	57.65	7.59	0.71
H_2O %	494	0.00	7.00	1.00	1.34	1.00	1.30
K_2O %	494	0.00	0.76	0.01	0.00	0.05	3.90
LOI	494	-2.98	10.60	0.76	5.66	2.38	3.12
LUMP	494	0.00	1.00	1.00	0.01	0.00	0.13
MAG	494	0.74	96.07	34.38	599.10	24.48	0.71
MgO	494	0.00	22.00	2.00	14.11	4.00	1.56
Mn %	494	0.00	0.99	0.09	0.02	0.13	1.55
Na_2O %	494	0.00	0.45	0.01	0.00	0.02	2.33
P %	494	0.00	1.28	0.08	0.01	0.09	1.21
S %	494	0.01	6.37	0.12	0.16	0.40	3.47
SiO_2 %	494	0.24	44.70	6.34	60.49	7.78	1.23
Metallurgical Testing Assays							
Apparent Density	21	3.82	4.51	4.07	0.04	0.20	0.05
Moisture %	21	0.15	4.73	1.60	2.19	1.48	0.93
RI	21	36.70	63.20	49.48	42.64	6.53	0.13
RUL	21	0.86	1.24	1.05	0.01	0.11	0.10
TA	21	0.00	55.50	27.54	198.30	14.08	0.51
TS	21	0.00	81.50	59.29	377.60	19.43	0.33

Table 4-8 Assay Statistics for Upper 2 Zone (400) Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Assays							
Al_2O_3 %	73	0.14	2.96	0.75	0.31	0.56	0.75
CaO	73	0.02	2.22	0.35	0.11	0.33	0.95
Fe %	73	51.31	69.44	63.26	20.53	4.53	0.07
FeO %	73	0.94	24.96	6.99	58.70	7.66	1.10
H_2O %	73	0.00	4.00	1.00	0.44	1.00	1.21
K_2O %	73	0.00	0.07	0.01	0.00	0.01	1.07
LOI	73	-1.99	4.69	0.65	1.24	1.12	1.73
LUMP	73	1.00	1.00	1.00	0.01	0.00	0.10
MAG	73	3.03	80.44	22.52	609.60	24.69	1.10

MgO	73	0.00	7.00	2.00	3.07	2.00	0.81
Mn %	73	0.00	0.31	0.04	0.00	0.05	1.09
Na_2O %	73	0.00	0.02	0.01	0.00	0.00	0.35
P %	73	0.00	0.28	0.08	0.00	0.06	0.72
S %	73	0.01	1.10	0.06	0.03	0.16	2.84
SiO_2 %	73	0.53	16.40	5.68	18.14	4.26	0.75
Metallurgical Testing Assays							
Apparent Density	5	3.81	4.05	3.95	0.01	0.10	0.03
Moisture %	5	0.23	2.59	1.46	0.70	0.84	0.57
RI	5	45.50	55.60	51.50	16.59	4.07	0.08
RUL	5	0.95	1.12	1.02	0.01	0.07	0.07
TA	5	24.10	47.30	37.22	72.58	8.52	0.23
TS	5	41.50	66.30	51.46	88.79	9.42	0.18

Table 4-9 Assay Statistics for NE Zone (600) Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Assays							
Al_2O_3 %	78	0.05	2.67	0.46	0.28	0.53	1.14
CaO	78	0.01	10.80	1.10	3.65	1.91	1.73
Fe %	78	30.42	69.94	63.23	72.36	8.51	0.13
FeO %	78	2.92	30.10	21.78	60.32	7.77	0.36
H_2O %	78	0.00	2.00	0.00	0.17	0.00	1.27
K_2O %	78	0.00	0.12	0.01	0.00	0.02	1.73
LOI	78	-2.31	13.30	0.78	8.41	2.90	3.73
LUMP	78	1.00	1.00	1.00	0.01	0.00	0.09
MAG	78	9.41	97.00	70.19	626.50	25.03	0.36
MgO	78	0.00	11.00	2.00	5.21	2.00	1.17
Mn %	78	0.01	1.44	0.27	0.05	0.22	0.80
Na_2O %	78	0.00	0.01	0.01	0.00	0.00	0.52
P %	78	0.00	0.15	0.02	0.00	0.03	1.64
S %	78	0.01	1.55	0.28	0.11	0.33	1.20
SiO_2 %	78	0.17	45.30	5.04	66.92	8.18	1.62
Metallurgical Testing Assays							
Apparent Density	3	4.42	4.48	4.46	0.00	0.03	0.01
Moisture %	3	0.13	0.43	0.32	0.03	0.17	0.52
RI	3	33.80	39.10	37.17	8.56	2.93	0.08
RUL	3	0.79	0.88	0.84	0.00	0.05	0.05
TA	3	17.80	53.30	32.63	340.60	18.46	0.57
TS	3	36.60	76.70	59.37	424.10	20.60	0.35

Table 4-10 Assay Statistics for 1300 and 1400 Zones Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Domain	Variable	Count	Min	Max	Mean	Variance	StDev	CV
1300	Mn %	167	0.00	3.66	1.28	0.56	0.75	0.58
	S %	167	0.01	12.20	1.13	1.90	1.38	1.22
1400	Mn %	155	0.05	2.80	0.82	0.33	0.58	0.70
	S %	155	0.02	7.23	1.38	1.57	1.25	0.91

4.6 Compositing

For Deposit No. 1, the sample lengths in the resource raw assay database for drill holes ranged from a minimum sample length of 0.25 m to a maximum of 16.76 m with an average of 2.15 m. A majority of the sample lengths exceeding the average originated with the WGM sampling and drilling programs. Samples were composited to five metre lengths for statistics and grade interpolation. Remaining composite intervals with a minimum length of at least 1.25 m were also included from the composite files. Initial compositing was done at two metre lengths down hole, however, these composites proved to be difficult for variogram interpretation and were thus abandoned in favour of using five meter composites with their inherent smoothing. Where assays are lacking for some attributes in the composites, a value of -999 was assigned which value is ignored during interpolation. A separate composite database was set up for the WGM “S” series holes that were mostly only assayed for Fe, S and SiO2 and interpolations for these attributes run using this simplified data.

Where the few implicit gaps in assaying occur within the resource solids, a background value was used for compositing to avoid zeros and generating waste blocks. The background levels are taken as the assays median values and were applied for the whole rock and lump attributes but not for Fe for which the background was taken as zero.

A significant portion of the LOI raw assay values in the database are negative indicating a gain on ignition likely caused by testing in a non-oxygen-free furnace. Compositing negative values produces erroneous results using the GEMS compositing algorithm consequently RPA transformed the LOI values to all positive by adding 100 to the assay value. The transformed values were interpolated.

For Deposit Nos. 2 and No. 3, samples were composited down hole to two metre lengths for statistics and grade interpolation. The short composites occur at the footwall and in many cases they are fractions of an assay split at the drill hole-solid intersection and are thus spurious. Statistical checks were performed to confirm no bias was created by rejecting the short fractions at the footwalls.

Blast holes were composited down-hole at 2.5 m lengths. Composites less than 0.63 m in length were excluded from the composite dataset.

4.7 Composite Summary Statistics

Summary statistics of the five metre composites were generated for each of the zone solids and for each of the attributes to be interpolated (Tables 4-11 to 4-19).

Table 4-11 Composite Statistics for 100 Zone Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Composites							
Al_2O_3%	2,103	0.01	21.86	1.39	5.43	2.33	1.68
CaO%	2,063	0.01	9.09	0.18	0.23	0.48	2.64
Fe%	2,317	6.14	71.66	66.03	48.03	6.93	0.10
FeO%	2,063	0.01	33.11	14.11	118.20	10.87	0.77
H_2O%	2,063	0.00	9.00	1.00	0.50	1.00	1.35
K_2O%	2,063	0.00	2.56	0.03	0.02	0.13	4.70
LOI	2,063	96.64	111.27	100.45	3.99	2.00	0.02
LUMP	2,063	0.18	0.99	0.86	0.01	0.10	0.11
MAG%	2,062	0.10	106.78	45.52	1228.00	35.04	0.77
MgO%	2,063	0.00	17.00	1.00	2.89	2.00	1.75
Mn%	2,103	0.00	3.24	0.23	0.13	0.36	1.55
Na_2O%	2,063	0.00	0.09	0.01	0.00	0.01	0.90
P%	2,451	0.00	1.14	0.03	0.00	0.07	2.65
S%	2,317	0.01	4.96	0.20	0.21	0.45	2.30
SiO_2%	2,317	0.04	45.69	2.29	18.81	4.34	1.90
Metallurgical Testing Composites							
Apparent Density	1,752	1.26	5.05	4.59	0.10	0.32	0.07
Moisture %	1,752	0.01	6.63	0.70	0.72	0.85	1.21
RI	1,752	8.92	58.00	38.52	94.74	9.73	0.25
RUL	1,752	0.19	1.33	0.86	0.04	0.21	0.24
TA	1,736	2.18	40.60	13.21	47.10	6.86	0.52
TS	1,736	16.80	91.90	77.52	96.91	9.84	0.13

Table 4-12 Composite Statistics for 200 Zone Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Composites							
Al_2O_3%	466	0.14	8.19	1.21	1.46	1.21	1.00
CaO%	466	0.01	5.49	0.30	0.32	0.57	1.92
Fe%	479	24.05	70.56	63.51	37.87	6.15	0.10
FeO%	466	0.36	30.70	13.24	98.79	9.94	0.75
H_2O%	466	0.00	6.00	1.00	0.66	1.00	0.99
K_2O%	466	0.00	0.19	0.01	0.00	0.01	1.20
LOI	466	97.24	110.97	100.06	2.33	1.53	0.02
LUMP	466	0.16	0.97	0.80	0.01	0.11	0.14
MAG%	466	1.15	98.93	42.67	1026.00	32.03	0.75
MgO%	466	0.00	12.00	1.00	2.70	2.00	1.18
Mn%	466	0.00	0.99	0.11	0.01	0.12	1.08
Na_2O%	466	0.00	0.04	0.01	0.00	0.01	0.67

P%	479	0.00	0.77	0.06	0.01	0.08	1.39
S%	479	0.00	2.42	0.13	0.06	0.25	1.84
SiO_2%	479	0.21	30.14	5.45	24.77	4.98	0.91
Metallurgical Testing Composites							
Apparent Density	414	1.23	4.80	4.19	0.21	0.46	0.11
Moisture %	414	0.05	5.26	1.06	0.96	0.98	0.93
RI	414	11.90	61.10	40.91	110.50	10.51	0.26
RUL	414	0.25	1.21	0.88	0.03	0.17	0.20
TA	403	1.40	47.40	21.26	83.82	9.16	0.43
TS	403	22.98	88.40	68.20	168.10	12.97	0.19

Table 4-13 Composite Statistics for 300 Zone Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Composites							
Al_2O_3%	190	0.08	14.38	1.37	5.04	2.25	1.64
CaO%	190	0.01	5.06	0.44	0.58	0.76	1.74
Fe%	190	15.47	70.86	61.35	115.10	10.73	0.17
FeO%	190	0.84	29.47	10.98	55.12	7.43	0.68
H_2O%	190	0.00	5.00	1.00	1.10	1.00	1.19
K_2O%	190	0.00	0.34	0.01	0.00	0.03	2.43
LOI	190	97.07	110.07	100.67	4.16	2.04	0.02
LUMP	190	0.45	0.98	0.78	0.01	2.03	0.13
MAG%	190	2.70	94.98	35.38	572.80	23.93	0.68
MgO%	190	0.00	20.00	2.00	10.24	3.00	1.37
Mn%	190	0.00	0.86	0.09	0.02	0.13	1.42
Na_2O%	190	0.00	0.24	0.01	0.00	0.02	1.86
P%	190	0.00	0.32	0.08	0.00	0.07	0.88
S%	190	0.01	3.59	0.12	0.11	0.33	2.78
SiO_2%	190	0.39	39.25	6.31	49.42	7.03	1.11
Metallurgical Testing Composites							
Apparent Density	124	2.38	4.51	4.05	0.12	0.34	0.08
Moisture %	124	0.13	5.49	1.42	2.28	1.51	1.06
RI	124	22.02	63.20	48.44	47.98	6.93	0.14
RUL	124	0.52	1.24	1.03	0.02	0.13	0.12
TA	121	7.74	55.50	25.92	139.00	11.79	0.45
TS	121	26.13	81.70	64.14	193.20	13.90	0.22

Table 4-14 Composite Statistics for 400 Zone Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Composites							
Al_2O_3%	30	0.22	2.20	0.77	0.20	0.45	0.59
CaO%	30	0.03	0.99	0.35	0.06	0.24	0.68
Fe%	30	53.35	68.95	63.13	17.47	4.18	0.07
FeO%	30	1.01	24.46	7.19	61.47	7.84	1.09
H_2O%	30	0.00	2.00	1.00	0.18	0.00	0.77

K_2O%	30	0.00	0.02	0.01	0.00	0.01	0.57
LOI	30	98.26	102.99	100.65	1.04	1.02	0.01
LUMP	30	0.72	0.98	0.82	0.01	0.08	0.10
MAG%	30	3.27	78.82	23.18	638.40	25.27	1.09
MgO%	30	0.00	6.00	2.00	2.55	2.00	0.72
Mn%	30	0.01	0.21	0.04	0.00	0.04	0.97
Na_2O%	30	0.00	0.01	0.01	0.00	0.00	0.30
P%	30	0.01	0.19	0.08	0.00	0.05	0.63
S%	30	0.01	0.50	0.06	0.02	0.13	2.23
SiO_2%	30	0.97	15.26	5.77	17.11	4.14	0.72
Metallurgical Testing Composites							
Apparent Density	24	3.81	4.05	3.94	0.01	0.09	0.02
Moisture %	24	0.23	2.59	1.45	0.60	0.78	0.54
RI	24	45.50	55.60	51.75	11.49	3.39	0.07
RUL	24	0.95	1.12	1.03	0.00	0.07	0.06
TA	24	24.10	47.30	37.12	62.07	7.88	0.21
TS	24	40.02	66.30	51.43	78.90	8.88	0.17

Table 4-15 Composite Statistics for 600 Zone Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Variable	Count	Min	Max	Mean	Variance	StDev	CV
Composites							
Al_2O_3%	33	0.08	1.55	0.45	0.18	0.43	0.95
CaO%	33	0.01	4.98	1.07	1.56	1.25	1.16
Fe%	33	41.26	69.48	63.30	57.07	7.55	0.12
FeO%	33	3.80	29.08	21.98	56.07	7.49	0.34
H_2O%	33	0.00	2.00	0.00	0.14	0.00	1.17
K_2O%	33	0.00	0.12	0.01	0.00	0.02	1.69
LOI	33	98.12	105.78	100.76	3.89	1.97	0.02
LUMP	33	0.74	0.98	0.84	0.00	0.07	0.08
MAG%	33	12.24	93.71	70.85	582.30	24.13	0.34
MgO%	33	0.00	8.00	2.00	4.24	2.00	1.07
Mn%	33	0.02	0.73	0.27	0.03	0.17	0.63
Na_2O%	33	0.00	0.01	0.01	0.00	0.00	0.46
P%	33	0.00	0.11	0.02	0.00	0.03	1.48
S%	33	0.01	0.96	0.29	0.08	0.29	1.01
SiO_2%	33	0.24	32.23	5.01	53.18	7.29	1.46
Metallurgical Testing Composites							
Apparent density	22	4.09	4.48	4.35	0.03	0.16	0.04
Moisture %	22	0.05	0.84	0.41	0.04	0.21	0.52
RI	22	29.00	45.30	38.60	18.72	4.33	0.11
RUL	22	0.75	1.05	0.89	0.01	0.10	0.11
TA	22	15.90	53.30	32.26	197.80	14.06	0.44
TS	22	36.60	77.30	57.71	231.90	15.23	0.26

Table 4-16 Composite Statistics for 1300 and 1400 Zones Deposit No.1
Baffinland Iron Mines Corporation – Mary River Project

Domain	Variable	Count	Min	Max	Mean	Variance	StDev	CV
1300	Mn %	67	0.00	2.69	1.30	0.38	0.62	0.47
	S %	67	0.07	5.86	1.12	0.85	0.92	0.82
1400	Mn %	67	0.09	1.93	0.80	0.23	0.48	0.59
	S %	67	0.08	3.40	1.31	0.54	0.74	0.56

Table 4-17 Composite Statistics for Blast Holes Lower Zone, Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Attribute	Count	Sum (m)	Min	Median	Max	Mean	StDev	CV
Al_2O_3%	32,616	77,489.71	0.05	0.60	23.90	2.13	3.64	1.71
CaO%	21,071	50,443.44	0.010	0.020	4.580	0.058	0.163	2.840
Fe%	32,616	77,489.71	5.70	68.10	72.40	63.43	11.85	0.19
FeO%	26,126	62,639.10	0.20	4.31	72.43	8.20	8.39	1.02
K_2O%	26,977	63,866.34	0.010	0.010	6.300	0.063	0.209	3.291
LOI%	28,222	67,367.01	-55.90	-0.31	3.17	-0.62	2.71	-4.37
MAG%	28,199	67,358.81	0.66	12.87	98.57	25.10	25.83	1.03
Mn%	32,610	77,474.85	0.010	0.120	3.260	0.189	0.240	1.267
Na_2O%	30,085	71,595.69	0.030	0.050	0.770	0.046	0.029	0.631
P%	24,848	58,880.83	0.010	0.020	1.590	0.036	0.061	1.673
S%	27,946	66,516.60	0.010	0.020	11.500	0.063	0.257	4.065
SiO_2%	32,616	77,489.71	0.01	0.90	73.50	4.71	93.90	9.69	2.06

Table 4-18 Composite Statistics for Deposit No.2
Baffinland Iron Mines Corporation – Mary River Project

Attribute	Count	Sum (m)	Min	Median	Max	Mean	StDev	CV	98%ile
Al_2O_3%	343	671.69	0.050	0.270	15.869	0.704	1.642	2.334	4.990
CaO%	276	546.51	0.005	0.030	0.470	0.056	0.073	1.313	0.335
Fe%	343	671.69	34.691	67.194	70.250	64.597	6.116	0.095	69.900
FeO%	276	546.51	0.120	0.995	23.400	2.307	4.377	1.897	20.350
H_2O%	276	546.51	0.001	0.065	3.540	0.242	0.485	2.004	1.536
K_2O%	276	546.51	0.002	0.006	1.321	0.051	0.163	3.189	0.598
LOI%	246	486.51	100.000	100.170	106.062	100.389	0.747	0.007	103.568
Lump	276	546.51	0.270	0.850	0.990	0.835	0.112	0.134	0.970
MAG%	246	486.51	0.390	3.349	75.410	7.960	14.846	1.865	71.701
MgO%	276	546.51	0.005	0.055	6.705	0.387	0.933	2.410	3.612
Mn%	343	671.69	0.001	0.013	0.170	0.021	0.031	1.433	0.139
Na_2O%	276	546.51	0.001	0.004	0.528	0.011	0.035	3.215	0.078
P%	343	671.69	0.001	0.010	0.157	0.017	0.020	1.179	0.079
S%	343	671.69	0.002	0.005	1.980	0.020	0.115	5.890	0.121
SiO_2%	343	671.69	0.111	2.850	40.899	6.263	7.206	1.151	23.347

Table 4-19 Composite Statistics for Deposit No. 3
Baffinland Iron Mines Corporation – Mary River Project

Attribute	Count	Sum (m)	Min	Median	Max	Mean	StDev	CV	98%ile
Al_2O_3%	437	861.67	0.010	0.490	23.630	1.449	2.878	1.985	10.149
CaO%	387	767.20	0.005	0.237	3.880	0.494	0.668	1.354	2.855
Fe%	437	861.67	18.380	67.070	70.840	65.010	6.602	0.102	69.743
FeO%	387	767.20	0.030	2.310	29.300	5.836	7.344	1.258	27.456
H_2O%	387	767.20	0.030	0.060	0.790	0.092	0.103	1.125	0.427
K_2O%	387	767.20	0.002	0.011	2.652	0.095	0.299	3.166	0.957
LOI%	273	540.40	100.000	100.650	107.500	101.222	1.395	0.014	105.497
Lump	387	767.20	0.580	0.856	0.990	0.838	0.091	0.109	0.980
MAG%	365	723.30	0.101	7.380	94.400	18.621	23.864	1.282	88.748
MgO%	387	767.20	0.040	1.090	11.799	1.473	1.483	1.007	6.556
Mn%	437	861.67	0.001	0.040	2.900	0.123	0.360	2.925	1.644
Na_2O%	387	767.20	0.001	0.008	0.840	0.036	0.101	2.842	0.361
P%	437	861.67	0.001	0.030	0.294	0.044	0.044	1.000	0.173
S%	437	861.67	0.003	0.005	2.730	0.054	0.235	4.367	0.706
SiO_2%	437	861.67	0.060	1.066	39.100	2.891	4.937	1.707	20.599

Some grade differences were noted within the various zones. The lower zone of Deposit No. 1 showed the highest mean Fe grade at 66.03 Fe (Zone 100, Table 4-10), while the middle zone average grade was 63.51% Fe (Zone 200, Table 4-12) and the upper zones 61.35% (Zone 300, Table 4-13) and 63.13% Fe. The difference in grade is a result of the middle zone containing a higher proportion of intervals which graded into banded iron formation along strike and therefore higher corresponding SiO2 grades. Mean P grades were also increasingly elevated from Lower Zone to the Upper Zones (Lower Zone 100 0.03% P (Table 4-11), Middle Zone 200 – 0.06% P (Table 4-12), and Upper 1 Zones 300 and 400 at 0.08% P (Table 4-13)).

The two deleterious zones show elevated S and Mn grades along the footwall of the Lower Zone. Zone 1300 along the Lower Zone (100) North Limb footwall has a mean S grade of 1.12% while Mn is 1.30%. The 1400 Zone located on the South Limb (100) footwall has a mean S grade of 1.31% and mean Mn grade of 0.80%.

Statistics for Deposit Nos. 2 and 3 analyses (Tables 4-18 and 4-19, respectively) show that Mn, P, and S mean and maximum grades are reasonably low. Mean Fe grades are 64.60% Fe for Deposit No. 2 and 65.00% Fe for Deposit No. 3.

Deposit No. 2 differs from Deposit No. 1 in that the magnetite content is significantly lower (Table 4-18) and specular hematite predominates. This may be a result of having a proportionally larger amount of near-surface drilling Deposit No. 2 and therefore, a greater proportion of near-surface martitization.

4.8 Block Model Limits and Attributes

A block model was constructed to cover the entire extent of the Mary River Deposit No. 1 potential pit limits. Block model size, origin, and extents for the Deposit No. 1 block models are listed in Table 4-20. A second block model was constructed to cover the entire lateral and vertical extent of the potential pit limits for Deposits No. 2 and No. 3 combined. The block model size, origin, and extents for the Deposit No. 2 and No. 3 block models are listed in Table 4-21.

Table 4-20 Block Model Description Deposit No. 1
Baffinland Iron Mines Corporation – Mary River Project

Type	Northing	Easting	Elevation
Minimum Coordinates	7913300	562190	-240
Maximum Coordinates	7916315	564455	750
Block Size	5	5	10
Rotation	0	0	0

Table 4-21 Block Model Description Deposits Nos. 2 and 3
Baffinland Iron Mines Corporation – Mary River Project

Type	Northing	Easting	Elevation
Minimum Coordinates	7912000	565000	-500
Maximum Coordinates	7916000	570500	700
Block Size	5	5	10
Rotation	0	0	0

In accordance with the anticipated mining equipment size and smallest selective mining unit (SMU), BIM requested a 5 m x 5 m x 10 m bench block size. This size is appropriate for operations but given the drill hole spacings at ≥75 m, it is smaller than the customary resource block size of ¼ to ½ the drill hole spacing that provides the appropriate interpolation resolution for the hole spacing. In practise, this means there is only small variation expected in the estimated block values at a scale of less than approximately 20 m.

Per BIM request, the block grade attributes for interpolation consisted of Fe%, SiO2%, Al2O3%, FeO%, Mag%, MgO%, S%, P%, Mn%, Na2O%, K2O%, CaO%, H2O%, LOI and Lump%. For Deposit No. 1, additional information is included in the block model for metallurgical blast furnace test attributes including: Moisture (SGA); LOI (%); Tumble Test Strength (% >6.3 mm) ISO 3271; Tumble Test Abrasion (% <0.5 mm) ISO 3271; Apparent Density (g/cc); Reduction Under Load (R40%/min) ISO 7992; and Reduction Index Test (%) ISO 7215.

Additional block attributes included resource rock code, classification, bulk density, distance to nearest sample, number of holes used for the block estimate, kriging variance for OK models and interpolation pass.

Block model rock codes for Deposit No. 1 are listed in Table 4-22. Codes for Deposit Nos. 2 and 3 are listed in Table 4-23. Resource classifications in the block model are coded as "1" for Measured resources, "2" for Indicated resources, and "3" as Inferred resources.

Table 4-22 Deposit No. 1 Block Model Rock Codes
Baffinland Iron Mines Corporation – Mary River Project

Rock Type Attribute Values in Deposit No. 1 Block Model	Rock Type Code
Lower Iron Ore Zone	100
Middle Iron Ore Zone	200
Upper 1 Iron Ore Zone	300
Upper 2 Iron Ore Zone	400
Northeast Iron Ore Zone	600
North Internal Waste Zone 1	1000
North Internal Waste Zone 2	1100
South Internal Waste Zone	1200
North Footwall Deleterious Fe Zone	1300
South Footwall Deleterious Fe Zone	1400
Overburden	5
Air	0

Table 4-23 Deposits Nos. 2 and 3 Block Model Rock Codes
Baffinland Iron Mines Corporation – Mary River Project

Rock Type Attribute Values in Block Model	Rock Type Code
Deposit No. 2 Lower Iron Ore Zone	2000
Deposit No. 2 Upper Iron Ore Zone	2010
Deposit No. 3 Main Zone	3000

For Deposit No. 1, the block model was divided into the following model folders:

- partial model folder for the Lower Zone (100), Upper zone (300) 1 and NE zone (600)
- partial model folder for the Middle Zone (200) and Upper 2 Zone (400)
- Deleterious zones (1300 and 1400) folder
- Blast hole folder

- Standard folder
- Diluted Ore-Waste folder

The partial model folders are necessary to preserve volumetric integrity for percent models in GEMS whole block space since Deposit No. 1 zones merge or have boundaries within one block size distance. The partial models, deleterious zones and blast hole models were interpolated separately. S and Mn in the partial models were estimated using composites outside the deleterious wireframes whereas the deleterious zones models were interpolated by composites within the zones' solids. The partial models, deleterious zones models and blast hole model were then merged into the Standard folder and rock codes consolidated (5000) for resource reporting. The Standard folder was transferred to the Ore-Waste folder and resource-waste edge blocks diluted. The basis for dilution is:

- Block with percent within the zone solid less than 85% is rejected as waste with zero grade and a bulk density of 2.82 t/m^3
- Grade for a block with percent within the zone solid ≥ 85% is diluted by weighting the resource percent, grade and bulk density by the percent dilution at 2.82 t/m^3 and average dilution grade. The latter determined as the weighted average values from 4,532 assays from the internal waste solids and waste outside the resource solids contacts.
- Metallurgical attributes were not diluted since samples were taken entirely within the resource solids and there is no data on dilution.

The Ore-Waste folder was exported to Whittle software for open pit design.

Waste rock in the Ore-Waste folder was assigned a bulk density of 2.82 t/m^3, based on 72 determinations as discussed above. Overburden was assigned a density of 2.0 t/m^3, as discussed above. For the iron ore zones, bulk density (BD) was estimated for each block based on an iron grade-based formula wherein BD = 2.65 t/m^3 + (0.0288 * block Fe%).

For Deposit Nos. 2 and 3 the Standard folder alone was used for interpolations, resource reporting and preliminary Whittle pit design work.

4.9 Variography

Variography study was carried out for Deposit No. 1 assay composites in the drill hole and blast hole databases. Linear down-hole and 3D semi-variograms in GEMS and Supervisor software were prepared to assess nugget and grade variance with distance along multiple

directions and to evaluate vectors of the best grade continuity. No attempt was made to model the non-metallurgical attributes owing to the spatial distribution and inconsistent lengths of the parent data.

The Deposit No. 1 down-hole variograms were reasonable for all attributes showing low nugget from 5% to <25% (Figure 4-2). The 3D variograms in general were not robust, showed a lack of stationarity likely due to incorporated waste and internal data trends, cyclical structures, or short-range spikes and required variance normalization with some needed transposition to normal scores to allow for their interpretation. Variograms were successfully interpreted for primary attributes Fe, SiO2, Al2O3, P, S, and MgO, however reliable variograms could not be developed for Lump. Variography was not performed in detail for CaO, FeO, H2O, K2O, LOI, Na2O, MAG, and Mn which were interpolated by the inverse distance squared (ID2) method.

Variography results for the Deposit No.1 primary attributes are summarized as follows:

For the South limb:

- Fe, Al_2O_3, MgO and SiO_2 variograms all collinear, all modelled separately in normal-scores space, with primary continuity approximately paralleling the fold hinge (-65→095)
- S was modelled with a slightly different primary axis (57→286), also approximately paralleling the fold axis. Modelled in untransformed space
- P with a radically different primary axis (19→135), approximately orthogonal to the other variograms (i.e. approximately parallel to the strike of the south limb)

For the North limb:

- Fe, Al_2O_3 variograms collinear, primary continuity somewhat oblique to the fold axis, 61→006; both modelled separately in normal-scores space
- Strong trends (non-stationarity) in this domain precluded modelling of variograms for MgO, S, SiO2 on the north limb; each respective variogram was copied from the south limb, and assigned the same orientations as Fe & Al_2O_3 on the north limb
- As on the S limb, P returned a radically different, roughly orthogonal primary axis (19→135); it was modelled in normal-scores space

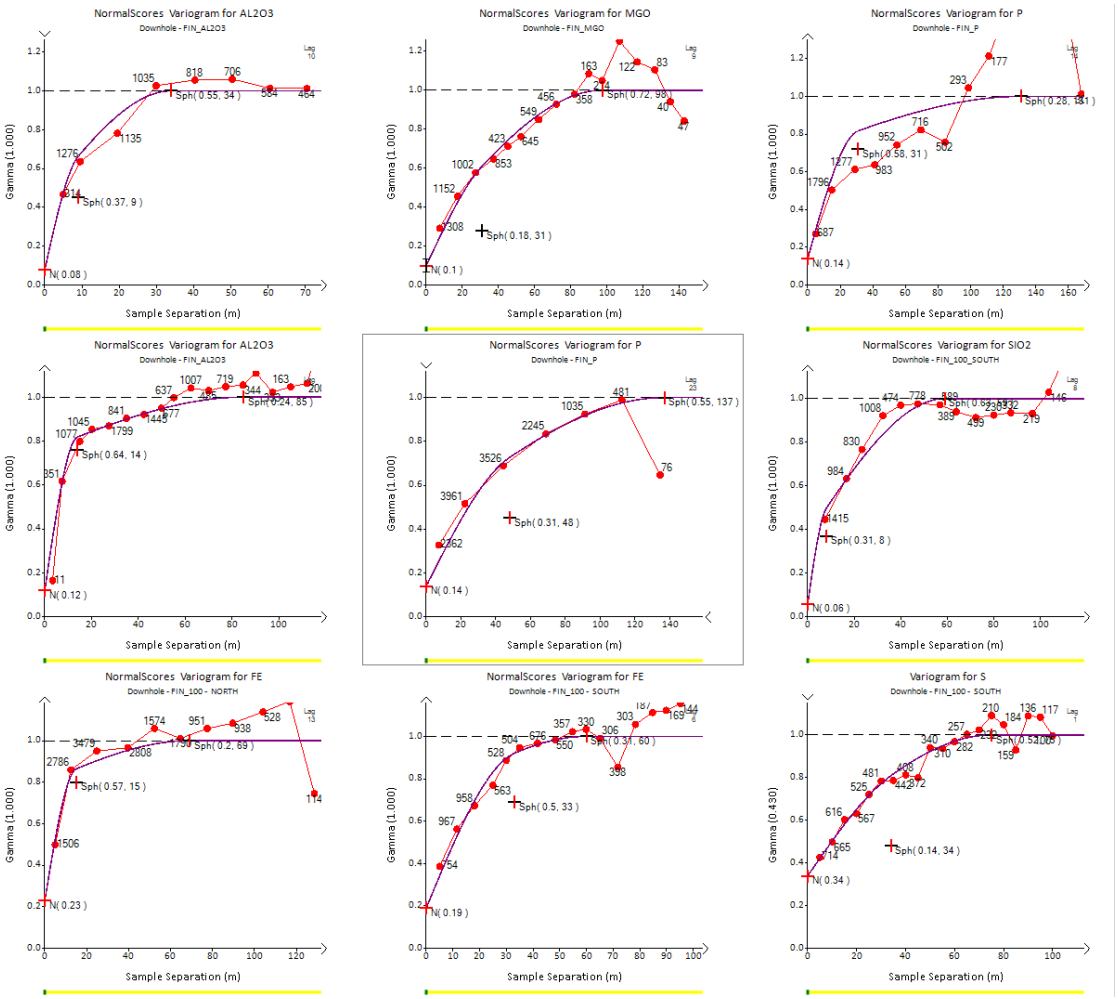
- LUMP and H2O could not be reliably modelled for either limb, so variograms were not produced for these attributes
- Variograms for P were generally poor in quality and at unusual angles with long ranges

For the transposed and normalized variograms it was noted that many of the experimental models failed to flatten out at the sill (instead flattening out above or below); in these instances, an attempt was made to emulate the shape of the experimental curve while maintaining an overall sill of 1.

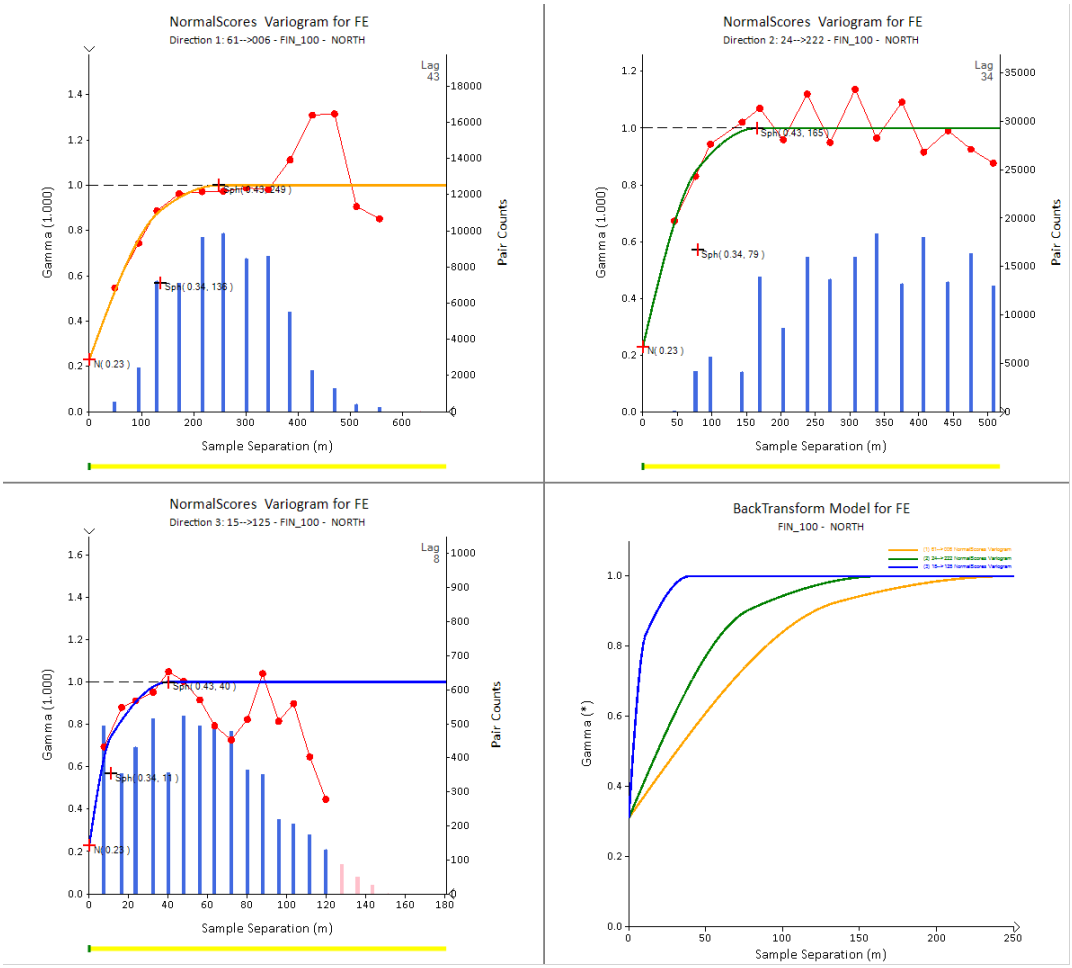
The linear down-hole and 3D variograms for the resource blast holes were very well behaved for Fe on strike and across width and resulted in reliable nested spherical models with ranges of 70 m and 50 respectively (Figure 4-3). There is insufficient mining depth to model blast hole grades down dip at the present time, however, ranges of continuity for Fe are expected to equal the on-strike distances.

In Deposit Nos. 2 and 3, wide drill hole spacing and limited drilling precluded the generation of reasonably informed variograms, however, preliminary omni directional semi-variograms showed ranges of up to 100 to 150 m for Deposit No. 2.

Figure 4-2 Downhole Variograms for Modelled Deposit No. 1 Zones



Fe North Limb



Fe South Limb

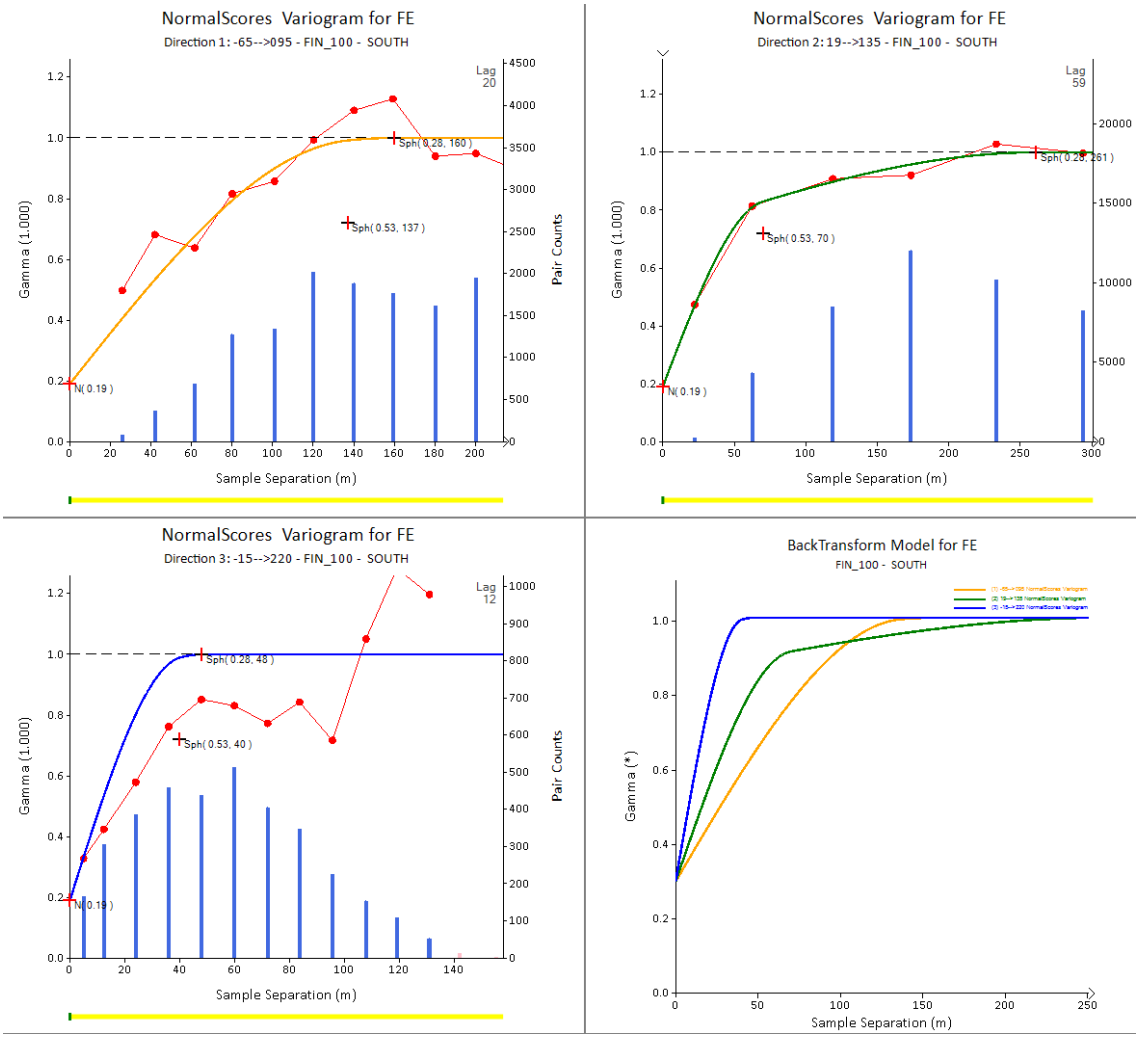
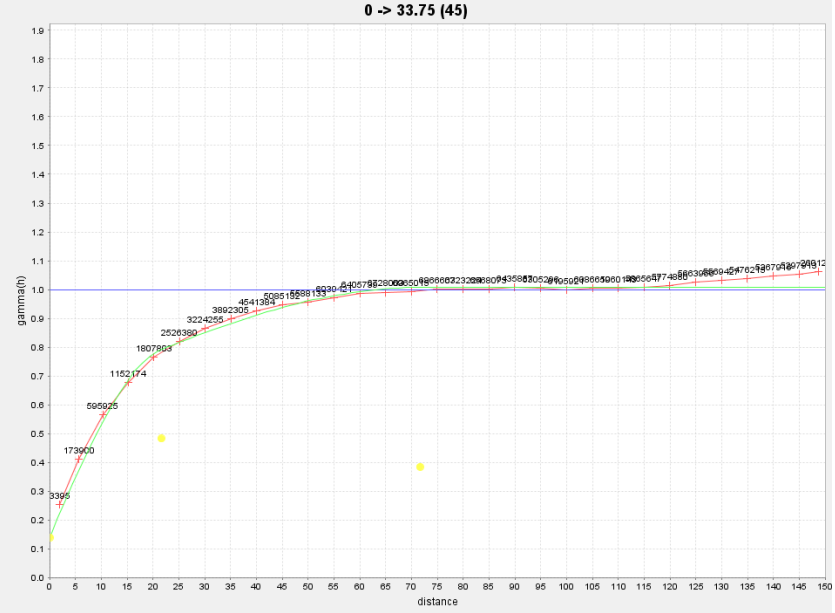
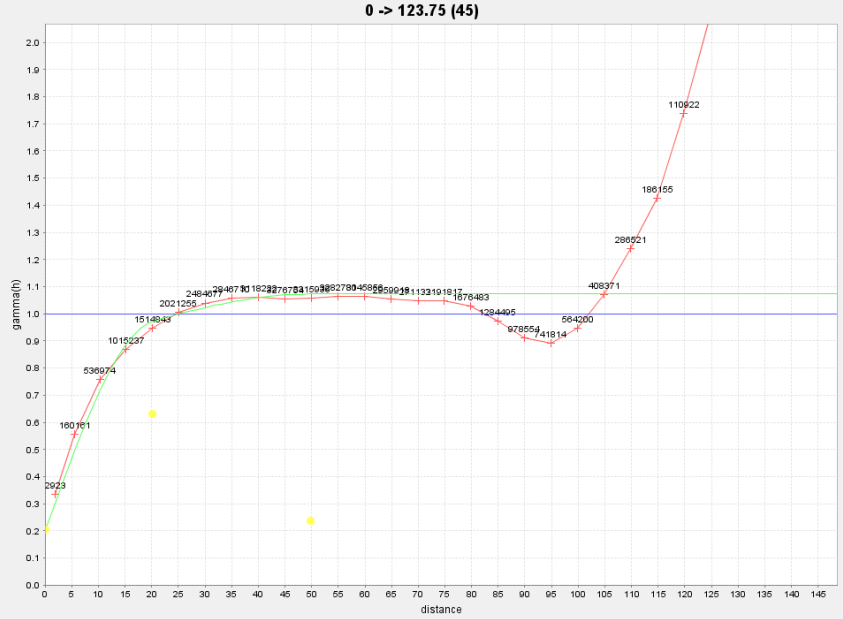


Figure 4-3 Variograms for Fe in Blast holes

Strike



Width



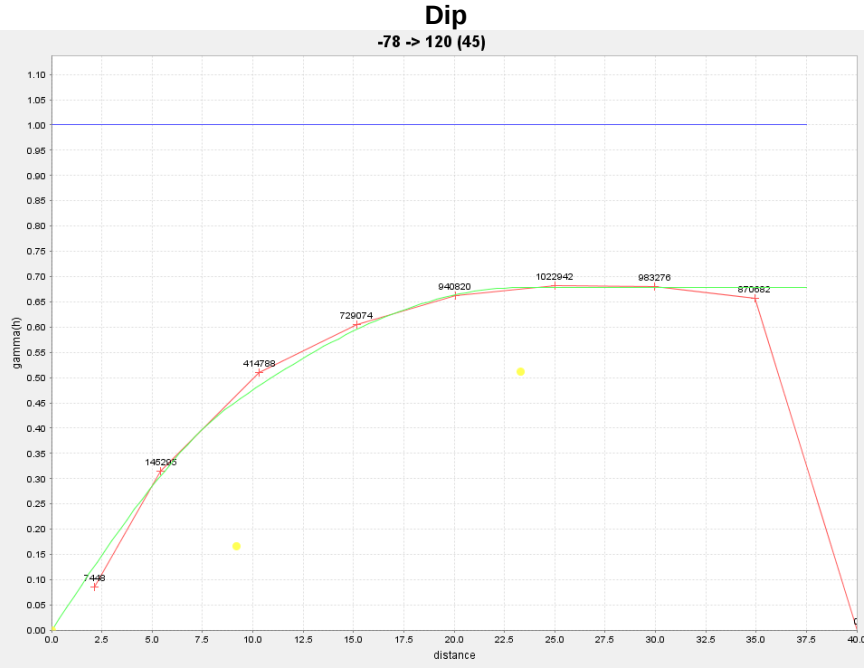

Dip
-78 -> 120 (45)
gamma(h)
distance
7446
146295
414788
729074
940820
1022942
983276
870682

Table 4-24 Deposit No. 1 Variogram Results for North Limb
Baffinland Iron Mines Corporation – Mary River Project

Parameter		Fe%	Al_2O_3%	MgO%	P%	S%	SiO_2%
	Z*	-125	-125	-125	-125	-125	-125
Rotation°	X*	-75	-75	-75	-75	-75	-75
	Z*	-115	-115	-115	155	-115	-115
Nugget	C_0	0.31	0.18	0.16	0.23	0.34	0.10
	Direction°	61-->006	61-->006	61-->006	-24-->042	61-->006	61-->006
	C_1	0.41	0.54	0.38	0.56	0.24	0.51
Vector 1	R_1 (m)	136	63	55	118	72	24
	C_2	0.28	0.28	0.47	0.21	0.42	0.38
	R_2 (m)	249	78	206	424	182	158
	Direction°	24-->222	24-->222	24-->222	61-->006	24-->222	24-->222
	C_1	0.41	0.54	0.38	0.56	0.24	0.51
Vector 2	R_1 (m)	79	40	54	106	81	19
	C_2	0.28	0.28	0.47	0.21	0.42	0.38
	R_2 (m)	165	41	139	176	137	106
	Direction°	15-->125	15-->125	15-->125	15-->125	15-->125	15-->125
	C_1	0.41	0.54	0.38	0.56	0.24	0.51
Vector 3	R_1 (m)	11	13	33	45	38	21
	C_2	0.28	0.28	0.47	0.21	0.42	0.38
	R_2 (m)	40	33	99	50	69	39

*Gems rotation about axes with respect to block model

Table 4-25 Deposit No. 1 Variogram Results For South Limb
Baffinland Iron Mines Corporation – Mary River Project

Parameter		Fe%	Al_2O_3%	MgO%	P%	S%	SiO_2%
	Z*	140	140	140	140	140	140
Rotation°	X*	75	75	75	75	75	75
	Z*	-110	-110	-110	160	60	-110
Nugget	C_0	0.30	0.15	0.16	0.29	0.34	0.10
	Direction°	-65-->095	-65-->095	-65-->095	19-->135	57-->286	-65-->095
	C_1	0.56	0.62	0.38	0.59	0.24	0.51
Vector 1	R_1 (m)	137	59	55	82	72	24
	C_2	0.15	0.22	0.47	0.12	0.42	0.38
	R_2 (m)	160	82	206	354	182	158
	Direction°	19-->135	19-->135	19-->135	65-->275	-29-->318	19-->135
	C_1	0.56	0.62	0.38	0.59	0.24	0.51
Vector 2	R_1 (m)	70	55	54	79	81	19
	C_2	0.15	0.22	0.47	0.12	0.42	0.38
	R_2 (m)	261	67	139	133	137	106
	Direction°	-15-->220	-15-->220	-15-->220	-15-->220	-15-->220	-15-->220
	C_1	0.56	0.62	0.38	0.59	0.24	0.51
Vector 3	R_1 (m)	40	13	33	34	38	21
	C_2	0.15	0.22	0.47	0.12	0.42	0.38
	R_2 (m)	48	35	99	61	69	39

*GEMS rotation about axes with respect to block model.

4.10 Estimation Methodology

The folding and variable dips dictated the partitioning of the block model into segments of similar strike and dip to permit reasonable capture of composite samples by search ellipses and to simulate stratigraphic/Fe depositional controls on the distribution of grades. For Deposit No. 1, the main north limb interpolation was constrained to the area north of Y=7914100N and within the rock code (domain) 100 solid. The northern 260 m extension of the Lower Zone strikes NS and was also partitioned and interpolated with parallel oriented ellipses.

The south limb grade interpolation was constrained to the area south of Y=7914100N and within the rock code 100 solid.

Interpolation of each rock code was restricted to using only composites contained within each corresponding domain.

Ordinary kriging (OK) was used to estimate block grades for Al2O3, Fe, MgO, P, S, SiO2 in the Deposit No. 1 Lower Zone (100) block model. Lump, FeO, Na2O, CaO, K2O, Mn, MAG, LOI, H2O and the six metallurgical test attributes and were interpolated by ID2. ID2 was also used to interpolate the Middle, Upper 1 and 2 and NE zones (domains 200, 300, 400 and 600) owing to the lower level of sampling, lack of robust variography and differences in geologic aspects (rock chemistry etc.) between these zones and the Lower Zone. All domain boundaries between the zones, i.e. 100, 200, 300, 400, and 600, were treated as hard during the interpolation. Boundaries between block model partitions were treated as soft. Interpolations were carried out in two passes for the Lower Zone domain 100 with the first pass requiring four composites minimum and a maximum of three composites per hole to ensure adequate smoothing and a minimum of one composite and maximum of 12 composites in the second pass to fill the wireframe. Domains 200 to 600 were interpolated in two passes requiring a minimum of three composites and maximum of 12 composites for the first pass and a minimum of 1 and maximum of 12 composites in the second pass to fill the wireframe. The ellipses for OK interpolation used the variogram orientations, and the Fe ellipses were also used for Lump and Al2O3, the latter because of the short ranges indicated from variography and built into the kriging profile. Ellipses for the ID2 interpolations were designed for adequate sample capture and paralleled the zones' strikes and dips.

In order for the search ellipses to follow the strike and dip changes caused by folding, the block model was partitioned into three areas for the Lower Zone (domain 100) North Limb, two areas for the South Limb; four areas for the Middle Zone (domain 200); and two areas for the Upper 1 zone (domain 300). Uniform orientations for the Upper 2 and NE zones (domains 400 and 600) required no model partitioning.

Search ellipse parameters used for Deposit No. 1 grade interpolation in are listed in Tables 4-26 and 4-27. Search ellipse parameters and model partitions for Middle, Upper and NE zones (domains 200 to 600) are listed in Table 4-28. The ellipse orientations have been converted from GEMS ZXZ and ZYZ rotation formats.

Table 4-26 Deposit No. 1 OK Search Ellipse Parameters and Model Partitions for Lower Zone
Baffinland Iron Mines Corporation – Mary River Project

					Ellipse Axis (m)			Partition Northing (m)	
Ellipse	Pass	Az°	Dip °	Rake°	Major	Semi Major	Minor	From	To
100NFEN	1	350	75	65 SE	249	165	40	7916315	7915085
100NFENL	2	350	75	65 SE	550	380	100	7916315	7915085
100NFE	1	35	75	65 SW	249	165	40	7915085	7914100
100NFEL	2	35	75	65 SW	500	330	80	7915085	7914100
100SFEL	1	310	75	70 SE	160	261	48	7914100	7913300
100SFEL	2	310	75	70 SE	420	622	96	7914100	7913300
100NMGON	1	350	75	65 SE	206	139	99	7916315	7915085
100NMGNL	2	350	75	65 SE	600	420	200	7916315	7915085
100NMGO	1	35	75	65 SW	206	139	99	7915085	7914100
100NMGL	2	35	75	65 SW	412	280	200	7915085	7914100
100SMGO	1	310	75	70 SE	206	139	99	7914100	7913300
100SMGL	2	310	75	70 SE	412	280	200	7914100	7913300
100NPN	1	350	75	25 NW	424	176	50	7916315	7915085
100NPNL	2	350	75	25 NW	550	350	100	7916315	7915085
100NP	1	35	75	25 NE	424	176	50	7915085	7914100
100NPL	2	35	75	25 NE	550	350	100	7915085	7914100
100SP	1	310	75	60 SE	354	130	61	7914100	7913300
100SPL	2	310	75	60 SE	700	270	120	7914100	7913300
100NSN	1	350	75	65 SE	182	137	69	7916315	7915085
100NSNL	2	350	75	65 SE	550	400	150	7916315	7915085
100NS	1	35	75	65 SW	182	137	69	7915085	7914100
100NSL	2	35	75	65 SW	400	300	140	7915085	7914100
100SS	1	310	75	60 SE	182	137	69	7914100	7913300
100SSL	2	310	75	60 SE	450	350	140	7914100	7913300
100NSiN	1	350	75	65 SE	158	108	39	7916315	7915085
100NSiNL	2	350	75	65 SE	500	400	150	7916315	7915085
100NSIO2	1	35	75	65 SW	158	108	39	7915085	7914100
100NSIOL	2	35	75	65 SW	450	350	100	7915085	7914100
100SSIO2	1	310	75	70 SE	158	108	39	7914100	7913300
100SSIOL	2	310	75	70 SE	550	450	150	7914100	7913300

Table 4-27 Deposit No. 1 ID2 Search Ellipse Parameters and Model Partitions for Lower Zone
Baffinland Iron Mines Corporation – Mary River Project

							Partition Northing (m)	
Ellipse	Pass	Az°	Dip °	Strike (m)	Dip (m)	Width (m)	From	To
100NIDN	1	304	63	160	261	48	7916315	7915085
100NIDN L	2	304	63	450	650	150	7916315	7915085
100NID	1	31	78	165	249	40	7915085	7914100
100NIDL	2	31	78	400	600	100	7915085	7914100
100SID	1	322	63	160	261	48	7914100	7913300
100SIDL	2	322	63	450	650	150	7914100	7913300

Table 4-28 Deposit No. 1 Search Ellipse Parameters and Model Partitions for Domains 200 to 600
Baffinland Iron Mines Corporation – Mary River Project

							Partition Easting (m)		Partition Northing (m)	
Ellipse	Pass	Az°	Dip°	Strike (m)	Dip (m)	Width (m)	From	To	From	To
200N	1	31	78	115	125	40	-	-	7916315	7914300
	2	31	78	250	275	80			7916315	7914300
200MID	1	0	78	115	125	40	-	-	7914300	7914045
	2	0	78	250	275	80	-	-	7914300	7914045
200S	1	322	63	115	125	40	562190	563505	7914045	7913300
	2	322	63	250	275	80	562190	563505	7914045	7913300
200E	1	285	40	115	125	40	563505	564455	7916315	7913300
	2	285	40	250	275	80	563505	564455	7916315	7913300
300N	1	0	78	115	125	40	-	-	7916315	7914045
	2	0	78	250	275	80			7916315	7914045
300S	1	322	63	115	125	40	-	-	7914045	7913300
	2	322	63	250	275	80			7914045	7913300
400	1	342	65	115	125	40	-	-	-	-
	2	342	65	250	275	80	-	-	-	-
600	1	60	82	115	125	40	-	-	-	-
	2	60	82	250	275	80	-	-	-	-

Table 4-29 Deposit No. 1 Search Ellipse Parameters for Blast Holes
Baffinland Iron Mines Corporation – Mary River Project

Ellipse	Pass	Az°	Dip°	Strike (m)	Dip (m)	Width (m)
BLASTHLE	1	35	78	72	72	50
BLASTHL	2	35	78	144	144	100

Table 4-30 Deposit No. 1 Search Ellipse Parameters for ID2 Interpolation of Deleterious Zones S and Mn
Baffinland Iron Mines Corporation – Mary River Project

Ellipse	Pass	Az°	Dip°	Strike (m)	Dip (m)	Width (m)
RT1300	1	50	73	125	150	15
RT1300L	2	omni		500	500	500
RT1400	1	317	56	125	150	20
RT1400L	2	omni		500	500	500

Search ellipse parameters used for grade interpolation in Deposit Nos. 2 and 3 are listed in Table 4-31. Due to the limited population of pairs of points at various distances apart available for variography, the search distances used for Deposit Nos. 2 and 3 were based on data capture to ensure adequate smoothing between holes. ID2 was used to interpolate grades.

Interpolations for Deposit Nos. 2 and 3 were carried out in two passes with Pass 1 requiring a minimum of four composites, a maximum of three per hole and up to 12 composites. Pass 2 required a minimum of one composite, maximum of 12 and used a larger ellipse to ensure the solid was completely populated by grades. For Deposit No. 3 the block model was partitioned into three areas each with common azimuth and dip of the iron formation. Search ellipse parameters and model partitions are listed in Table 4-31. Ellipse orientations in GEMS were set in GEMS ZYZ format with respect to the block model and have been converted to azimuth and dip for reporting. Table 4-31 indicates that the dip of Deposit No. 3 at its western extent is sub-vertical while the eastern extent develops a significantly flatter dip.

Table 4-31 Deposit Nos. 2 and 3 Search Ellipse Parameters
Baffinland Iron Mines Corporation – Mary River Project

Ellipse	Pass	Az°	Dip°	Strike (m)	Dip (m)	Width (m)	Partition Easting (m) From	Partition Easting (m) To
D2-1	1	76	79	150	200	30	-	-
D2-2	2	76	81	300	425	50	-	-
D3West	1	93	90	500	600	50	565,000	567380
D3WestL	2	93	90	900	1000	200	565000	567380
D3West1	1	81	80	500	600	50	567380	567905
D3West2	2	81	80	900	1000	200	567380	567905
D3-E1	1	63	77	500	600	50	567905	570505
D3-E2	2	63	77	600	700	100	567905	570505

4.11 Mineral Resource Classification

Definitions for resource categories used in this report are consistent with those defined by CIM (2014) and adopted by NI 43-101. In the CIM classification, a Mineral Resource is defined as “a concentration or occurrence of solid material of economic interest in or on the Earth’s crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction”. Mineral Resources are classified into Measured, Indicated, and Inferred categories.

Mineral resources for both block models were classified by RPA according to the following criteria:

Deposit No. 1:

- Measured Mineral Resources: block informed by a minimum of three samples, within an interpreted mineralized solid, and within 45 m of the nearest informing sample.
- Indicated Mineral Resources: block informed by a minimum of three samples, within an interpreted mineralized solid and greater than 45 m and less than 120 m of the nearest informing sample.
- Inferred Mineral Resources: block informed by a minimum of one sample and constrained within the interpreted mineralized solid and greater than 120 m of the nearest informing sample.

Resource classification is based on the confidence in the estimation for iron only. Assaying for iron is complete whereas assay data is lacking to varying degrees for the other attributes

and high coefficients of variation for assays for some of the attributes indicates that more detailed geologic interpretation and sub-domaining may be necessary to improve confidence in their estimation.

Application of the above classification criteria is derived from variography and results in localized “bullseyes” and irregular spatial distribution of resource classes owing to variability of the drill hole spacing. RPA modified this classification by smoothing the outlines of the Measured and Indicated blocks into more continuous and coherent shapes and reclassifying isolated blocks within areas dominated by other resource categories. This was done by developing solids to define volumes designated as Measured and Indicated Mineral Resources, with the remaining blocks designated as Inferred Mineral Resources. The results were not materially different from previous classifications by RPA (2013) and Wahl and Gharapetian (2011).

Deposit Nos. 2 and 3:

- Indicated Mineral Resources: block informed by a minimum of three samples, within an interpreted mineralized solid and equal to or less than 120 m from the nearest informing sample.

- Inferred Mineral Resources: block informed by a minimum of one sample within an interpreted mineralized solid and greater than 120 m from the nearest informing sample.

Deposit No. 2 is classified into Indicated and Inferred Mineral Resources. Deposit No. 3 resources are all classified as Inferred Mineral Resource.

4.12 Validation of Block Models

The block models were validated by on-screen review of block grades and drill hole composites, volumetric comparison of resource solids and resource reports, comparison of results of estimates by solid models and percent models and comparison of block grades to composites average grades on a global basis (Table 4-32). The global results for the different interpolation methods OK/ID2 versus nearest neighbour for Fe were also reviewed and served to validate the estimate of Fe grades in the block models.

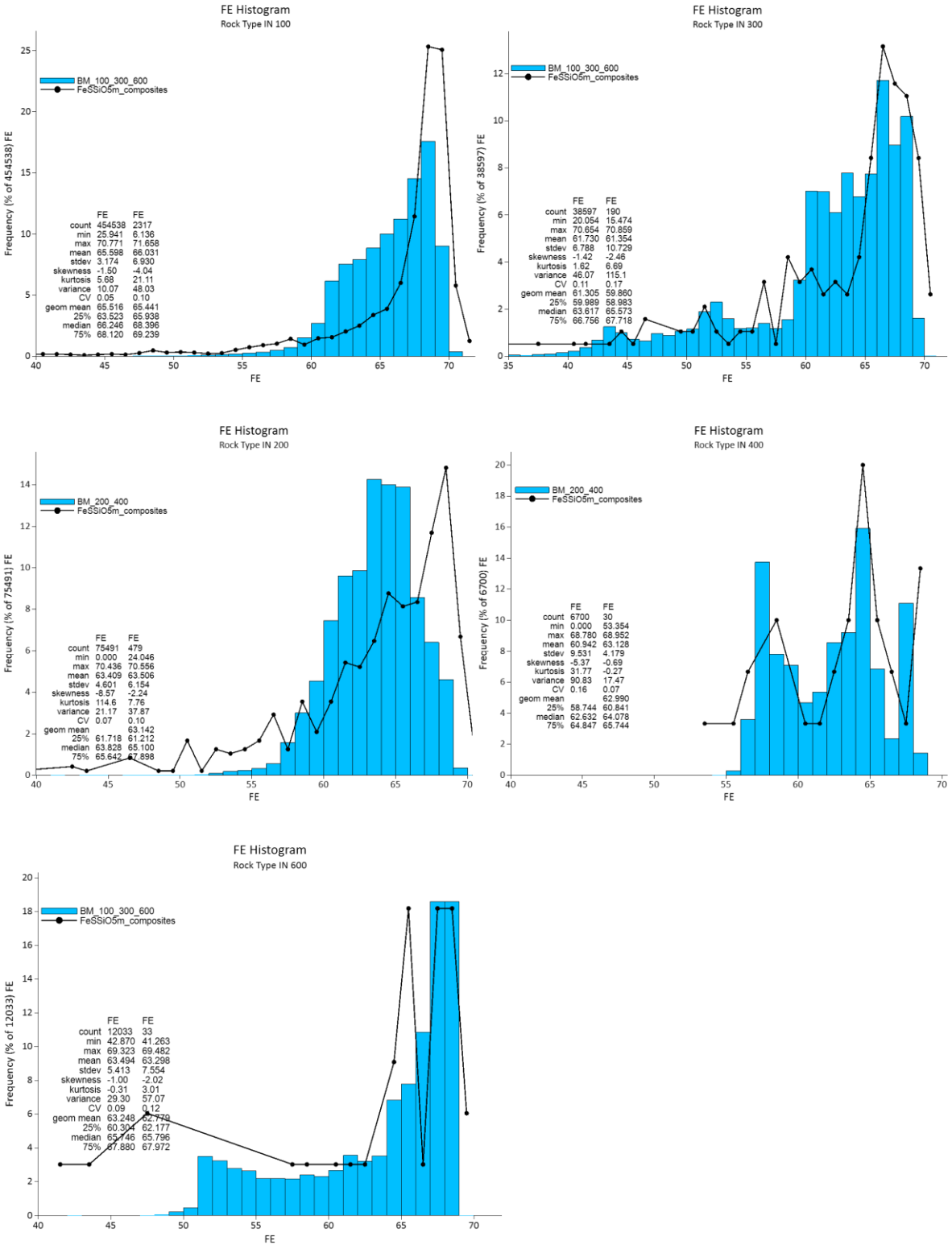
For Deposit No. 1, the local block grade estimates were validated graphically by comparing block grades by grade distribution (Figures 4-5 to 4-10).

Table 4-32 Comparison of Means Blocks vs Composites
Baffinland Iron Mines Corporation – Mary River Project

	100		200		300		400		600	
Attribute	**Model**	**Comps**	**Model**	**Comps**	**Model**	**Comps**	**Model**	**Comps**	**Model**	**Comps**
Al_2O_3%	1.237	1.390	1.098	1.210	1.251	1.370	0.796	0.770	0.390	0.450
CaO%	0.341	0.181	0.374	0.300	0.477	0.440	0.357	0.350	1.120	1.070
Fe%	65.598	66.030	63.409	63.510	61.730	61.350	62.233	63.130	63.494	63.300
FeO%	17.022	14.110	17.905	13.240	13.592	10.980	9.734	7.190	23.339	21.980
H_2O%	0.451	0.525	0.658	0.823	0.748	0.878	0.556	0.550	0.267	0.315
K_2O%	0.023	0.030	0.010	0.010	0.012	0.010	0.009	0.008	0.013	0.010
LOI Transformed	100.318	100.450	99.606	100.060	100.329	100.670	100.388	100.650	100.592	100.760
LOI	0.318	0.450	-0.394	0.060	0.329	0.670	0.388	0.650	0.592	0.760
LUMP	0.853	0.857	0.786	0.800	0.791	0.780	0.833	0.820	0.837	0.840
MAG%	54.868	45.520	57.710	42.670	43.814	35.380	31.369	23.180	75.214	70.850
MgO%	1.040	1.000	1.693	1.000	2.346	2.000	2.502	2.000	1.938	2.000
Mn%	0.260	0.175	0.117	0.110	0.082	0.090	0.035	0.040	0.305	0.270
Na_2O%	0.008	0.010	0.007	0.010	0.009	0.010	0.006	0.010	0.006	0.010
P%	0.033	0.030	0.049	0.060	0.080	0.080	0.085	0.080	0.014	0.020
S%	0.383	0.197	0.186	0.133	0.134	0.120	0.094	0.060	0.333	0.290
SiO_2%	2.443	2.290	5.632	5.450	6.338	6.310	6.930	5.770	4.811	5.010
Apparent density	4.602	4.590	4.247	4.190	3.999	4.050	3.937	3.940	4.386	4.350
Moisture %	0.810	0.700	0.881	1.060	1.347	1.420	1.283	1.450	0.372	0.410
Reduction Index	35.741	38.520	38.361	40.910	48.159	48.440	43.763	51.750	37.843	38.600
Reduction Under Load	0.800	0.860	0.844	0.880	1.049	1.030	1.013	1.030	0.865	0.890
Tumble Abrasive	14.106	13.210	23.508	21.260	29.028	25.920	39.150	37.120	31.773	32.260
Tumble Strength	76.666	77.520	65.306	68.200	61.539	64.140	49.383	51.430	58.953	57.710
Fe%NN	64.860	66.030	64.132	63.510	61.908	61.350	61.779	63.130	64.137	63.300

	Deposit 2 & 3 Domain				Deposit No.1 Domain			
	2000		3000		1300		1400	
Attribute	**Model**	**Comps**	**Model**	**Comps**	**Model**	**Comps**	**Model**	**Comps**
Al_2O_3%	0.849	0.704	1.288	1.449				
CaO%	0.073	0.056	0.466	0.494				
Fe%	63.682	64.597	65.978	65.01				
FeO%	3.084	2.307	4.556	5.836				
H_2O%	0.158	0.242	0.077	0.092				
K_2O%	0.047	0.051	0.081	0.095				
LOI	100.370	100.389	101.139	101.22				
LUMP	0.849	0.835	0.844	0.838				
MAG%	9.963	7.96	14.454	18.621				
MgO%	0.472	0.387	1.233	1.473				
Mn%	0.019	0.021	0.102	0.123	1.24	1.409	0.74	0.804
Na_2O%	0.009	0.011	0.034	0.036				
P%	0.025	0.017	0.038	0.044				
S%	0.024	0.02	0.029	0.054	1.14	1.119	1.19	1.311
SiO_2%	7.567	6.263	2.210	2.891				
Fe%NN	63.986	64.597	67.335	65.01				

Figure 4-4 Grade Distribution in Blocks and Composites Deposit No. 1



Swath plots were generated for Fe grades in composites and OK or ID2 and Fe nearest neighbour (NN) interpolations. Swath plots for Fe in the Deposit No. 1 Lower (100) and Middle Zones (200) by easting (X), northing (Y) and elevation (Z) and are depicted in Figures 4-5 to 4-10.

Figure 4-5 Deposit No. 1 Lower Zone Swath Plot Fe% for X

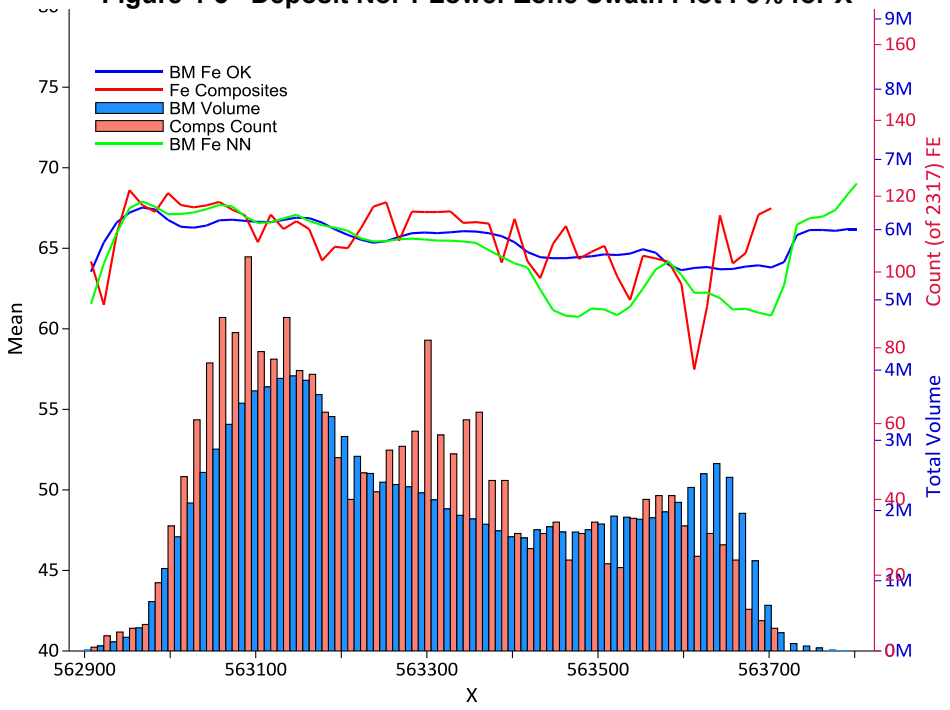


Figure 4-6 Deposit No. 1 Lower Zone Swath Plot Fe% for Y

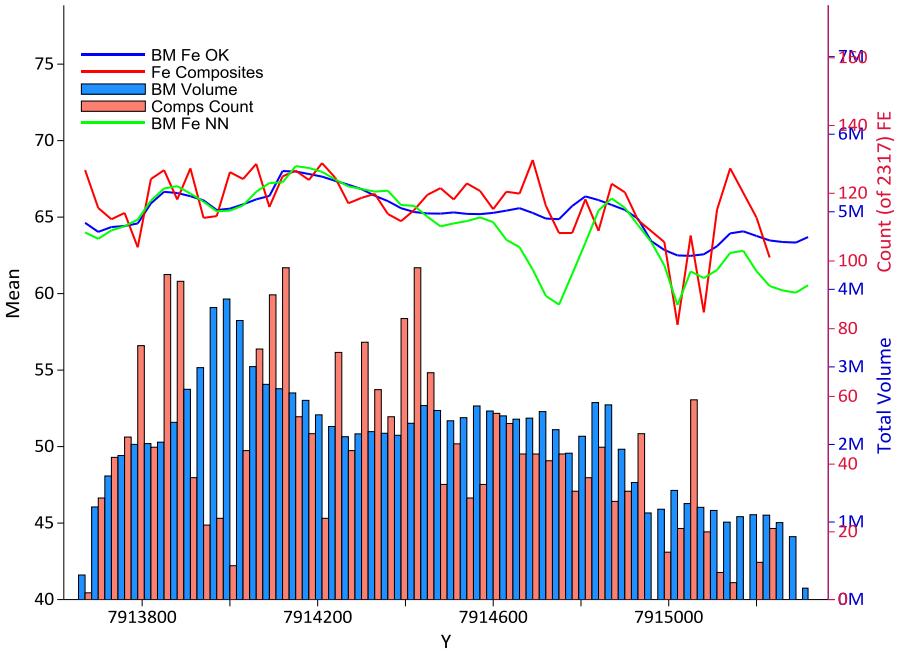


Figure 4-7 Deposit No. 1 Lower Zone Swath Plot Fe% for Z

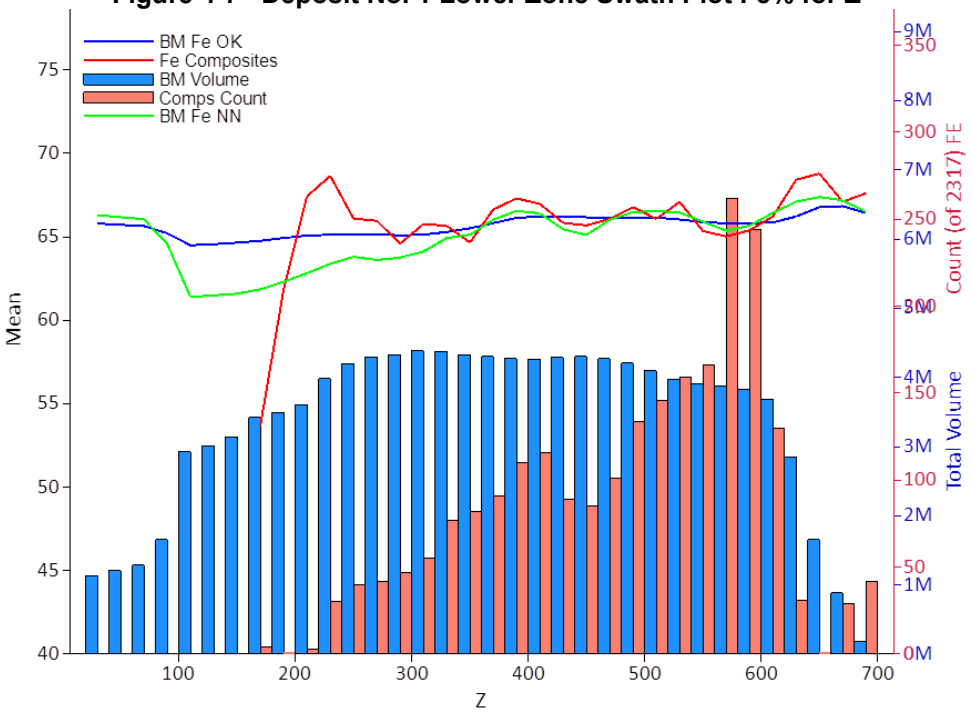


Figure 4-8 Deposit No. 1 Middle Zone Swath Plot Fe% for X

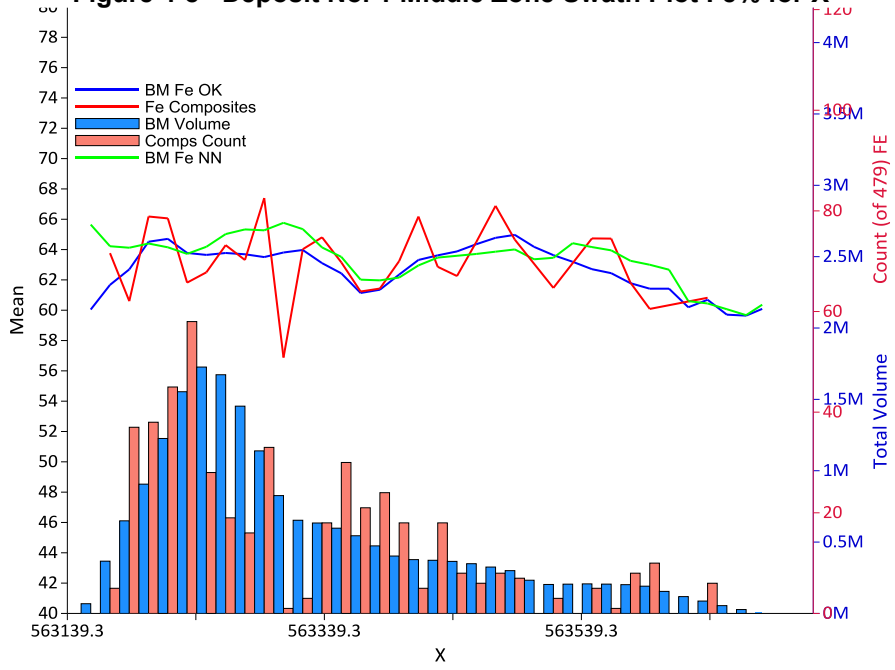


Figure 4-9 Deposit No. 1 Middle Zone Swath Plot Fe% for Y

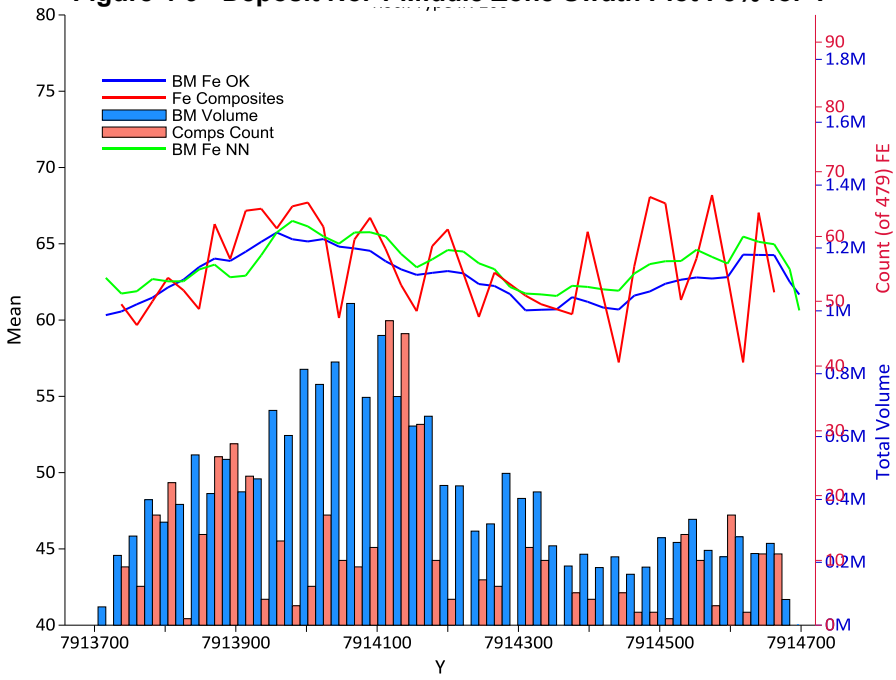
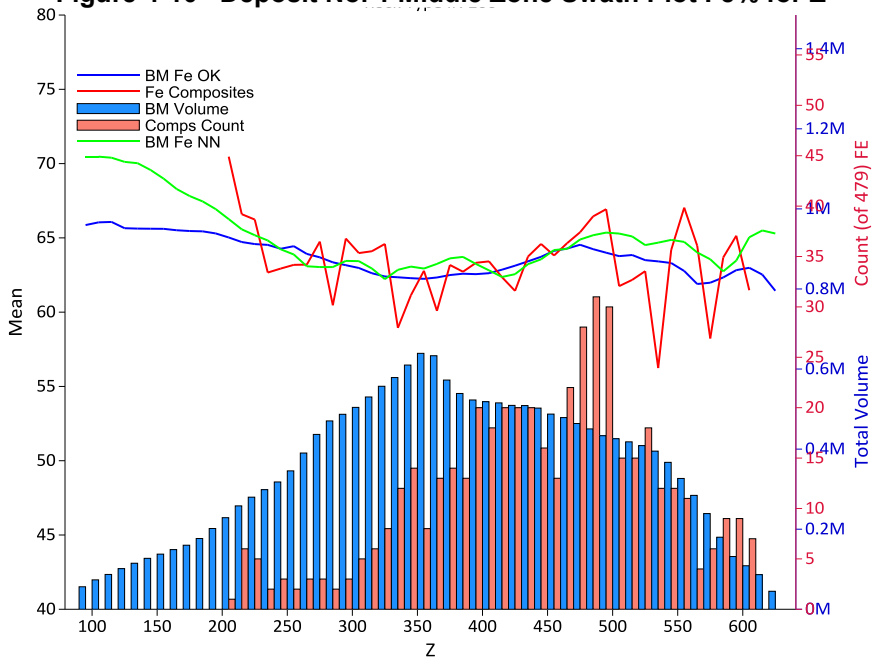


Figure 4-10 Deposit No. 1 Middle Zone Swath Plot Fe% for Z



4.13 Mineral Resource Reporting

In order to fulfill the Mineral Resource requirement for reasonable prospects for economic extraction, RPA has developed preliminary Whittle open pit optimizations for Deposit Nos. 1, 2, and 3 using all categories of Mineral Resource. This preliminary pit exercise is only to determine which blocks in the block models can be reasonably classified as Mineral Resources, and does not define Mineral Reserves, which is the subject of Section 15 Mineral Reserve Estimate. Parameters used for the preliminary Whittle pit optimization were applied using diluted block grades and a whole block approach for the 5 m by 5 m by 10 m block size (Table 4-33). For this estimate, costs were assumed for anoperation at 12 Mtpa.

Metal prices used for reserves are based on consensus with BIM, long term forecasts from banks, financial institutions, and other sources. For resources, the metal prices that RPA uses may be slightly higher than those for reserves, however, wherein a portion of the resources have been converted to reserves that are actively being mined, the prices for resources and reserves are the same.

Table 4-33 Pit Optimization Inputs - Resources

Baffinland Iron Mines – Mary River Project

Parameter	Units	Value	Source
Resource Classification	Categorical	1,2,3 (M+I+Inf)	Assigned in block model
Base Iron Price	US$/dmt	70	Based on forecasts for 62% North China fines
Whittle Price Input	US¢/dmtu	106	Based on 2013 price calculation (see Appendix 1)
Exchange Rate	C$/US$	1.28	Hatch Dec 2016 Study
Mining Extraction	%	100%	No modifying factors for resources
Process Recovery	%	99%	Allowance for ore loss during transport to port
Production Rate	Mtpa	12	Hatch Dec 2016 Study
Operating Costs			
Mining (Ore)	C$/t	5.01	Hatch Dec 2016 Study
Mining (Waste)	C$/t	5.01	Hatch Dec 2016 Study
Processing	C$/t	26.82	Hatch Dec 2016 Study
Cut-Off Grade	% Fe	55	Elevated, consistent with previous resource estimates
Pit Slopes (Azimuth)			
40 – 82	Degrees	37	Hatch Dec 2016 Study
82 – 177	Degrees	45	Hatch Dec 2016 Study
177 – 224	Degrees	42	Hatch Dec 2016 Study
224 – 260	Degrees	37	Hatch Dec 2016 Study
260 – 343	Degrees	42	Hatch Dec 2016 Study
343 – 40	Degrees	45	Hatch Dec 2016 Study

The reported in-pit resources are reported from the resource percent block model (Standard Folder) using the above described Whittle pit design and the merged Deposit No. 1 EOY2016 pit floor and topographic/overburden contact surface. The effective date of the Mineral Resource estimate for Deposit Nos. 1, 2, and 3 is EOY2016, December 21, 2016 (Table 4-34).

RPA is not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that could materially affect the Mineral Resource estimate.

Table 4-34 Summary of Mineral Resources – December 31, 2016

Baffinland Iron Mines Corporation – Mary River Project

Category	Tonnes (Mdmt)	Tonnes (Mwmt)	Fe %	P %	S %	Mn %	SiO_2 %	Al_2O_3 %
Deposit No. 1								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	117	118	65.3	0.038	0.36	0.22	3.1	1.0
M+I	426	429	65.7	0.031	0.28	0.21	2.8	1.2
Inferred	73	74	65.5	0.036	0.50	0.28	2.5	0.9
Deposit No. 2								
Indicated	23	23	67.1	0.014	0.01	0.02	3.3	0.5
Inferred	14	15	65.3	0.027	0.01	0.02	4.7	1.1
Deposit No. 3								
Inferred	252	254	66.2	0.035	0.02	0.09	1.9	1.1
Totals Deposit Nos. 1, 2, and 3								
Measured	309	311	65.9	0.028	0.25	0.21	2.6	1.2
Indicated	140	141	65.6	0.034	0.30	0.19	3.1	0.9
M+I	449	452	65.8	0.030	0.27	0.20	2.8	1.1
Inferred	339	342	66.0	0.035	0.12	0.13	2.2	1.1

Notes:
1. CIM Definition Standards are followed for Mineral Resources.
2. Mineral Resources are estimated at a cut-off grade of 55% Fe for Deposits No. 1 and 2, and 62% Fe for Deposit No. 2.
3. Mineral Resources are estimated using a long-term iron ore price of $70/t Fe, and a US$/C$ exchange rate of 1.28 C$/US$.
4. Bulk density is based on a formula relating bulk density to iron content.
5. Mineral Resources are reported in dry and wet tonnes, and dry grades. In situ moisture is estimated to be 0.7%.
6. Mineral Resources are inclusive of Mineral Reserves.
7. Numbers may not add due to rounding.

The block model contains 22 attributes. Some are more reliable than others largely dependent on the support data. Table 4-35 provides comments on the reliability of each attribute.

Table 4-35 Comments on the Reliability of Support Data for Block Model Attributes
Baffinland Iron Mines – Mary River Project

Attribute	Note 1	Note 2
CLASS	Assigned by RPA based on dh spacing & interpolation pass; modified for shape irregularities	Resource table
Density	Assigned based on Fe grade; waste density at 2.82 t/m3; overburden at 2.0 t/m3	Resource table
Al2O3	Based on regular 'assay' data; ~7383 records for D1 Data incomplete for S series DH	Resource table
FE	Based on regular 'assay' data; ~7383 records for D1; Data incomplete for D2&3	Resource table
LUMP	Based on regular 'assay' data; ~7383 records for D1 Data incomplete for S series DH and D2&3	
MGO		
P		Resource table
S	Based on regular 'assay' data; ~7383 records for D1	Resource table
SIO2		Resource table
Moisture	Based on met. Tests. Limited data. ~355 records for D1	Test core sample lengths range from 7.6 m to 191.2 m which are difficult to spatially regularize for interpolation. Results are approximations only, reliability will decrease with distance from nearest drill hole. Limited data for D1 Middle and Upper zones: no data for D2 & 3
Apparent Density		
Reduction Index		
Reduction under load		
Tumble Abrasion		
Tumble Strength		
FEO		

H2O	Based on regular 'assay' data; ~7383 records for D1 Data incomplete for S series DH and D2&3	
K2O		
LOI		
MAG		
MN		Resource table
NA2O		
Reduction Disintegration	Not estimated	
Size Fraction (%>10mm)	Not estimated	
Size Fraction (%>6.3mm)	Not estimated	

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 5 – Mining

May 2/17	A	DRAFT	JC	JC	JC	
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Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
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5. Mining

Mine production is based on the RPA December 31, 2016 resource model, reported within a December 2016 pit design by Hatch. The design consists of five phases, and is based on mining 12 Mtpa direct-shipping ore, to be transported by rail to port.

5.1 Mineral Reserves

Mineral Reserves have been estimated for Deposit No. 1, based on Measured and Indicated Resources within the pit design. Inferred Resources within the pit design are minimal, and have been treated as waste. A cut-off grade of 55% Fe was used to achieve a target head grade of >65% Fe.

Table 5-1 Summary of Mineral Reserves – December 31, 2016

Baffinland Iron Mines Corporation – Mary River Project

Category	Tonnes (Mdmt)	Tonnes (Mwmt)	Fe %	P %	S %	Mn %	SiO_2 %	Al_2O_3 %
Proven & Probable	292	298	66.0	0.027	0.18	0.2	2.6	1.2

Notes:
1. CIM Definition Standards are followed for Mineral Reserves.
2. Mineral Resources are estimated at a cut-off grade of 55% Fe.
3. Mineral Resources are estimated using a long-term iron ore price of $60/t Fe, and a US$/C$ exchange rate of 1.28 C$/US$.
4. Bulk density is based on a formula relating bulk density to iron content.
5. Mineral Reserves are reported in dry and wet tonnes, and dry grades. Moisture content is estimated to be 2%, reflecting additions during processing and transport.
6. Numbers may not add due to rounding.

Mineral Reserves have not been estimated for Deposit Nos. 2 and 3.

5.1.1 Dilution & Extraction

Dilution and extraction (mining loss) are addressed by an algorithm in the block model that assesses the percentage of each 10 m x 10 m x 5 m block within the resource wireframe. Only blocks that are 85% or higher are considered for conversion to Mineral Reserves. Those blocks are diluted by the portion outside the model, at grades based on drill hole assays (approximately 32% Fe). The diluted blocks are assessed against the cut-off grade of 55% Fe, and included or excluded on that basis.

This process has the effect of applying mining losses at the edges, and adding small amounts of dilution to the Mineral Reserves.

5.2 Mining Methods

This study describes an expansion from current operations, at nominally 5 Mtpa, to 12 Mtpa. Mining is by conventional truck and shovel open pit methods.

5.2.1 Current Operations

Current operations at the Mary River Project, referred to as the "Early Revenue Phase" in previous studies, is permitted to mine and ship up to 4.2 Mtpa lump and fine iron ore through the port at Milne Inlet. The permit allows for unused capacity (i.e., in 2015 and 2016) to be carried forward. Mining is carried out using a Baffinland workforce. Existing facilities consist of:

- An open pit mine with associated haul roads at Deposit No. 1
- A waste rock dump
- A mobile mining equipment fleet based on 90 t haul trucks
- Mobile crushing and screening equipment
- A 120 t ore haul truck fleet for transportation of ore to Milne Port
- Stockpile locations at the port, equipped with stacking and reclaim equipment, of nominally 4 Mt capacity
- Maintenance shops
- Warehousing
- Accommodation facilities and utility systems
- Power generation facilities and fuel tank farm
- Airstrip

5.2.2 Mine Expansion

Expansion to 12 Mtpa ore mining rate will be achieved using a new fleet of larger equipment:

- 220 T haul trucks
- 570 T hydraulic shovels

The new fleet is scheduled to arrive on sealift in Q3 2019, for commissioning and deployment. As production ramps up with the new equipment, the current fleet will be retired.

5.3 Mine Design

Mineral Reserves are based on an updated resource block model, reported within a design by Hatch that was carried out on the previous resource block model, and the December 31, 2016 pit topography. RPA reviewed the changes within the pit volume, and investigated potential for new pits via pit optimization.

The Hatch pit design was found to be reasonable for use in reporting of Mineral Reserves – pit optimizations on the new model result in larger pits.

5.3.1 Geotechnical Parameters

Pit wall slopes are based on previous analyses, and are summarized in Table 5-2:

Table 5-2 Pit Slope Summary
Baffinland Iron Mines Corporation – Mary River Project

Azimuth	Min. Bench Width (m)	Bench Face Angle (degrees)	Inter-Ramp Slope Angle (degrees)
0-40	13.0	70	45
40-79	12.6	60	40
79-177	13.0	70	45
177-224	11.0	60	42
224-256	12.6	60	40
256-343	11.0	60	42
343-360	13.0	70	45

5.3.2 Pit Design Parameters

Pit design parameters were selected based on the overall pit geometry, geotechnical data and information, and the mine production rate. Hatch applied the following parameters:

- Bench Height: 20 m (double-benched)
- Ramp Width: 31.9 m (dual-lane traffic)
- Ramp Grade: 10%
- Minimum bench width: 60 m (phases) or 30 m (ultimate pit)

5.3.3 Pit Phasing

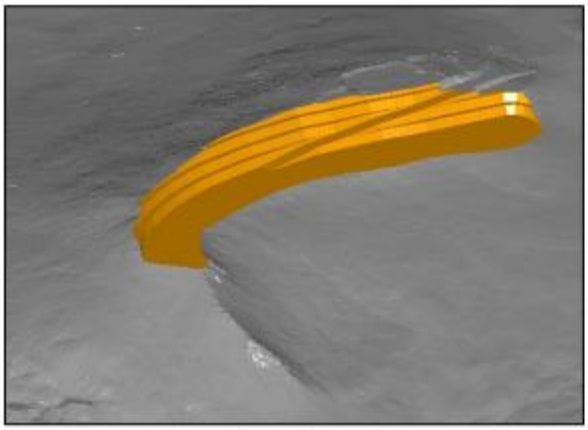
The pit was designed in five phases, summarized in Table 5-3:

Table 5-3 Pit Phase Summary
Baffinland Iron Mines Corporation – Mary River Project

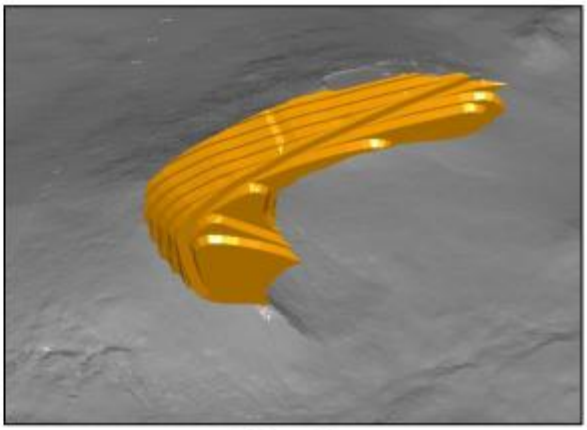
Phase	Ore (Mt)	Fe (%)	Waste (Mt)	Strip Ratio	Total Mined (Mt)
1	17.4	66.6	3.8	0.22	21.2
2	38.8	67.1	15.3	0.40	54.1
3	96.9	66.0	86.7	0.90	183.4
4	63.2	65.7	150.8	2.39	213.9
5	76.1	65.4	93.0	1.22	169.1
Total	**292.1**	**66.0**	**349.6**	**1.20**	**641.7**

Isometric, plan, and section views of the pit phases are shown in Figures 5-1 to 5-3:

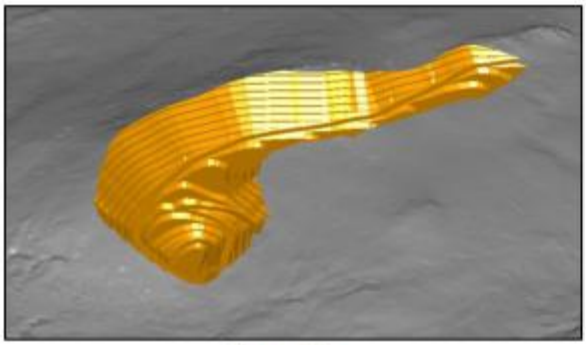
Figure 5-1 Pit Phase Designs – Isometric View



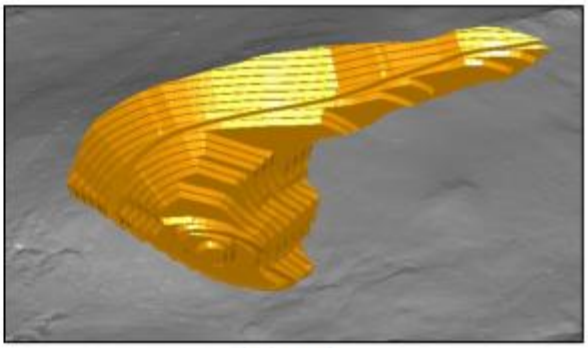
Stage 1



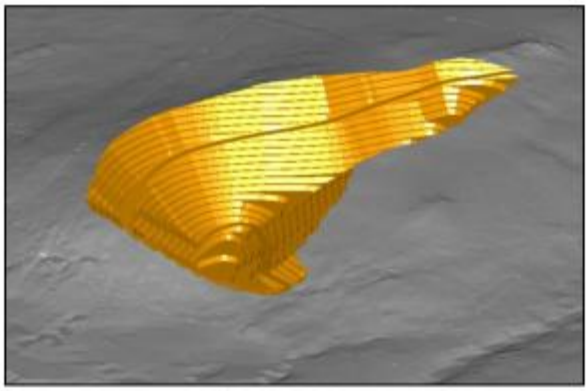
Stage 2



Stage 3



Stage 4



Ultimate Pit

Figure 5-2 Pit Phase Designs – Plan View

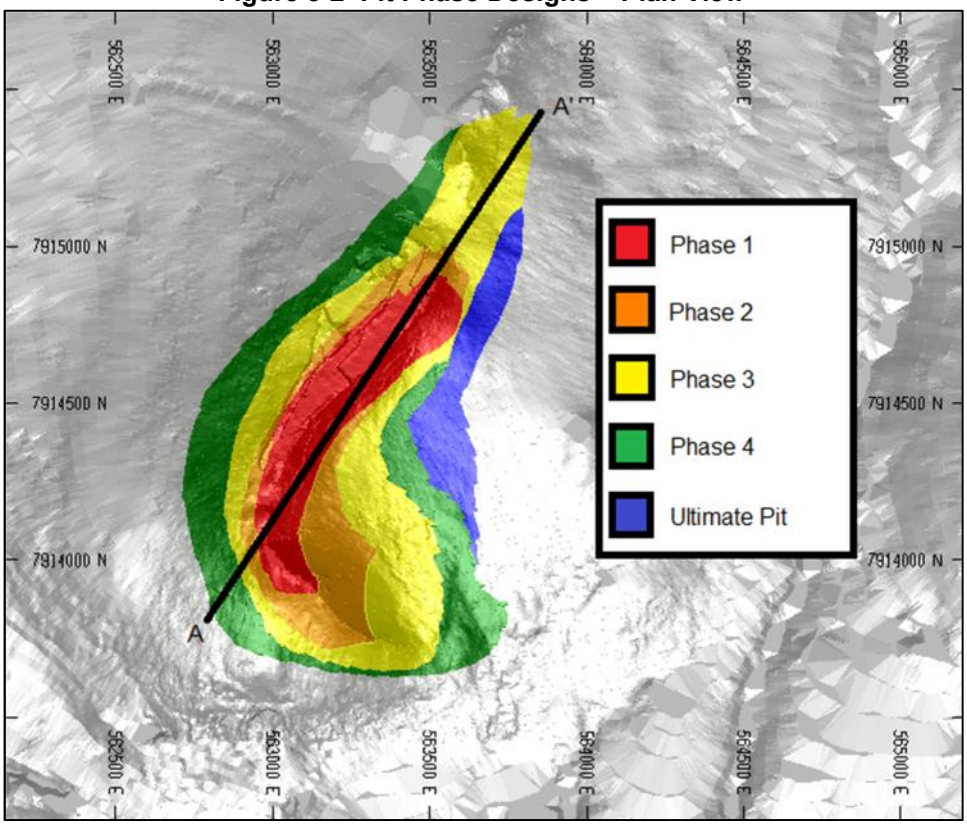
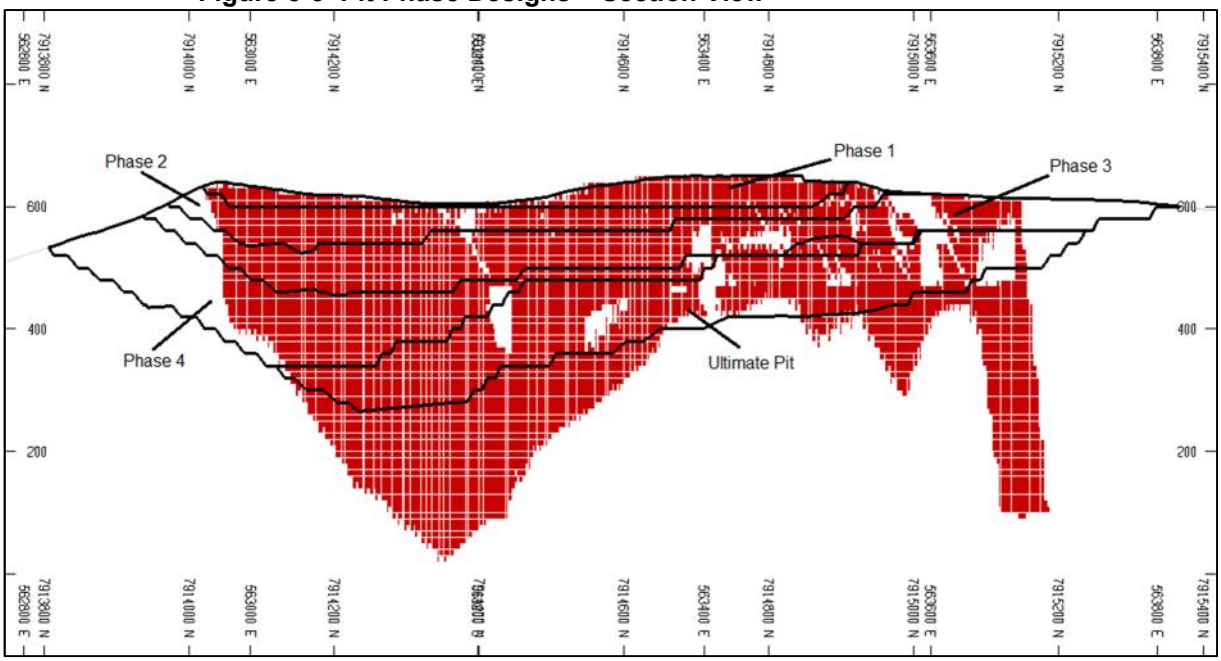


Figure 5-3 Pit Phase Designs – Section View



5.4 Production Schedule

The mine production schedule was prepared for a 12.0 Mtpa mining rate for a direct shipping iron ore product, consisting of 75% lump and 25% fines.

Open pit mining is carried out on two 12-hour shifts per day, seven days per week. Total annual effective working days is budgeted at 330, including an allowance of five weeks (35 days) of bad weather delay during the year.

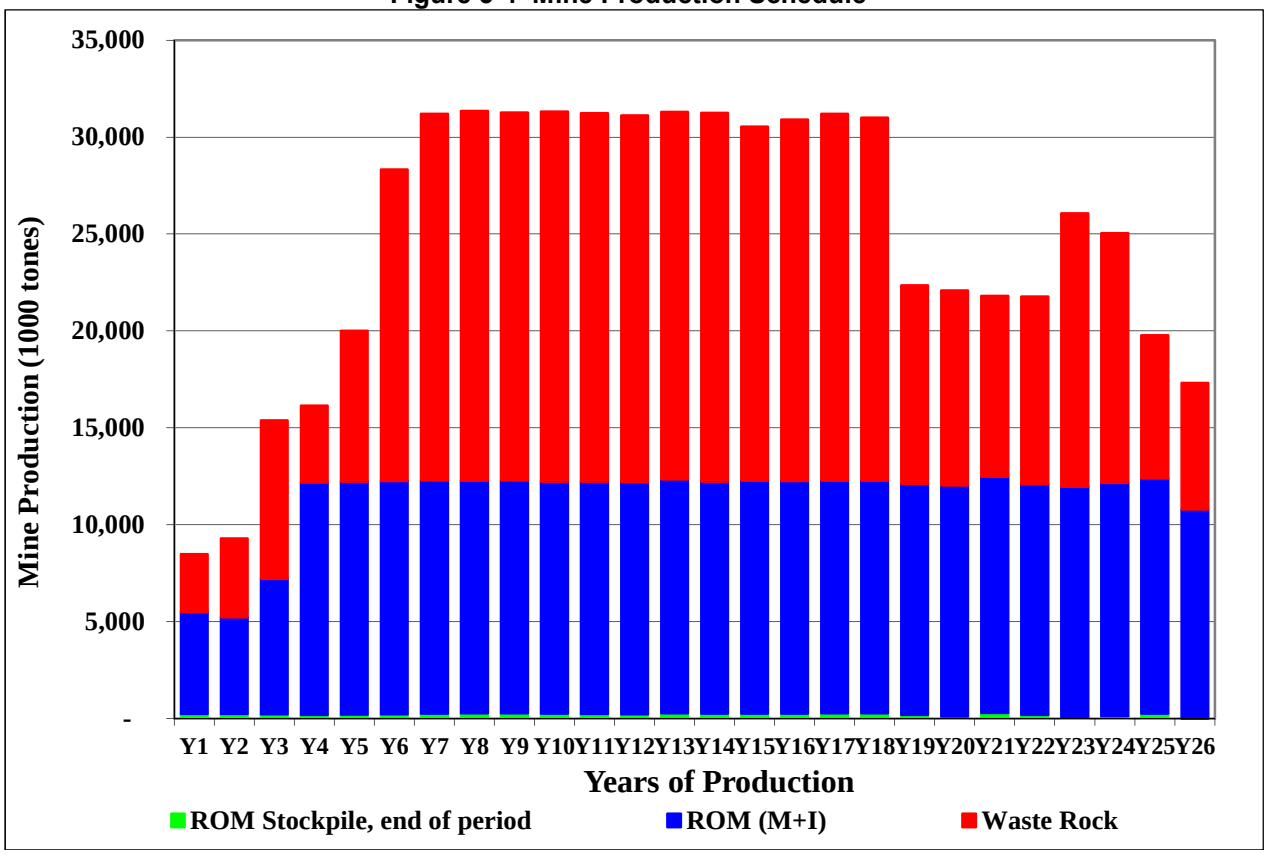
The production schedule starts on January 1, 2017, with continuation of current operations, and covers a ramp-up to 12 Mtpa starting in 2019, as ore handling infrastructure (rail and port facilities) is completed.

The production schedule is summarized in Table 5-4 and Figure 5-4:

Table 5-4 Mine Production Schedule
Baffinland Iron Mines Corporation – Mary River Project

Year	Ore (Mt)	Fe (%)	Waste (Mt)	Strip Ratio	Total Mined (Mt)
2017	5.2	66.5	3.0	0.57	8.2
2018	5.0	66.4	4.0	0.81	9.0
2019	7.0	66.6	8.2	1.17	15.2
2020	12.0	66.6	4.0	0.33	15.9
2021	12.0	66.9	7.8	0.65	19.8
2022	12.0	66.8	16.1	1.34	28.1
2023	12.0	66.3	18.9	1.57	30.9
2024	12.0	65.2	19.1	1.59	31.1
2025	12.0	65.7	19.0	1.58	31.0
2026	12.0	66.4	19.1	1.59	31.0
2027	12.0	66.9	19.0	1.58	31.0
2028	12.0	66.6	18.9	1.58	30.9
2029	12.1	66.3	18.9	1.57	31.0
2030	12.0	65.7	19.0	1.59	31.0
2031	12.0	65.6	18.3	1.52	30.3
2032	12.0	66.2	18.6	1.55	30.6
2033	12.0	66.1	18.9	1.58	30.9
2034	12.0	65.5	18.7	1.56	30.7
2035	11.9	65.0	10.2	0.86	22.2
2036	11.9	64.9	10.0	0.84	22.0
2037	12.2	65.3	9.3	0.77	21.5
2038	11.9	65.3	9.7	0.81	21.6
2039	11.9	65.0	14.1	1.18	26.0
2040	12.0	65.3	12.9	1.07	24.9
2041	12.1	66.1	7.4	0.61	19.5
2042	10.8	66.5	6.5	0.60	17.3
Total	**292.1**	**66.0**	**349.6**	**1.20**	**641.7**

Figure 5-4 Mine Production Schedule



5.5 Waste Dump Design

The following is taken from Hatch (2016):

The proposed waste dump is located northwest of the pit, which also delineates the crest of the constrained resources pit shell. Waste and noneconomic mineralized rock should be categorized into potentially acid-generating (PAG) rock and clean waste. As detailed studies and investigations into the possible occurrence and/or volume of PAG waste rock within the mining limit are ongoing, no waste quantities per category were estimated.

The following criteria were used for the dump design and incorporate recommendations from previous studies:

- Setback distance of 100 m from pit crest
- 2H:1V overall effective slopes
- 1.5H:1V individual bench slopes
- 15 m berms between benches
- 30 m final bench face height

- 150 m segments (5 benches)

Assuming the occurrence of PAG waste rock, the following management criteria will be applied:

- Minimum 50 m thickness of non-PAG placed between overburden and final waste rock dump face
- Minimum 50 m thickness of non-PAG placed between PAG and final waste rock dump face
- Minimum 20 m thickness of non-PAG placed below PAG
- Minimum 10 m thickness of non-PAG placed as a cap above PAG

The waste dump capacity is estimated to be 158 Mm^3 by using a swell factor of 25% for all rock types. As directed by the client, it was assumed that 15% of the waste mined and dedicated for waste deposition will be designated as PAG material. This factor was implemented due to the lack of waste characterization modeling which in turn is due to the lack of waste characterization data.

5.6 Mine Equipment

The mine equipment fleet for the expanded open pit operation is summarized in Table 5-5. Fleet sizing was based on the 220 t haulage truck as the primary hauling unit and is at peak equipment requirements. The estimation of drilling, loading, and hauling requirements were carried out based on the LOM production schedule and the existing and projected haul distances to waste dump and crusher. Ancillary equipment was selected for road maintenance, snow clearing, equipment maintenance, secondary mining activities, and other related earthworks.

Table 5-5 Mine Equipment Summary
Baffinland Iron Mines Corporation – Mary River Project

Equipment Type	Quantity
Haulage Truck 220 t	10
Hydraulic Shovel 570 t	2
Front End Loader 32 t	1
Rotary Drill	7
Tracked Dozer 450 kW	3
Wheel Dozer 370 kW	1
Ancillary Drill	5
Grader	1
Water/Sander Truck	2
Tow Haul Tractor/Gooseneck/Lowbed	1
Fuel/Lube Truck	2
Stemming Loader	1

5.7 Mine Infrastructure

The following is taken from Hatch 2016.

5.7.1 Material Handling

The mineralized material and waste will be hauled out of the pit with the off-highway equipment fleets listed previously. The material deemed as waste rock will be transported to the waste dump, located northwest of the open pit. The ROM will be delivered nearby the primary crusher. Crushing and screening will be performed prior to stockpiling and then railing to Milne Inlet port.

5.7.2 Dewatering

A pumping network will be installed to pump water run-off from the open pit. Pumped water will be directed through a water treatment system comprising settling/polishing ponds prior to its release into the environment.

5.7.3 Explosives

Detonators and explosives are stored and prepared in approved explosives magazines and plant. They are located at a safe distance from the mining operations, and managed by a specialized supplier/contractor.

Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 6 – Process Definition

2017-05-01	0	Approved for Use	N. Mason	M. Dionne	S. Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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6. Process Definition

Ore handling systems are required to crush, screen and stockpile the mined ore as two products, lump and fines, and to reclaim the stockpiled ore for feed to the ship loading systems. The system will be designed to maximise the ratio of lump produced and ensure products comply with BIM product specifications.

The ore handling system proposed for the 12 Mtpa expansion is shown in Figure 6-1 and includes:

- Primary crushing and train loading at the Mine Site.
- Secondary crushing and product screening at the Port Site.
- Stockpiling of fines in the existing stockpile area for Ship Loader #1; reclaimed using the existing mobile equipment reclaim.
- Stockpiling of lump in a new stockpile area for Ship Loader #2 using an automated boom stacker; reclaimed with a bucketwheel reclaimer.
- Ship loading of ore from two docks during a summer shipping season.

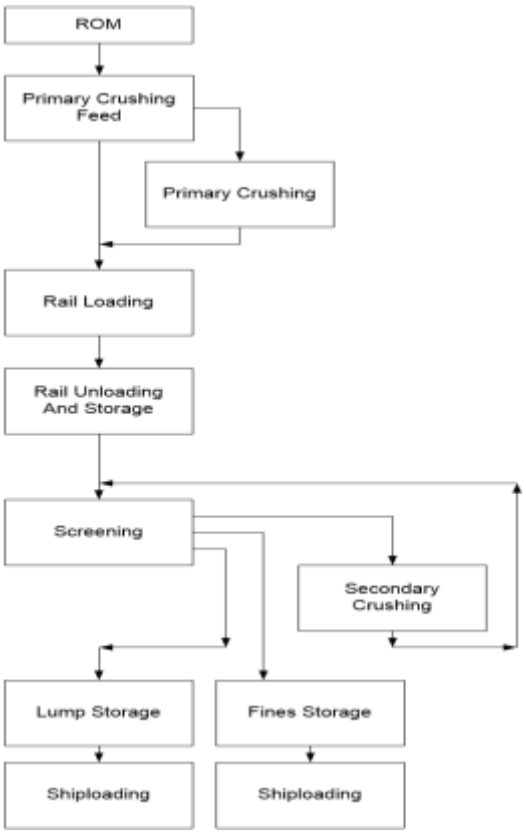

Figure 6-1: 12 Mtpa Simplified Process Block Flow Diagram

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The fundamental design of the process has not changed since the STAGE 2 STUDY. The vendor bidding process sought further process optimisation. Process optimisation alternatives received and accepted for inclusion in this Study are described in the following.

Design information provided by vendors during the Stage 3 Study have been used to confirm process design decisions made in the Stage 2 Study.

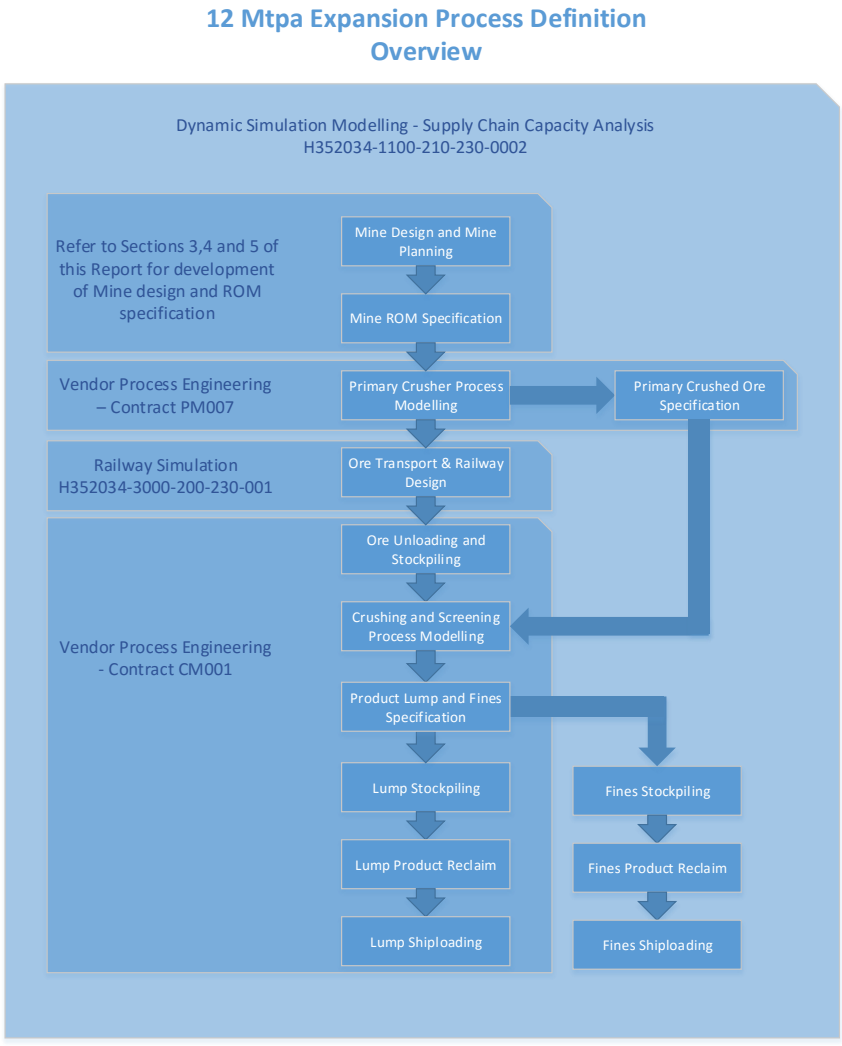

Figure 6-2: Stage 3 Study - Process Definition Work Flow and Responsibilities

A detailed process design criteria which includes basis for availability and other key operating parameters was developed (refer Appendices A6-1 and A6-2). This forms the basis of the process definition provided to vendors and contactors for them to provide process details and against which to validate vendor proposals for equipment supply.

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The contracting strategy adopted for the Stage 3 Study is based upon obtaining firm bids for the design supply of the major process plant elements (primary crushing, rail unloading through ship loading). At the completion of the Stage 3 Study firm bids capable of being converted into execution contracts for the execution phase have been received. Equipment proposed by vendors represents equipment that will be bought and installed, hence represents the process that will be built. Process performance provided by vendors in response to competitive bid processes therefore represents the expected process performance of the Project.

The workflow for definition of the process and its functional requirements follows.

To define the operating requirements of each of the mining, primary crushing, ore transport (by rail), unloading, stockpiling, secondary crushing and screening through ship loading elements of the project a dynamic simulation model has been created to enable definition of steady state materials flow rates and stockpile sizes required to support 12Mtpa of DSO shipping. The input criteria for the simulation model is defined in the model functional specification (ref Appendix A6-4). Supporting this specification is a Process Design Basis – Ore Handling (Appendix A6-1) and the Process Design Report (Appendix A6-2). The data contained within these documents provides the basis on which functional performance specifications have been prepared and submitted to vendors for them to complete detailed process design and equipment selections to support their firm bid offers.

The approach adopted to definition of the process is outlined in Figure 6-2 and outlined in the following.

Overall functional definition of the process is driven by three major project elements:

1. Mining rate and operating philosophy for the primary crushers at Mary River.
2. Railing of ore from Mary River to Milne. Ore will be loaded and transported to Milne in discrete amounts, set by train length and train frequency. The non-continuous nature of rail transport defines the need for primary crushed ore stockpiles at the mine as well as Milne and also the production rates for the crushing and screening plant and stacking rates for lump and fines product.
3. Limited windows for shipping product, outside the ice season. The shipping window definition applied to this Study is shown in Table **6-1**. Ore shipments are planned for the Open Water Season. The shipping window sets the parameters for the ship loading, reclaim and product stockpile elements of the project.

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Table 6-1: Shipping Seasons Summary

Season		Dates	Days	Ship Classification
Shoulder Season		Jul 1 – Jul 24	24	Polar Class
Open Water	Early Season	Jul 25 – Aug 14	21	Ice Class
	Mid-Season	Aug 15 – Sep 20	37	No ice classification
	Late Season	Sep 21 – Oct 15	25	Ice Class
Shoulder Season		Oct 16 – Dec 20	66	Polar Class
Winter Season		Dec 21 – Jun 30	192	No Shipping[1]

The sections that follow describe the functional requirements arising from each of these drivers and the results of vendor technical definition work.

6.1 Mining Rate and Primary Crusher Operating Philosophy

6.2 Mine Materials Handling

6.2.1 Process Definition

The flow sheets developed for the mine incorporating primary crushing and screening are driven by the material flow requirements for the project and have not changed since the Stage 2 Study. Alternative approaches to re-configuring the existing three crusher lines to produce a coarse (p90 passing 150mm) product to be railed to Milne for further crushing and screening to meet Direct Shipping Ore (DSO) specifications have not been identified during the Stage 3 Study.

The process at the mine site for ore processing is shown in Appendix A6-6.

6.2.2 In Loading

Ore will be delivered to the Run of Mine (ROM) stockpiles from the Mine according to the Mine Production Schedule detailed in Section 5 of this report. Mine haul trucks will deliver ore to a pad located upstream of the primary crushing strings. Front End Loaders (FEL) will be used to reclaim material dumped before the primary crusher strings and feed to the primary crushers.

It is planned that mining and ore movements in the Mine, including ROM ore delivery to the ROM pad occurs at a uniform average rate 24hrs/day, 365 days/year.

FEL equipment on site has been used as the basis for specifying equipment type and duty and as the basis for dynamic simulations used to define project scope.

[1] The Stage 3 Study has not considered shipping during the winter season. Use of Polar Class vessels during the winter season may be considered in future project phases.

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6.2.3 *Run of Mine Stockpiles*

Primary Crushers will operate in accordance with the schedule shown in Table 6-2 (Appendix A6-4).

Table 6-2: Primary Crushing Operation

Item	h/a/unit	Notes
Calendar time	8760	365 d/a x 24 h/d
Weather delays	120	5 d x 24 h/d
Annual shutdown during Freshet (all units down)	240	10 d x 24 h/d
Available time	8400	8760-120-240
Daily inspection/PM (1 unit down at a time)	700	(8400/24)d x 2 h/d
Weekly maintenance (1 unit down at a time)	700	(8400/168)w x 14 h/w
Scheduled time	7000	8400-700-700
Required operating hours	5698	12Mt / 2106 t/h
Unplanned maintenance	855	5698 x 15%
Free time	447	7000-5698-855
Expected utilization – scheduled time	81.4%	5698/7000
Expected utilization – calendar time	65%	5698/8760
Expected availability – scheduled time	87.8%	(5698+447)/7000
Expected availability – calendar time	70.1%	(5698+447)/8760

When operating (required operating time) the primary crushers will have a throughput of 700tph.

For periods when the crushers are down for maintenance, weather or other seasonal time, ROM ore will be stockpiled either at the mine face, or pad area currently occupied by the three primary, secondary and crushing strings; the 12 Mtpa expansion scope will relocate the primary crusher strings to a new location adjacent to the rail line.

When more than 100,000 tonne of ROM ore has been stockpiled, crushers and the rail system is available, a single mine haul truck and production loader will be assigned to reclaim stockpiled material until the ROM stockpile is depleted. 1228 hrs per year are available for crushers to operate to process recovered ROM material.

A typical build up and drawdown curve for the ROM ore stockpile is shown in Figure 6-3.

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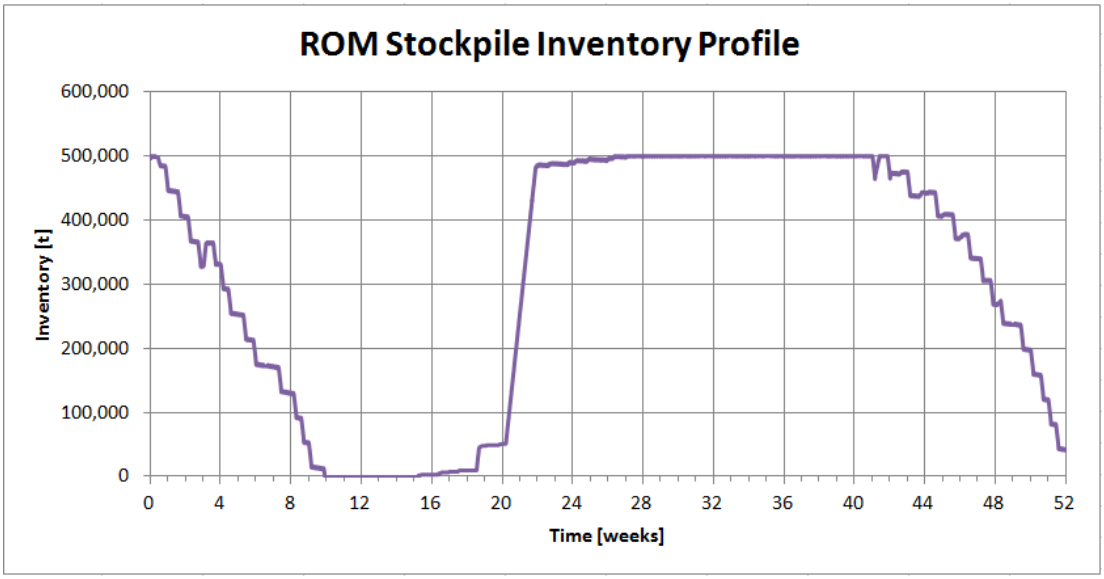

Figure 6-3: ROM Ore Stockpile Ore Profile (typical year profile)

In addition to the bulk ROM stockpile (described above) a smaller surge capacity is provided immediately before the primary crushers. Once the ROM stockpile is depleted, circa week 8 in Figure 6-3, crusher feed is directly fed to the primary crusher pad by Mine Haul Trucks. A 10 kt primary crusher feed stockpile has been selected which is located ahead of the three primary crusher strings.

6.2.4 Primary Crushing and Stockpile

6.2.4.1 Run of Mine Sizing

During the Stage 2 Study data collection to establish a Run of Mine (ROM) feed specification was completed and reported within the Process Design Basis – Ore Handling (Appendix A6 1). Mining definition work completed over the duration of this study confirms the specification of Run of Mine (ROM) material to be unchanged from that reported in the basis of design.

The ROM particle size distribution curve is used as the basis for the crushing simulations and equipment sizing. It plays a key role in the plant performance since it influences the proportion of lump and fines generated. Recent operation data were used to update the ROM curve and assess the variability impact on process equipment design.

The Wipfrag data from 18 different samples covering the period between February and July 2016 were received from BIM. Wipfrag data are obtained based on a camera that capture images of the ROM and evaluate the size distribution. Wipfrag data are known to be accurate at coarser size (+20 to 1000 mm) but inaccurate at finer size (-20 mm). They provide relatively accurate measurement of ROM F80 which is a measurement at coarser size.

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The Wipfrag data were adjusted using the Swebrec formula (see report H352034-1000-210-230-0001 for details). After the correction, it is estimated that the amount of particles below 6.3 mm should account for 6 to 10% of the total ROM. The new corrected average, minimum and maximum curves shown on Figure 6-4 were used for equipment design and sizing.

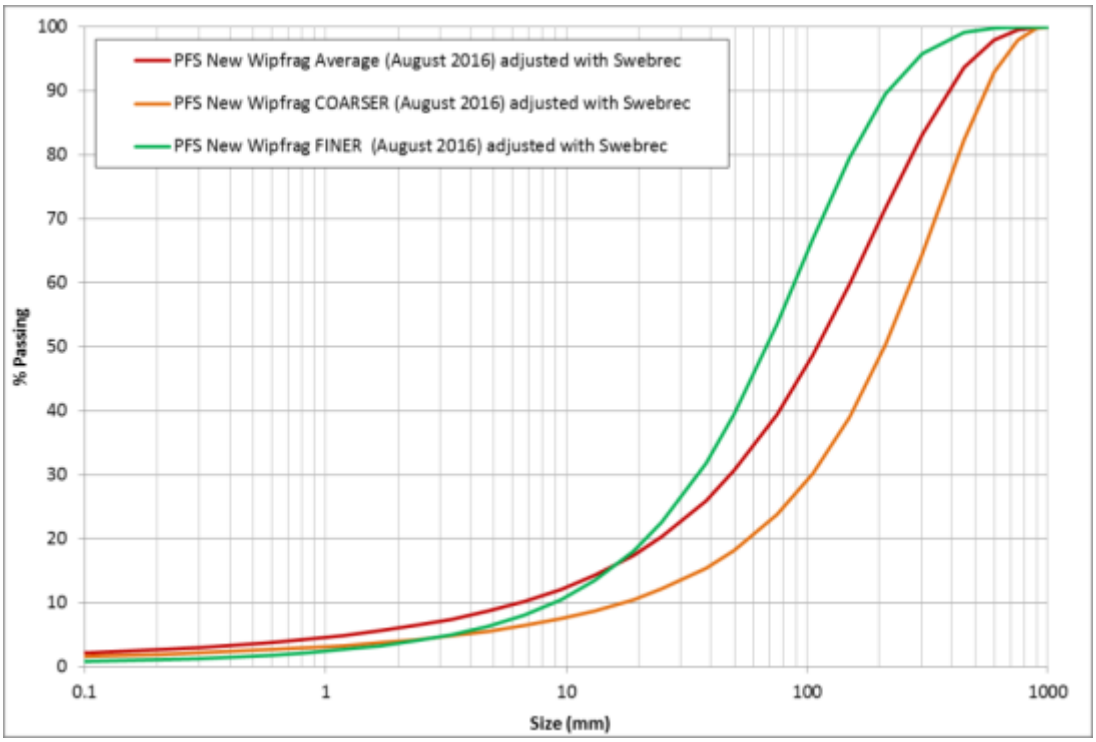

Figure 6-4: ROM Minimum, Average and Maximum PSD

The process design (crushing and screening concepts) were developed in the Stage 2 Study. The design considered reconfiguration of the existing crushing and screening lines so they produce a nominal -150 mm product (p90 passing) which is then railed to Milne for final sizing to meet DSO specifications.

Design parameters defined in this study provided the basis for setting the specifications for primary crushing, crushed ore screening and secondary crushing duties.

The Stage 3 Study execution plan defined in the Stage 2 Study Report noted the equipment and plant required for the project was typically off the shelf designs provided by reputable and large mining industry equipment suppliers. The execution plan adopted for Stage 3 included preparation of functional operating specifications for the design and supply of the majority of the equipment required for the project. During the Stage 3 Study, process equipment was defined using a functional specification approach, with equipment design and specification undertaken by experienced equipment vendors. The equipment vendors undertook detailed process design and equipment specification and proposed equipment in aligned to the functional requirements defined during the Stage 3 Study.

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The crusher strings were considered special equipment having been previously supplied by MASABA. MASBA has provided a budget bid for relocating and performing modifications to the crushers in accordance with a functional specification based upon predictions for production of a -100 mm Primary Crushed Ore from ROM materials.

MASABA has confirmed a single modified crusher string is capable ore processing ROM ore at a rate of 700 tph. The 700 tph rate is the rate required for processing of 12Mtpa of ore with a crusher availability of 65% over and entire year (8760 hours). For the typical size distribution of ROM feed, only 248 tph will be processed by the crusher with the remaining 452 tph bypassing the crusher after pre-screening on the grizzly ahead of the jaw crusher. A feed rate of 700tph aligns with the required and predicted feed rate for three crusher units of 2107 tph or 700 tph for a single unit.

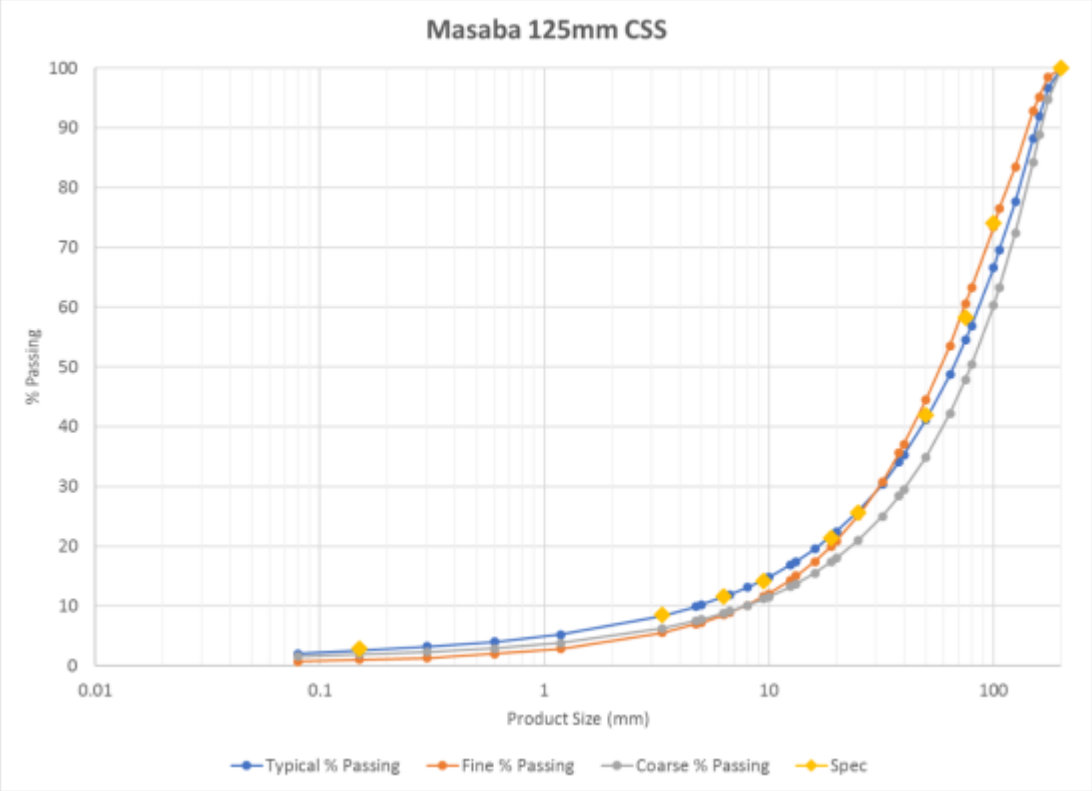

Figure 6-5: MASABA Modified Primary Crusher Performance

MASABA's offering (Appendix A6-8) increases the Closed Side Set (CSS) of the jaw crusher from 100 mm to 125 mm in their proposal. At 125mm CSS the crusher system (ref Figure 6-5 and Appendix A6-8) produces a product which is marginally more coarse than the typical size fraction defined in the Stage 2 Study. For the +32 mm fraction this maximises lump production from the primary crusher, offering potential for increasing lump produced from the downstream product crushing and screening plant. During detailed design fine tuning of the

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CSS and robust integration with the detailed specification of the crushers and screens for the secondary crushing and screening plan will be required.

6.2.4.2 *Train Load Out Inventory*

The primary crushing circuit is expected to operate at full capacity for all designed operating hours. Appendix A6-4 presents the results of annualized rail system outages and their impact upon train load out inventories at the mine. These results are presented in Figure 6-6. The figure shows inventory levels typically between 5 kt to 7 kt will arise at the mine. Larger scale inventories as high as 20kt and 35 kt may arise in exceptional circumstances.

Provision has been made for construction of a primary crushed ore stockpiles downstream of each of the three crusher strings. Each pile has a capacity of 10 to 12 kt. The stockpile build up before arrival of a train and the crusher string thoughput during train loading provides the requisite -100 mm material for loading to each train.

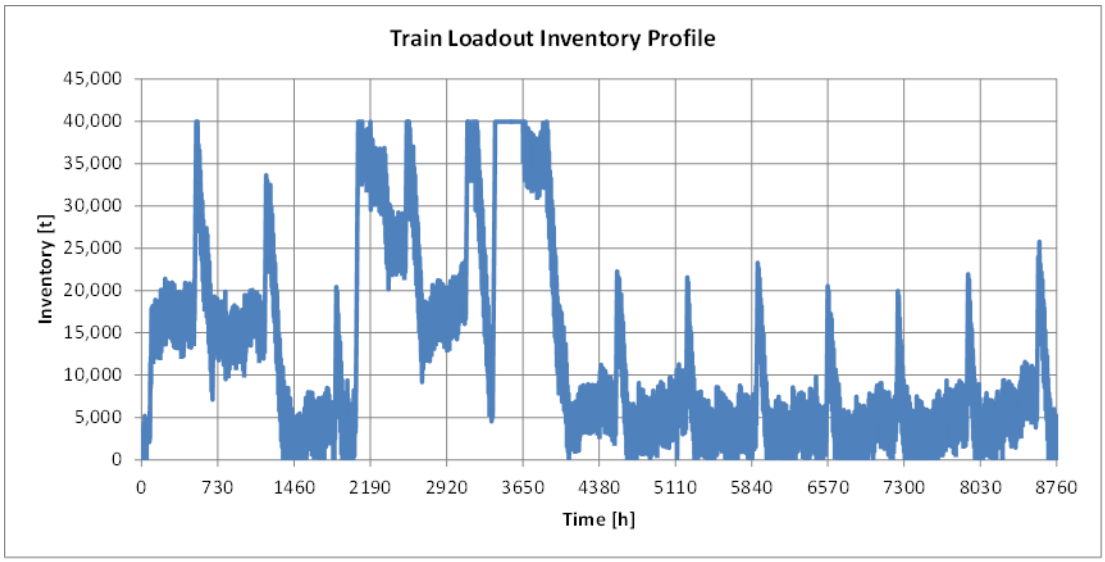

Figure 6-6: Train Loadout Inventory Profile

6.3 Ore Transport and Rail Operations

Appendix A6-1 defines the outcomes of the operations simulation defining the needs for the rail system to haul 12 Mtpa of -100 mm material from Mary River to the port at Milne. The report notes the need for:

- Two trains to be in service each comprising two locomotives with 72 ore cars with each ore car having a capacity of 106 tonne.
- Trains running on a run when ready basis.
- Single track with a single passing loop.

During the Stage 3 study a discrete Rail Operations – Static and dynamic modelling analysis was completed which undertook a detailed assessment of train operations which considered

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the alignment (vertical and horizontal) of the track, rolling stock performance, rolling stock characteristics, locomotive performance factors, and other factors (refer to Appendix A6-9). The approach taken is shown in **Figure 6-7**.

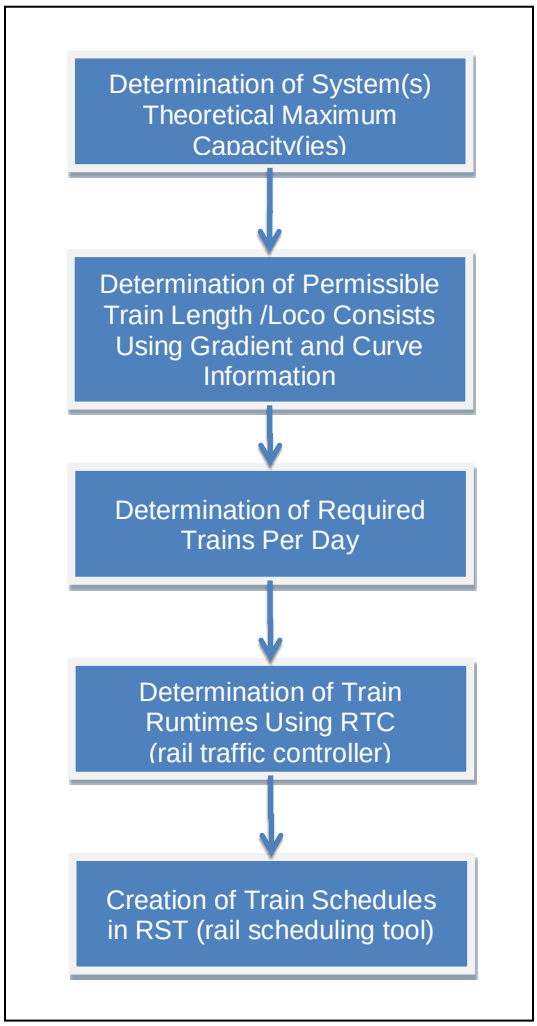

Figure 6-7: Rail Study Approach

The report confirmed the outputs of the overall materials management process reported in Appendix A6-3.

Figure 6-8 shows that approximately 5 trains (72 cars, 106t payload) per 24 hour period will meet the production requirements of the project with the track geometry defined for the project and described in Section 8 and 10 of this report.

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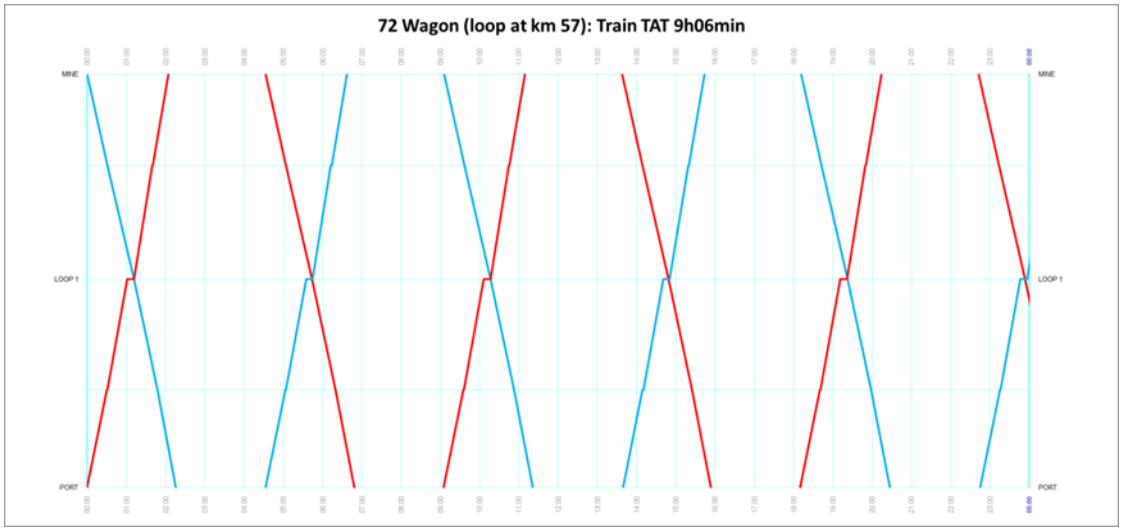

Figure 6-8: Two Train-Set, 72 Car Train Schedule

With this schedule expected ore deliveries to Milne will follow the profile shown in Figure 6-9. A period of 12 days for a rail outage circa week 21 has been allowed for a rail system shut down during the seasonal freshet and allows for planned maintenance work on the rail line.

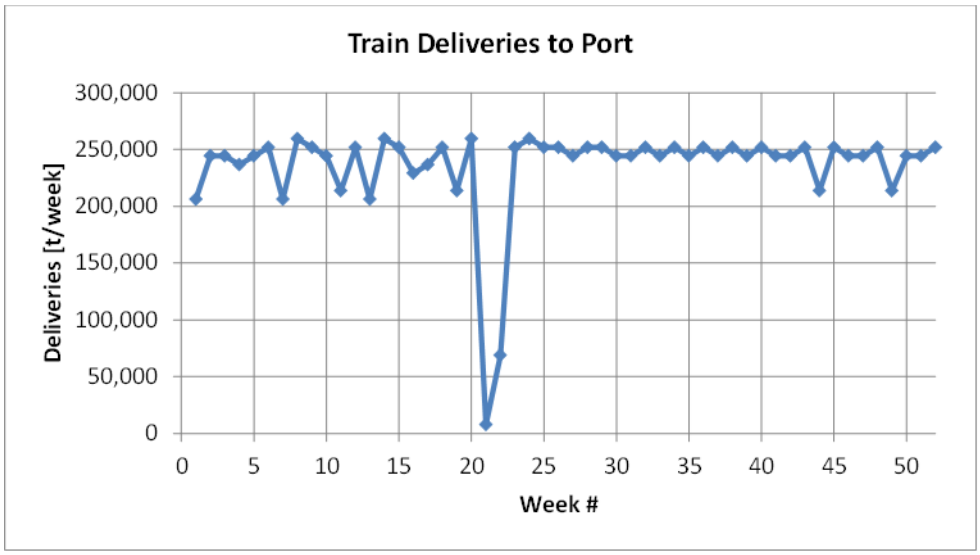

Figure 6-9: Train Deliveries to Milne from Appendix A6-3

6.4 Iron Ore Process Plant, Onsite Infrastructure and Port

6.4.1 Process Definition

The flow sheets developed for the Milne port area in which will be located train unloading, product crushing, product screening, product stacking, reclaim and shiploading are driven by the material flow requirements for the project and have not changed since the Stage 2 Study.

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Development of the process plant for processing facilities at Milne has been driven by:

1. Arrival and unloading times for trains.
2. Achieving constant year round steady state operation of the product crushing and screening plant and stacking operations.
3. Seasonal reclaim of both lump and fines product to match arrival of ships sized from Panamax to Cape during the defined shipping season.

The process at the Milne Port processing area for ore processing is shown in Appendix A6-10 and Appendix A6-11.

Definition of supporting infrastructure elements (Water, sewage and fuel) have been defined and are shown in Appendix A6-12 and Appendix A6 -13.

The definition of the processing requirements have been developed through the bid of design, supply and install contracts on a firm price basis. The work for the port has been combined into a single package, CM001 – Bulk Materials Handling & Processing. This scope of this package includes design, fabrication, supply and construction related to:

- Rail car unloader.
- Primary crushed ore stockpile.
- Primary crushed ore reclaim tunnel.
- Primary crushed ore screening and secondary crushing plant.
- Lump ore stacker for stockpile #2 (fine ore will be stacked by way of wheeled mobile equipment to stockpile #1).
- Automated lump ore reclaiming plant.
- Ship loading plant, including bins for balancing ship loader downtime for hatch changes.
- Conveyors to connect the rail unloading system to the crushing and screening plant, stockpile, reclaimer, and ship loader.

Firm bids have been received from five vendors. At the completion of the Stage 3 Study, two vendor submissions have been eliminated. Offers from Thyssen Krupp, Sandvik and DF will require further work to finalise negotiations to form and execution contract. Notwithstanding the three remaining bidders (DF, Thyssen Krupp and Sandvik) have presented technical solutions which are compliant with the functional requirements of issued functional specifications for contract CM001.

6.4.2 Material Properties

Substantial testwork has been completed to assess the material handling properties of the Mary Rive Iron Ore. Details of prior testwork, provided to contractors bidding package

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CM001 is contained in Appendices A6 -13 to A6 – 22. Of importance in this material are the following:

- Mary River iron ore extremely hard and abrasive. Contractor's completing design contracts shall ensure designs are adequate for the specified material properties.
- Based on the Employers current operations Primary Crushed Ore and Lump Ore will remain flowable in all weather conditions without heating of chutework or equipment.

6.4.3 Ore Unloading and Stockpile

Appendix A6-1 noted the need for a rail car unloading system with the ability to unload a single rail car in 61 seconds per car. Appendix A6-9 demonstrates how the operation of the rail unloader integrates with the train system. Appendix A6-9 includes the 61 second train loader cycle time into calculations to demonstrate the viability of a train consist and schedule as defined in Section 6.3, above.

Bids received show that car unloading cycle times of 61 seconds per car are achievable. Thyssen Krupp notes a cycle time of 80 to 95 seconds. Adoption of the Thyssen Krupp proposal will alter the train cycle time requiring addition of two ore cars per train to ensure project throughput. This change represents a minor process variation with Thyssen Krupp which is does not materially change the process design proposed for the Project.

To maintain constant operation of the crushing and screening plant and batch wise operation of the train unloading system (i.e. it operates continuously 5 times per day) a stockpile is required to decouple the train unloading process and the downstream crushing and screening plant.

The dynamic process modelling recognised the need to install a stockpile after the train un loading station, refer to Figure 6-10 from Appendix A6-5.

The figure reflects a need for approximately 10 kt with long term peak of approximately 25 kt of buffer storage ahead of the crushing plant. Designs provided by Thyssen Krupp and Sandvik have validated this modelling outcome with both contractors recommending a crushed ore stockpile with a live capacity of 8-10 kt with a dead capacity of 25 kt. Access to the dead zone of the stockpile will be granted through use of a dozer or Front end loader when access to the dead zone is required.

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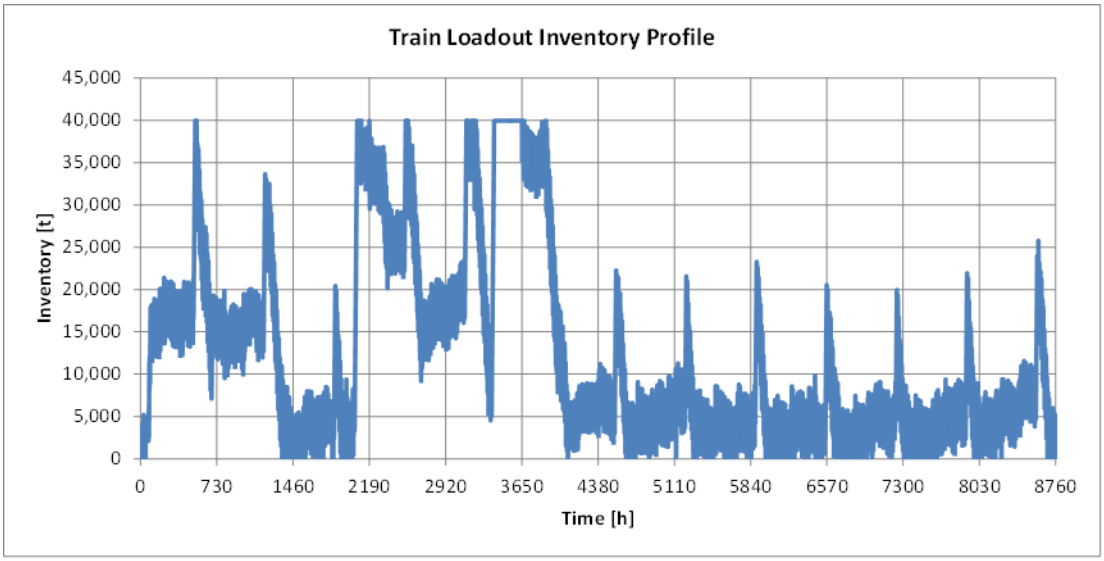

Figure 6-10: Milne Primary Crushed Ore Stockpile Capacity

The throughput of the reclaim system has been set to match the required federate to the crushing and screening plant.

6.4.4 Secondary Crushing and Screening

The crushing and screening process has been designed such that ore reclaimed from the Primary Crushed Ore Stockpile is first screened to scalp out fines and lump product sized material from the -100 mm primary crushed ore. Over size material (+32 mm) is directed to a secondary crusher to produce material with a top size of -32 mm. Crusher product is directed to the screen feed belt as a recirculation flow to be rescreened and recover lump and fines product.

Process simulations show that with an average feed of 2107 tph will generate a recirculating load of 2645 tph which becomes the design feed rate to the screens. The plant defined in Appendix A6-10 was intended to produce 77% lump and 27.5% fines with a fines in lump (-6.3 mm content) ratio of no more than 8%. The fines product should contain no more that 15% +6.3 mm material.

Process plant proposed by during the bid process show plant to be able to produce between 68 & 74% lump. Fines in lump levels less than 1% and lump levels in fines approaching 0% have been proposed. Variations in plant configurations for the options tendered give rise to a variation in internal flows when compared to the process design issued for bid. At a crushing and screening plant battery limit, plants proposed align with the mass flow requirements contained in the bid documents and as defined in Appendix A6- 1.

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6.4.5 *Stockpiling*

Definition of stockpile volumes derives directly from dynamic simulations of ship loading, reclaiming and stacking activities. Appendix A6-3 defines the total on ground stockpile needs to be 9.4 Mt (lump and fines), see Figure 6-12.

The operating methodology is that whist ships are at berth and loading, ore from the lump yard conveyor bypasses the stacker is direct loaded. Lump or from the screening plant is supplemented by ore reclaimed from the bucket wheel reclaimer.

Dimensions of the new lump stockpile have been set according to physical repose data collected from site. The need to constrain the length of the stockpile within permit boundaries requires that the stacker have reach to stack to the full width required to achieve required stockpile volumes. Use of machines with 60m booms limits the live capacity of the lump pile to less than the total volume of the lump pile. Design of the stockpile has been completed so that quantity or ore available for live reclaim is maximised and only 1.4 Mt will need front end loaders to move this ore to be accessible by the reclaimer, refer to Figure 6-11.

Equipment proposed by the remaining bidders for lump stacking do not preclude stacking operations using frequently used stacking methods for ore blending. Bidders have noted the likelihood of using pilgrim step reclaim methods for lump reclaim. The large stockpile size (approximately 600 train loads per lump stockpile) provides substantial linear blending capability in stockpile creation. Use of a pilgrim step reclaim methodology further increases the blending ratio that may be achieved from the stockpile system, such that ore reclaimed from the stockpile will be uniform in grade with a low grade variance, subject to imposition of mine grade control measures in line with accepted practice within the iron ore processing industry. Ore processing grade reporting will be driven by samplers installed at Mine:

- Lump and fines automated sample collection from ore discharging the screen system which is immediately prior to stacking.
- Ship loader samplers to sample ore as it is loaded via Ship loader 1 and the new ship loading system to be installed on the new dock.

Ore sampling at Milne will capture grade and mineralogy variations on ore presenting to the stockpiles, after selective mining, ROM pad, primary crusher pad, trainloading, train unloading, primary crushed ore stockpile blending and crushing and screening circuit blending operations.

The stockpile and blending operations proposed differ from other comparable operations where grade control is focussed on ship to ship variability and stockpiles being created to suit specific shipment grade targets. The proposed lump piles will provide a consistent grade of product on a year to year basis.

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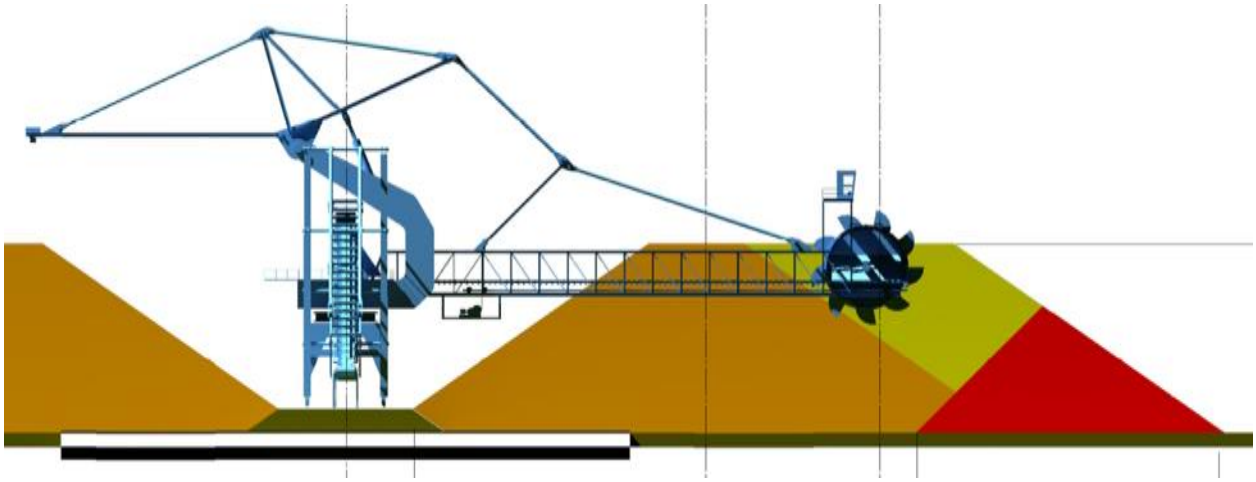

Figure 6-11: Lump Stockpile Geometry

- Orange cross section – standard stockpile cross section = 4.8 Mt.
- Yellow cross section – added live volume[2] = 1.6 Mt.
- Red cross section – added dead volume = 1.4 Mt.
- Total live volume = 6.4 Mt; total stockpile volume reclaimed with assistance from mobile equipment = 7.8 Mt

  Thyssen Krupp and Sandvik have confirmed stockpile sizes and configuration.

[2] Added live volume based on 45 deg drained angle of repose (compared to 35 deg stacking angle)

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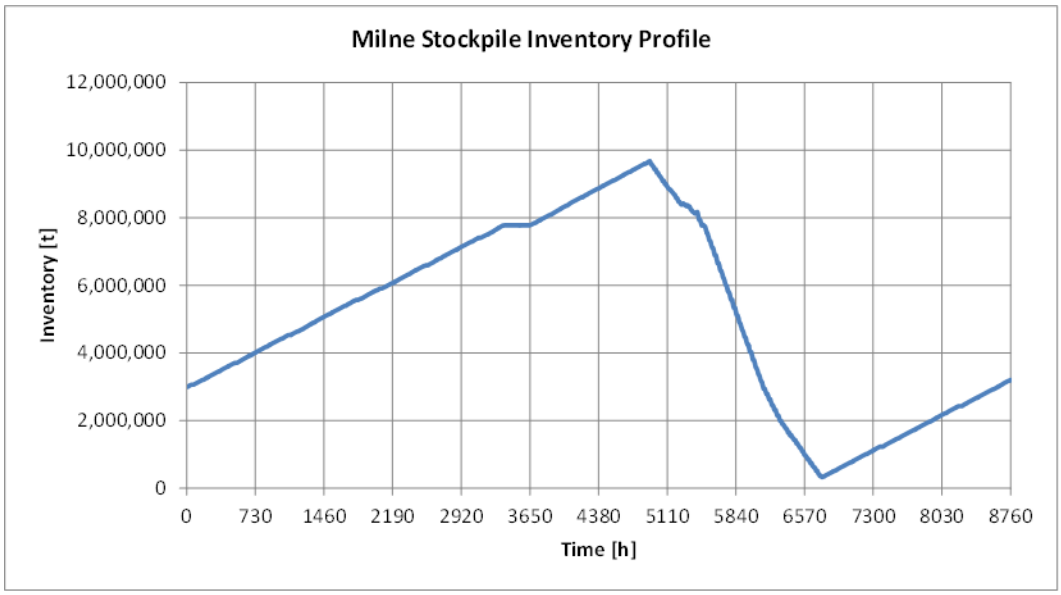

Figure 6-12: Product Stockpile Volumes (lump and fines)

Fine ore will be stockpiled on existing stockpiles using mobile plant. A small stockpile will be created adjacent to the screening plant to allow for FEL reclaim of fines before it is trucked to the existing fines stockpiles. The ratio of lump to fines in the ore mined and processed sets the fines production and stacking rates.

6.4.6 Reclaiming

6.4.6.1 Lump Ore

Appendix A6-5 provides an analysis of port operations and ship loading activities calibrated to data collected in ship movements in 2016. The analysis concludes that to obtain 12 Mtpa of DSO; shipped the lump ship loading facility has to have a capacity of 16,000 tph whilst ship loading during the open water season. The lump ship loading function is directly drives required reclaim rate for lump. Appendix A6-5 shows that maximising berth time and shiploading rate requires lump ship loading at a rate of 16,000 tph. The design rate for the lump reclaim system has been set at this rate and considers shiploading during the summer season must occur at 16,000 tph under conditions when the crushing and screening plant is off line. Reclaimer load during periods when the crushing and screening plant is operational may be relaxed by the amount of ore produced in the crushing and screening plant which will bypass the lump stockpile.

6.4.6.2 Fine Ore

Fines from the screening plant will be transport to a modified stockpile for existing Ship Loader #1.

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Required stockpile live capacity for average year production and shipping is 2.1 Mt. The stockpile concept is as per existing operations however the reclaim conveyor will be modified to suit the proposed lump stockpile arrangement as shown in Figure 6-13.

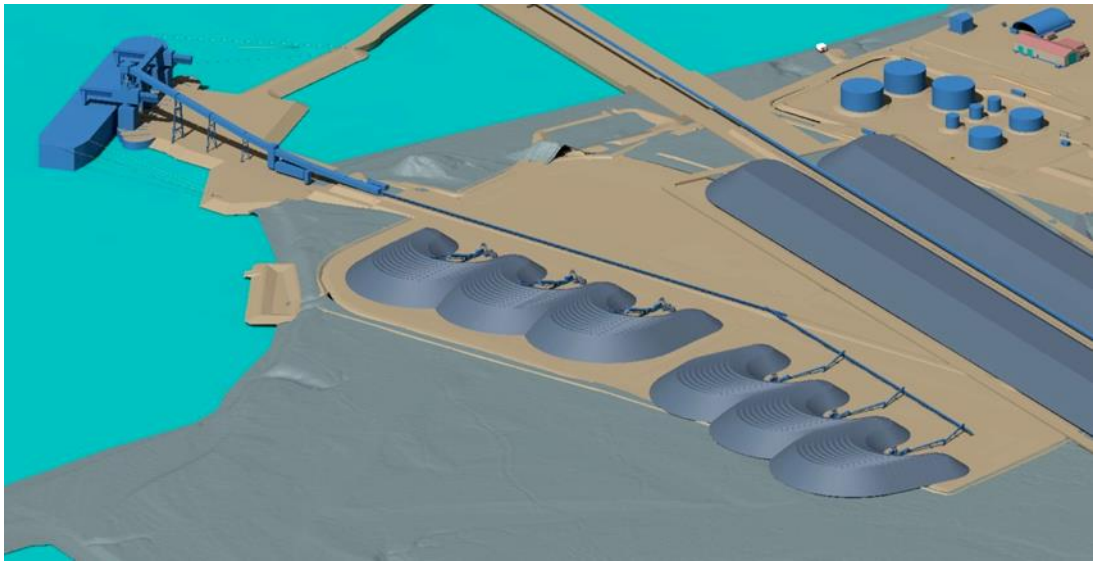

Figure 6-13: Fine Ore Stockpile and Reclaim

Fines from the screening plant are discharged into an intermediate stockpile adjacent to the screening building. Four (4) Heavy Mining Equipment (HME) vehicles (existing CAT 740's) will transport the fines from the intermediate stockpile to the ship loading stockpile where the material will be stacked using the existing radial stackers.

Reclaim from the stockpile to feed Ship Loader #1 will be as per current operations with no upgrade included in the Expansion Project scope. The design reclaim rate is 6,000 t/h with an assumed operating efficiency of 80% (ie. the average reclaim rate achieved during "full rate" operations is 6,000 x 80% = 4,800 t/h). Appendix A6-5 confirms the adequacy of the current ship loading circuit for 12Mtpa project fine ore ship loading requirements.

6.4.7 Ship Loading – Conveyor

Conveyors connecting the reclaimers and ship loading facility for lump export have been sized to suit the maximum duty of the reclaimer and ship loader operations.

6.4.8 Ship Loading

Appendix A6-5 sets the context for defining the number, type of vessel, size of vessel and loading time required to maximise shipping rates during the limited shipping season. To achieve the required export of 12 Mtpa of ore, the existing shiploader #1 will continue to load at a rates define in Section 6.4.6. No work will be undertaken to increase shiploader #1 capacity during the 12 Mtpa expansion.

To achieve lump export consistent with 12 Mtpa of total exports, the shiploaders for dock #2 are required to operate at 16,000 tph.

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Bids received confirm analysis contained in Appendix A6-5.

6.5 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H352034-1000-210-210-0002	Process Design Basis – Ore Handling	2	2017-01-10	A6 - 1
H352034-1000-210-230-0001	Process Design Report	2	2017—1-10	A6 - 2
H353024-2100-210-230-0002	Supply Chain Capacity Analysis	0	2017-15-12	A6 - 3
H352034-1100-210-242-0001	Dynamic Simulation – Model of Supply Chain Operations	0	2017-01019	A6 - 4
H353024-2100-210-230-0001	Port Shipping Capacity Analysis	1	2017-01-10	A6 - 5
H353024-4100-210-282-0001	Mine Site Ore Handling Process Flow Diagram	I	2017-01-23	A6 - 6
H353024-4700-221-282-0001	Mine Site Water and Sewage Process Flow Diagram	2	1/13/2017	A6 - 7
	MASABA Process Outputs – Primary Crushing	157317	March 17 2017	A6 - 8
H352034-3000-200-230-0001	Rail Operations – Static and Dynamic Modelling	2	2017-01-10	A6 - 9
H352024-2100-210-282-0001	Milne Port Ore Crushing and Screening Process Flow Diagram	I	23-01-2017	A6 - 10
H352024-2100-210-282-0002	Milne Port Ore Crushing and Screening Process Flow Diagram	I	23-01-2017	A6 - 11
H353024-2700-221-282-0001	Milne Port Water and Sewage Process Flow Diagram.	2	1/13/2017	A6 - 12
H353004-48000-210-282-0001-0001	Port Site TM001 Fuel system Process Flow Diagram	0	2017-03-27	A6 - 13

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Document Number	Title	Revision	Date	Appendix Number
	SGS MINERALS SERVICES. Baffinland Mary River Grindability Summary, Project Number 13831-001, 02/01/2013			A6 - 14
	SGS MINERALS SERVICES. An Investigation into The Characteristics of DSO Samples from The Mary River Deposit, Prepared for Baffinland Iron Mines Corporation, Project Number 13831-001 – Final Report, 15 May 2013			A6 - 15
	SGS MINERALS SERVICES. An Investigation into The Abrasivity Characteristics of Five Samples from the Baffinland Mine, Prepared for Baffinland Iron Mines Corporation, Project Number 15296-001, 23 September 2015			A6 - 16
	Jeneke & Johansen - Flow Property Test Report 9510-1 (28 January 2009) – Flow Property Test Results for Iron Ore			A6 - 17
	Jeneke & Johansen - Flow Property Test Report 9510-2 (August 5, 2009) – Flow Property Test Results for Iron Ore Dust			A6 - 18

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Document Number	Title	Revision	Date	Appendix Number
	Jeneke & Johansen - Flow Property Test Report 9719-1 (April 30, 2013) – Flow Property Test Results for Iron Ore			A6 - 19
	Jeneke & Johansen - Flow Property Test Report 9719-2 (June 4, 2013) – Stockpile Drainage Results and Analysis for Iron Ore Fines			A6 - 20
	Metso Minerals, Test Summary Report, Test Code 0600-81 (November 29, 2006)			A6 - 21
	Metso Minerals, Test Report on MP Cone Pilot Crushing Tests (November 28, 2006).			A6 - 22

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 7 – Engineering Development

2017-05-01	0	Approved for Use	N. Mason	J. Cleland	S. Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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7. Engineering Development

7.1 Site Conditions

The following section is a summary of the site conditions experienced at both the Milne Port and Mine site. For a more detailed description refer to Appendix A7-1.

7.1.1 Temperature

Table 7-1 presents the average maximum and minimum temperatures for the Mary River site from 1971 to 2000. This information is based on a report prepared by consulting engineers Rowan Williams Davies and Irwin Inc. (RWDI). Design outdoor temperature is outlined in Table 7-2.

Table 7-1: Average Temperature 1971-2000
(Ref.: RWDI, 2011 Table 5-1.1)

Season (Months)	Mean Daily Temperature Maximum (°C)	Mean Daily Temperature Minimum (°C)
Winter (December – February)	-28.1	-35.3
Spring (March – May)	-16.6	-24.8
Summer (June – August)	9.6	3.1
Fall (September – November)	-8.4	-14.9
Annual	**-11.5**	**-18.6**

Table 7-2: Design Temperature

January, 2.5% Basis:	-43°C
January, 1% Basis:	-45°C
Winter, extreme minimum:	-54°C
July, 2.5% Basis (dry bulb):	+14°C
July, 2.5% Basis (wet bulb):	+10°C
Summer, extreme maximum:	+26°C
The Number of Degree-Days under 18ºC (1971 - 2000):	11500 for Mine Site 12000 for Milne Port

7.1.2 Rain

Rainfall can generally occur from April to November. August is the wettest month with 32.9 mm of rain. The historical data shows that the rainfall is increasing over the years at a rate of 0.24 mm/year (RWDI 2011 report). Design rainfall data is outlined in Table 7-3.

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Table 7-3: Design Rainfall Data

Maximum Precipitation Month	500 mm (2005; Nanisivik station, RWDI Report)
Total annual rainfall: • Mary River Mine • Milne Inlet	 • 262 mm • 217 mm
One day rain (1/50 year): • Mary River Mine • Milne Inlet	 • 46 mm • 35 mm
15 min rainfall (1/10 year) • Mary River Mine • Milne Inlet	 • 4 mm • 3 mm

7.1.3 *Snow and Ice*

Design ground snow loads are shown in Table 7-4.

Table 7-4: Design Ground Snow Loads

Snow	Units	Mary River	Milne Inlet
Ground Snow Load (S_s) (1/50 year)	kN/m^2	2.9	2.1
Associated Rain Load (S_r) (1/50 year)	kN/m^2	0.2	0.2
Unit weight of snow, γ	kN/m^3	3.0	3.0

Ice Accretion:

- Ice thickness: 12 mm for marine structures and shiploader(s).
- Ice thickness: 50 mm for other outdoor structures.
- Ice density: 9.8 kN/m^3.

7.1.4 *Wind*

The wind rose for Milne Inlet for Open Water Season from 8/1/2016 to 10/31/2014 is shown in Figure 7-1.

The wind rose for Milne Inlet for Non-Open Water Season from 11/1/2006 to 6/16/2015 is shown in Figure 7-2.

Figure 7-3 shows the open water season wind rose at Mary River mine meteorological station from 8/1/2006 to 10/31/2014.

Figure 7-4 shows the non-open water season wind rose at Mary River mine meteorological station from /3/2006 to 6/16/2015.

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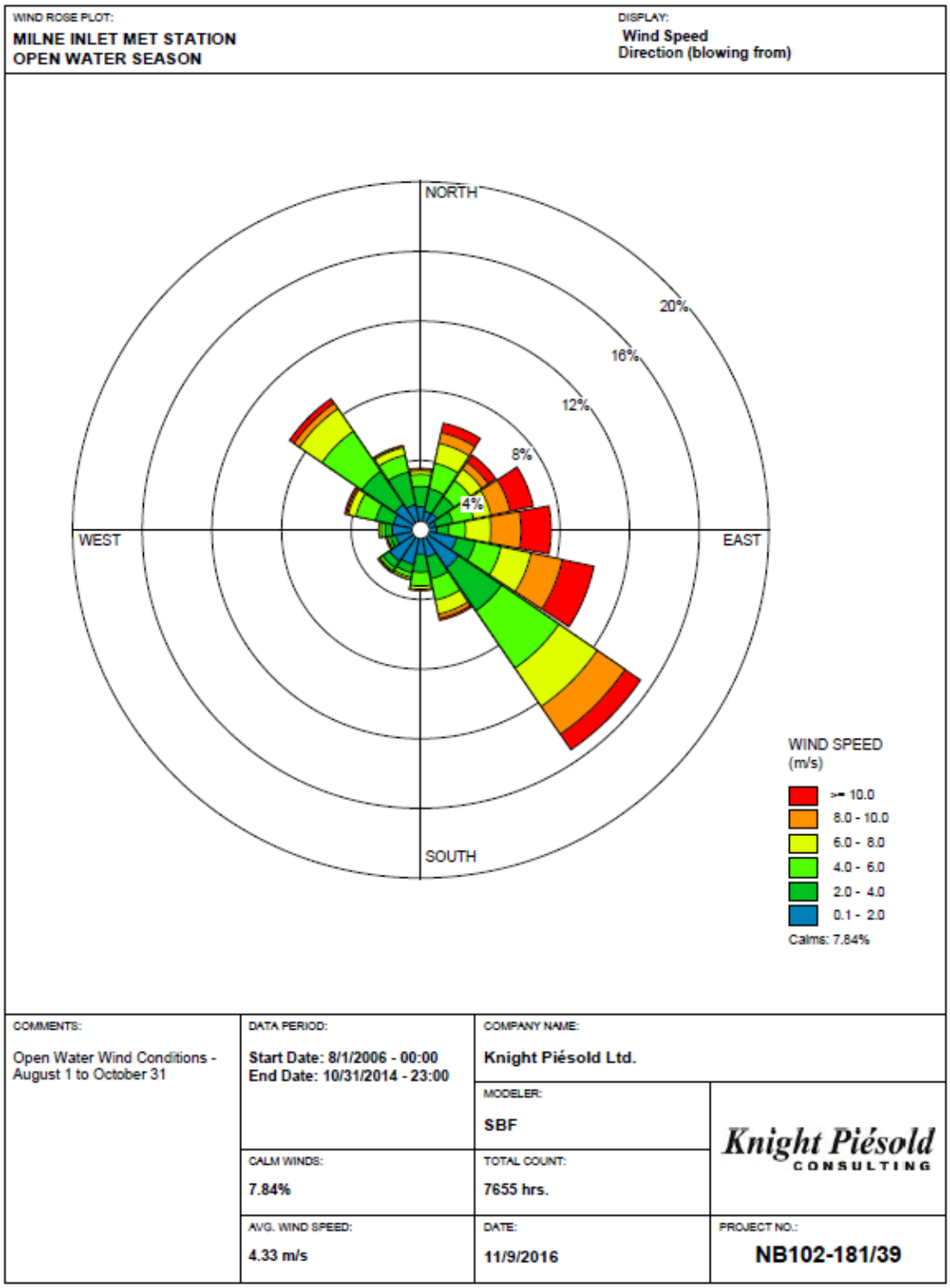

Figure 7-1: Milne Inlet Wind Rose for Open Water Season

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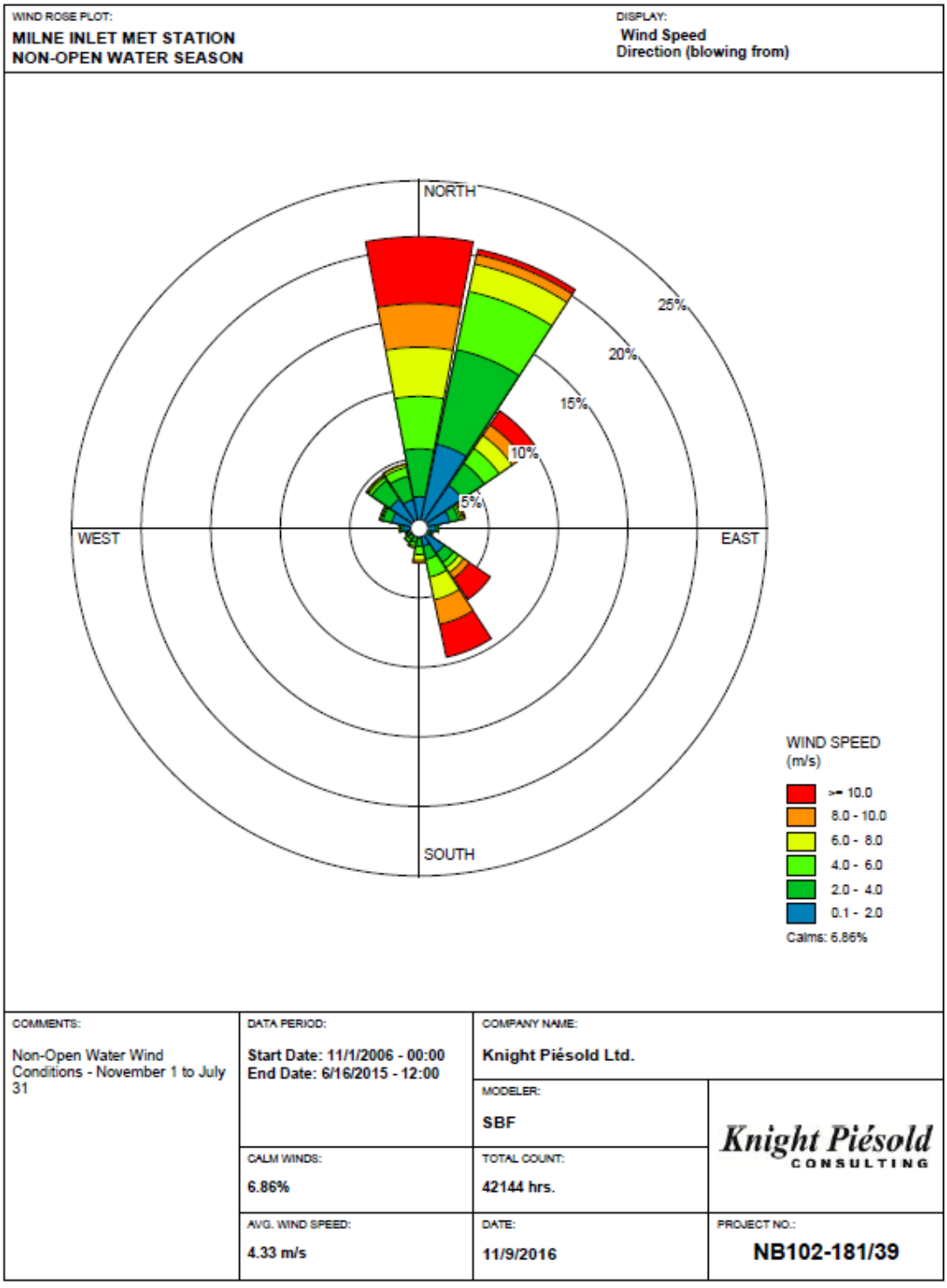

Figure 7-2: Non-Open Water Season Wind Rose at Milne Inlet

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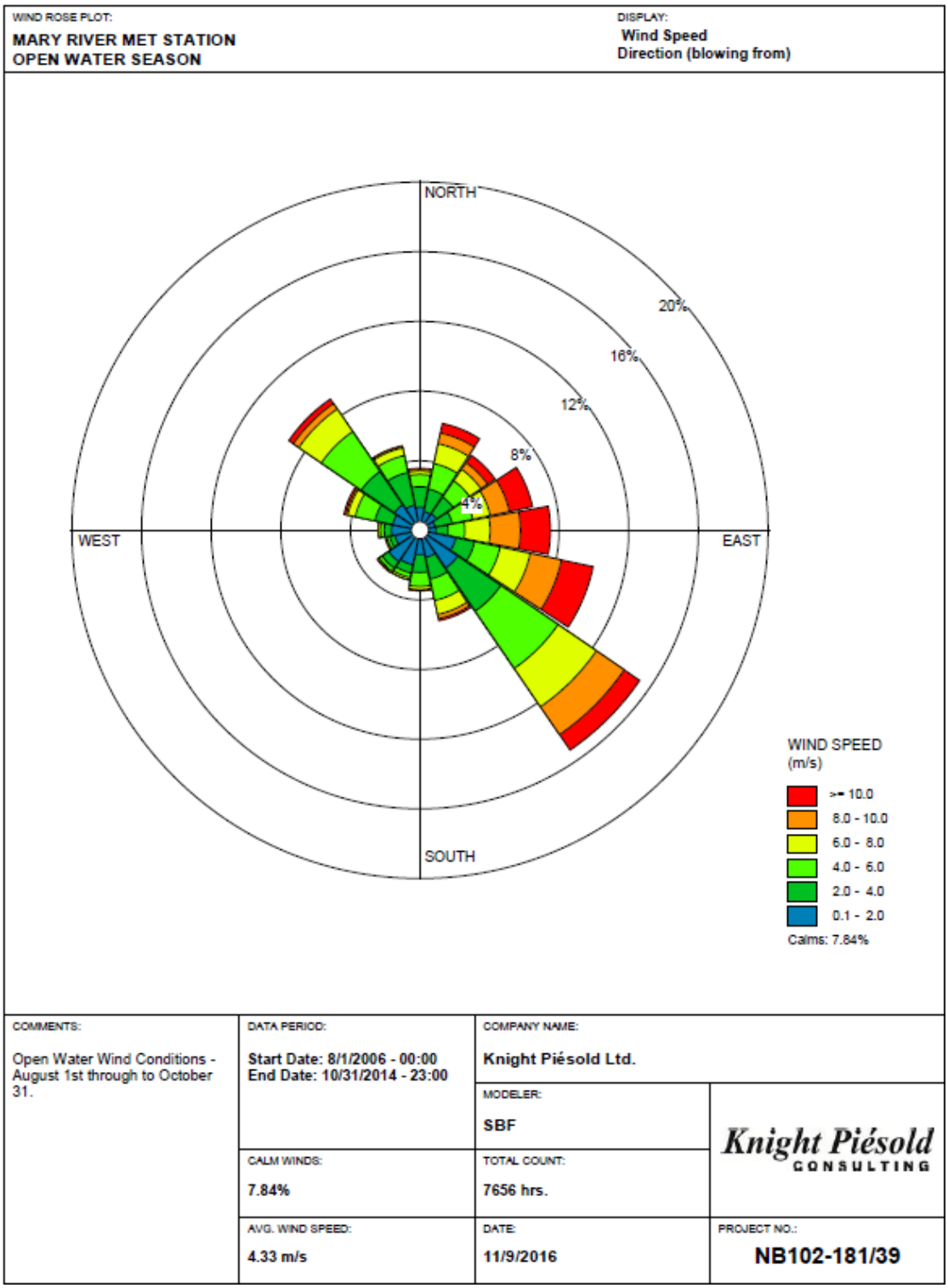

Figure 7-3: Open Water Season Wind at Mary River Mine Station

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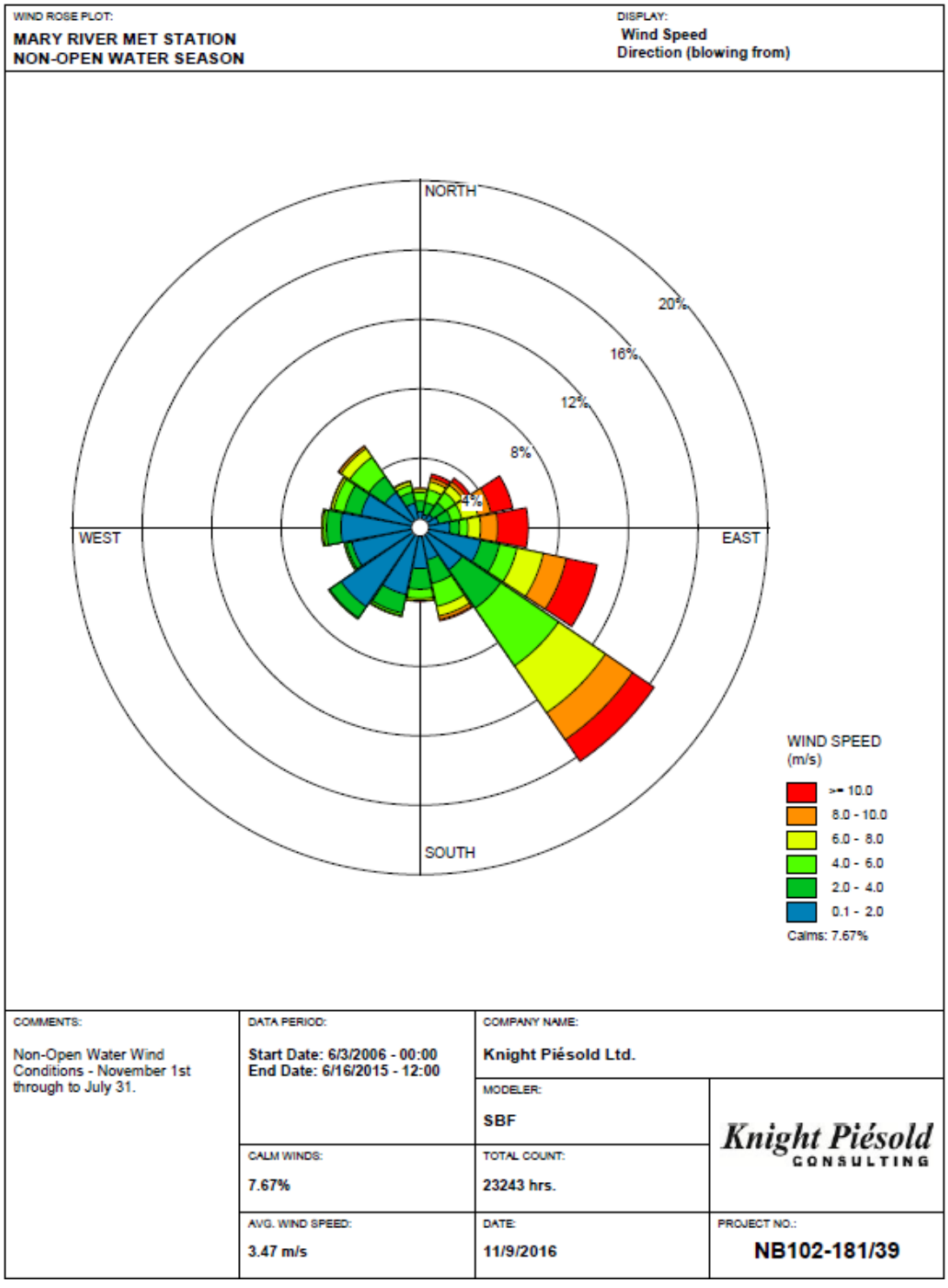

Figure 7-4: Non-Open Water Season Wind at Mary River Mine Station

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7.1.5 Marine Conditions – Milne Inlet

The following provides a summary of relevant marine conditions at the Milne Inlet. For a more detailed description refer to Appendices A7-2 and A7-3.

7.1.5.1 Tides

Department of Fisheries and Oceans (DFO) provided the following tidal levels based on data recorded for a period of 2 months in 1965at Milne Inlet Station, located at 71°54' N, 80°51' W (data received March 25, 2013):

- Water: saline.
- Tides: yes, semi-diurnal.
- Highest Astronomical Tide (HAT): elevation +2.4 m CD (1.2 m GD).
- High High Water Large Tide (HHWLT): elevation +2.3 m CD (+1.1 m GD).
- High High Water Mean Tide (HHWMT): elevation +2.0 m CD (+0.8 m GD).
- Mean Water Level (MWL): elevation +1.2 m CD (0.0 m GD).
- Low Low Water Mean Tide (LLWMT): elevation +0.5 m CD (-0.7 m GD).
- Low Low Water Large Tide (LLWLT) or Lowest astronomical Tide (LAT): elevation 0.0 m CD (-1.2 m GD).

The veracity of these tidal planes should be independently established by The Design and Build Contractor (CG001 – Ore Dock), if required by establishing a tide gauge at the existing dock to confirm tidal planes at the ore dock project site.

7.1.5.2 Surge

The storm surge was calculated analytically to be 0.30 m, assuming a fetch length of 40 km and steady wind conditions of 30 m/s (Refer Appendix A7-3). Where possible, this predicted surge level is to be verified against any available water level measurements near the site or at comparable locations in the region.

7.1.5.3 Sea Level Rise

An estimated sea level rise of 0.3 m is expected along the Northeast shore of Baffin Island (refer Appendix A7-3).

7.1.5.4 Currents

Current measurements were taken at two sites over the month of September 2010 (Ref. appendix A7-3).

Currents were measured at the entrance to Milne Inlet (ADCP located at 71°59' N, 80°47' W) at a mean depth of 148 m. Measurements indicate peak speeds of 0.31 m/s at a depth of 9 m below the water surface. A maximum current speed of 0.55 m/s was calculated for the region of the water column nearer to the surface.

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Currents were also measured near the Milne port (ADCP located at 71°53' N, 80°55' W) at a mean depth of 27 m. Measurements indicate peak speeds of 0.31 m/s at a depth of 4 m below the water surface. A maximum current speed of 0.54 m/s was calculated for the region of the water column nearer to the surface.

Due to the lack of data a safety factor 1.25 has been applied to the measured maximum currents to arrive at a design current speed. The maximum calculated design current speed is therefore 0.7 m/s. Any further quantification of current magnitudes will require execution of a hydrodynamic model validated against available measurements.

7.1.5.5 Waves

The design wave parameters were established (refer Appendix A7-2) and are shown in Table 7-5.

Table 7-5: Milne Inlet Design Wave Parameters

Return Period (years)	Significant Wave Height (m)	Peak Wave Period (s)
1	1.46	4.36
5	1.74	4.62
10	1.85	4.72
20	1.96	4.80
30	2.02	4.80
50	2.09	4.90
100	2.19	4.97

7.1.5.6 Sea Ice Thickness

Sea ice thickness values are given for both freeze-up and break-up conditions. Freeze-up is defined as the time at which a continuous and immobile ice cover forms. Breakup is the time when the ice cover begins to move downstream in a river or when open water becomes extensive at the measurement location.

The design sea ice thicknesses are shown in Table 7-6 (Refer Appendix A7-3 and A7-4).

Table 7-6: Design Sea Ice Thickness Values

Description	Value	Notes
Freeze-up	0.9 m (first year)	Note[1]
Break-up	2.05 m (first year)	

[1] Design ice thicknesses are not presented here for old ice because it was shown that the annual probability for an old ice loading event is less than 0.01.

7.2 Codes Standards and Criteria - Regulatory

The Mary River project is located in the territory of Nunavut, Canada, and falls within the jurisdiction of the Nunavut Mine Health and Safety Act. All Facilities and equipment are required to comply with:

- The National Building Code 2010.
- Nunavut Mine Health and Safety Act (S.N.W.T 1998 C.34).

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- Nunavut Mine Health and Safety Regulation (R-125-95).
- Nunavut Electrical Protection Act (R.S.N.W.T. 1988 C.E-3).
- Nunavut Electrical Protection Regulation (R.R.N.W.T. 1990 C.E-21).
- National Fire Code of Canada.
- Canadian Electrical Code.
- CCME PN1326 Above Ground and Underground Storage Tank Systems.

In addition to legislated codes and standards the design has been developed generally in compliance with:

- Applicable Canadian Standards.
- Recommendations contained within the Nunavut Good Building Practice Guidelines.
- Design Criteria and standards developed for the Mary River Expansion Stage 3.

7.3 Hydrology

7.3.1 Regional Characterization and Stream Flow Estimates

Regional hydrologic characteristics and stream flow estimates for the Mary River site are summarized in the Hydrology Baseline Report (Refer Appendix A7-4):

> *Baffin Island is one of the northernmost and coldest parts of Canada and the Mary River Project is situated towards the northern end of the Island. The long duration of sub-zero temperatures in this region results in a very short runoff period that typically occurs from June through September, but may extend to late October or even early November in systems where large lakes are present. The frigid temperatures also result in very low precipitation values, from the combined effect of the low moisture carrying capacity of cold air and the scarcity of liquid water for much of the year. According to Natural Resources Canada, the mean annual total precipitation ranges from 200 to 400 mm in the Project area, classifying it as semi-arid. Processes that act to further limit water available for runoff are evaporation, transpiration and sublimation. The frigid climate and subsequent lack of significant vegetative cover combine to minimize the volume of water evaporated and transpired to very low levels. Sublimation, which is the process by which solid water changes phase directly to water vapour, occurs during the winter months and is increased by blowing snow transport which is very common in the Mary River region. Therefore, sublimation may result in a greater loss of potential runoff than either evaporation or transpiration, and has been found to result in losses of up to 50% of winter precipitation in Arctic environments (Liston and Sturm, 2004).*

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As temperatures rise above freezing snow and ice melt commence. Considerable differences in the timing and volume of runoff occur between systems depending on elevation, aspect, glacial cover and lake cover. A watershed's elevation affects the timing of the onset of the summer melt, and can also affect the volume of precipitation it receives as a result of orographic influences. The aspect of a watershed can also play a role in the timing of the summer melt, and possibly in the depth, and therefore volume, of permafrost melt later in the summer. Glacial cover tends to greatly increase the volume of runoff in a watershed, especially in the late summer, relative to other catchments that receive runoff only from permafrost melt and precipitation. Finally, lake content within a watershed acts to attenuate the effects of storm and melt events, resulting in a smoothed hydrograph without the rapid changes in runoff observed in catchments without significant lake area. Lakes also provide a source of water to river systems later in the year, due to attenuation of inflows, when precipitation is falling as snow, permafrost melt has ceased, and other systems are no longer receiving input of water and are therefore drying up and/or freezing over. As a result, systems that include significant lake components tend to continue to flow later into the winter than watersheds with little or no lake volume. The presence of permafrost within the watersheds of the region, coupled with the lack of vegetative cover, also has an effect on hydrologic systems. Permafrost typically does not allow water to infiltrate the ground to any great depth, while the lack of surface vegetation results in little to no impedance or loss of runoff as it flows to the river channels. Therefore, storm driven runoff events tend to produce flashy streamflow conditions.

Five regional hydrologic stations operated by WSC were reviewed in an attempt to characterize the hydrology in the region around the Mary River Project Area. Due to the sparse hydrologic network in the Canadian Arctic, these systems are a significant distance from the Project, have records with few complete years, and are not all currently active. The five stations range in location from 640 km northwest, to 1000 km southeast of Mary River, and have drainage areas ranging from 60 km2 to 2980 km2. These systems begin to flow in late May to mid-June, with the southern watersheds melting earlier than the northern watersheds. The majority of annual runoff then typically occurs during the nival freshet in late June through July, with runoff decreasing through the late summer before freezing up again at the onset of winter. The freeze-up date is significantly different between the northern and southern sites, ranging from late September in the northern watersheds more similar in latitude to Mary River, to November and December for the sites located far to the south near Iqaluit. Mean annual unit runoff (MAUR) also differs between the northern and southern watersheds. The southern watersheds have an average MAUR of 10 l/s/km2, while the northern watersheds average 6 l/s/km^2. The mean annual peak daily unit runoff varies more randomly amongst the sites, with a low of 105 l/s/km^2 at Marcil Creek and a high of 251 l/s/km^2 on the Mecham River. Through analysis of the regional WSC streamflow stations, it is assumed that the smaller, non-lake containing watersheds in the immediate vicinity of

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the Mary River Mine Site should begin to flow in early to mid-June and cease to flow in late September to early October, have MAUR values of approximately 8 to 10 l/s/km^2, and have mean annual peak daily unit runoff values ranging from approximately 100 to 400 l/s/km^2. In watersheds containing significant lake coverage, flows are expected to end later and have a lower mean annual unit runoff.

Climate change was also discussed as it pertains to the Mary River Mine Site. It was concluded that a conservative approach should be applied to hydrologic estimates to account for potential changes in annual, seasonal and extreme flow events due to climate change.

7.3.2 Rail Hydrology Characteristics

Hydrologic characteristics for the Tote Road from Mary River to Milne Port were investigated by Knight Piesold (KP) in 2006 and are summarized in KP memorandum Hydrology for Tote Road Design (Refer Appendix A7-6). The KP hydrology work followed industry standards, and is considered valid and sufficient for the study. In 2016 KP updated the regional analyses performed previously with new data collected by WSC since 2006. Refer to Knight Piésold document in Appendix A7-8.

Utilising the Water Survey of Canada (WSC) data, KP calculated both “normal” and linear moment (L-moment) statistics on the historical peak daily flow records. From this data expected Q_{mean}, L-Stdev, L-Cv (linear moment coefficient of variance), and L-Cs (linear moment coefficient of skewness) statistics at the 10 km^2 and 1000 km^2 basin scales were derived. Peak instantaneous, rather than peak daily, flow estimates are typically required for culvert or bridge design. KP used the few WSC gauges having concurrent peak daily and peak instantaneous flow data to develop ratios of instantaneous to peak flows to drainage area. This relationship was applied to the estimates of peak daily flow values to yield final estimates of peak instantaneous flow values for a range of return periods. KP considered these relationships applicable for basins with drainage areas from 0.5 km^2 to 1000 km^2. KP recommended the Rational Equation ($Q = CIA$) for basins smaller than 0.5 km^2, using a runoff coefficient, C, of 0.90 and a rainfall intensity/corresponding to the basin’s time of concentration as computed using the Kirpich Equation.

7.3.3 General

The hydraulic design for culverts and bridge structures for the Tote road was based on 1 in 5 years return flood period, whilst normally 1:50 for culverts and 1:100 return floods and intensities for major structures are considered for railway line designs.

The Hatch Feasibility Optimization report also recommended that the initial Steensby approach to analyze and provide for 1:200 return periods be adjusted to 1:100 year return periods after analysis showed that there wasn’t a substantial change in run-off volumes – only a 10.9% reduction in design volumes.

The hydrologic analysis for the Tote road has been reviewed refer to Appendix A7-7 titled the In-Principle Review of Previous Tote Road Hydrology Assessments.

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Baffinland Iron Mine requested Knight Piésold to complete an update of previous studies concerning the design peak flows for the region and to incorporate the most resent stream flow data. Refer to Knight Piésold document in Appendix A7-8.

7.3.4 Methodology

7.3.4.1 Design Peak Flows

In the Hatch report reviewing Hydrologic analysis for the Tote Road (refer Appendix 7-7) Hatch raised queries with regard to the method used to derive the design peak flows. Following the updated design peak flows by Knight Piésold, the following methodology was adopted by the project for the design of drainage structures.

Drainage structure locations will be identified along the proposed rail alignment, some of these structures will be to facilitate cross-drainage and others will be to perform the function of balancing culverts to balance the water that may collect in a low spot from either side of the rail alignment.

Catchments will be delineated by the project for all drainage structures, excluding the rail over river bridges which will be delineated by the responsible engineer to be appointed under procurement package CC003.

The delineated catchments will be used in conjunction with the formulas presented as output from the Knight Piésold design peak flows update report to calculate the associated run-off flows for a 1:100 year flood.

The flow volumes calculated were then used to determine the ultimate sizing of the culvert structure in terms of number and size of barrels.

Baffinland Iron Mine will supply information concerning which drainage structures are located in fish bearing streams. BIM will also supply stream flow data for fish bearings streams which, have been monitored on site so as to enable the project to determine the 3-day delay for a 1:10 year flood. This information will then be used to size the drainage structures. It is impossible to have stream flow data for every fish bearing stream. Thus the project will use ratios based on the known flow in monitored stream to scale the flow up or down for other fish bearing streams where no stream flow data is available.

7.3.4.2 Flood Return Period

One in one hundred year return period.

7.3.4.3 Design Velocities

Velocities of water flow through culverts less than 3 m/s subcritical flow. Normal culvert, embankment and stream side slopes treatment against erosion will be applied.

For velocities determined as more than 3 m/s and less than 5 m/s applicable treatment to normalize the flow will be recommended for erosion protection and/or fish bearing streams.

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For flows higher than 5 m/s special treatment shall be considered on a case by case approach.

7.4 Geotechnical

7.4.1 Site Overview

A geotechnical summary for the various project areas has been developed (refer to Appendix 7-16) and a brief overview is provided in the following section. The summary is based on a combination of all the desk and field studies that have been carried out.

7.4.1.1 Milne Port

In general, the overburden soils encountered at Milne Port consist of glacial alluvial deposits of cohesionless soils consisting of sand, sand and gravel, and gravel, containing frequent cobbles and boulders. A thin layer of organics at the ground surface is encountered in some locations. The glacial alluvial deposits are found at the ground surface to a depth of 42 m. Bedrock has not been encountered at the Site within the low lying area located at the base of the rock ridge.

Vegetation is sparse and consists primarily of a variety of mosses and grasses in areas where surface moisture is present during the thaw season. No shrubs or trees exist in the area and no peat deposits have been observed.

The entire Site is underlain by permafrost, except area's of bedrock at the Q quarry location and below large bodies of water where water depths exceed 3-4 m. Ground ice and ice lenses exist throughout the site perimeter.

7.4.1.2 Mine Site

Mary River is located on the north side of a wide valley. The valley wall on the north part of the site consists of granite bedrock overlain by glacial till which rises about 300 m above the valley floor. The glacial till varies in depth from 2 m to over 20 m deep and generally consists of sands and gravels with cobbles and boulders. The topography of the valley wall is steep and the ground surface is mainly covered with cobbles and boulders.

The valley bottom, where the mine infrastructure is located, is underlain by overburden soils that consist primarily of glacio-fluvial deposits and gravelly glacial till that are underlain by sandstone bedrock. The composition of the glacial till varies from sandy silts to sand and gravel; cobbles and boulders are common throughout the till. The glacial till varies in depth from about 1.0 m to over 26 m. The glacio-fluvial deposits generally consist of poorly graded sands and vary in depths from 3 m to over 18 m. The contact between the sandstone bedrock and the granite is located near the toe of the valley wall.

Vegetation is sparse over the entire Site and consists primarily of a variety of mosses and grasses in areas where surface moisture is present during the summer months. No shrubs or trees exist in the area and no peat deposits were observed. Organic soils, which are present in only a few poorly drained locations, are usually less than 150 mm thick.

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The entire area is underlain by permafrost, except below large bodies of water where water depths exceed 3 or 4 m. The maximum annual depth of thaw in this area ranges from 0.5 to 2 m and varies significantly, depending primarily on surface drainage. Large ice lenses are found throughout the site, but are more common in the area of the airstrip.

7.4.1.3 Railway

The proposed railway alignment in preliminary design stage generally follows the existing Tote road with 10 pertinent deviations. Regional geologic mapping is available for the entire route of Tote Road (Scott and de Kemp, 1998), which can be used for railway preliminary design. In summary:

- Approximately the first 20 km of the Tote Road from Milne Inlet passes through Precambrian terrane, glaciofluvial sand and gravel terraces.
- The middle 70km spans across relatively flat lying Paleozoic rocks mainly dolomitic limestone units.
- The final 14 km of the road to the Mary River mine site traverses glaciolacustrine and glaciofluvial plains, terraces, eskers and bedrock outcrops ranging from granitic gneiss to sedimentary rocks.
- The rail line follows the Tote road alignment between Mary River Mine and the Milne Port to a large extent with 10 pertinent deviations. These deviations are required due to permafrost, the topography, and the geotechnical findings.

Based on the existing geotechnical investigation data along the Tote Road, alternating deposits of cohesionless soils consisting of sand, sand and gravel, gravel, cobbles and boulders were generally encountered. Bedrock was encountered at three of the bridge locations at depths varying between about 6 m and 14 m below existing ground surface. Typically gneiss bedrock was encountered near Milne Inlet and gneiss, schist and carbonate bedrock were encountered near Mary River Site.

Layers of cobbles and boulders were encountered at Milne Inlet and along the Tote Road. Cobbles and boulders were noted during the limited geotechnical investigation to be present within the majority of the cohesionless deposits at various depths with variable thickness.

A significant portion of the Railway alignment site is underlain by permafrost with an estimated annual thaw depth ranging from 0.5m to 2.5m.

7.4.1.4 Permafrost and Active Layer Thicknesses

The permafrost depth and active layer thicknesses are shown in Table 7-7.

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Table 7-7: Permafrost Depth and Active Layer Thicknesses

Frost	Value	Addition for Global Warming[1]
Permafrost Depth Depth of Active Layer: • Till • Sand and Gravel	Down to Rock 0.6 – 3.0m 1.0m 1.5 – 2.5m	 0.5m max. 1.0m max.

[1] Global Warming allowance for 50 years can be included by adjusting values for active layer thickness.

7.4.2 Field Investigation

7.4.2.1 Previous Studies

Multiple geotechnical investigations have previously been conducted at the Mary River mine site, Steensby Inlet port site, Milne Inlet port site and along the Milne Inlet Tote Road, including:

- Knight Piesold Consulting Ltd investigation programs in 2006 (refer Appendix A7-11), 2007 (Refer Appendix A7-12), and 2008 (refer Appendix A7-13).
- AMEC Earth and Environmental investigation in 2010 (refer appendix A7-14)
- Thurber Engineering Ltd. investigation in 2011 (refer appendix A7-15).
- Hatch investigation programs and geotechnical interpretations from 2011 to 2014 (refer to Appendices A7-35 to A7-40)

7.4.2.2 2016 Expansion Project Drilling Program

Hatch was retained by BIM to conduct geotechnical drilling investigations for the design of the railway alignment spanning from Milne Port to the Mine Site and for the proposed infrastructure at Milne Port. The drilling program consists of two phases; the first phase was executed in Q4 of 2016; the second phase is currently being executed and is discussed in the following section.

Drilling supervision, field core logging and sampling was carried out by Hatch. Boart and Longyear Ltd. was selected as the drilling contractor. Hatch field personnel and the drilling contractor mobilized to site on September 28, 2016. The field investigation was completed on December 14, 2016.

A total of 113 boreholes were drilled ranging from a depth of 1.5 m to 30 m. There were 88 boreholes drilled at the proposed rail alignment, 12 boreholes drilled at the proposed rail bridge abutments, 5 boreholes drilled at proposed rail quarry locations and 15 boreholes at Milne Port.

These boreholes provide data regarding overburden depth, soil type, ground ice and type of bedrock. Approximately 590 samples were collected on site and shipped to the Hatch geotechnical laboratory in Niagara Falls for further analysis.

Due to access restrictions drilling was not completed in 2016 along the major rail alignment deviation from nominally tote road km60 to km78 or at the abutments for bridge 2.

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Most quarry location boreholes were not drilled in the 2016 investigation due to weather constraints and challenges associated with location access. However:

- Representative samples of the Dolomitic limestone were recovered approximately 3 km east of the rail alignment at Km 58.
- A sample of the granitic gneiss was collected from the rail unloading area boreholes at the Milne Port.
- Diorite samples were collected from the surface near Km 103 during a site visit in September 2016.

Boreholes were drilled at Milne Port at locations of the proposed infrastructure (per the site layout at the time of drilling) including rail unloading, tanks, crusher, screening, tail pulley, reclaimer berm, reclaim tunnel and conveyors.

The data and findings from this investigation can be found in Appendix 7-9 and Appendix 7-10.

7.4.2.3 2017 Expansion Project Drilling Program

Further geotechnical drilling is currently being executed by Hatch and Boart Longyear including:

- Marine drilling program in the area of the proposed ore dock
- Boreholes along the major rail alignment deviation from nominally tote road km60 to km78
- Boreholes at the abutment locations for rail bridge 2
- Boreholes at specific locations of cut identified by the rail design and geotechnical teams.
- Ground penetrating radar investigations.

Field observations and results to date generally align with expectations.

7.4.3 Preliminary Geotechnical Recommendation for Railway Embankment

Requirements for constructing stable rail embankment along the proposed alignment were initially developed referencing previous field reports from early Tote Road investigations and were subsequently updated following a field inspection and air photo interpretation by Hatch in 2016 (refer to Appendix A7-17).

Recommendations for rail embankment by sub-grade type were established (refer to Appendix A7-18) jointly between the geotechnical and rail engineering teams including:

7.4.3.1 Railway Embankment-Section I – Cuts in Precambrian Rock

Figure *7-5* shows the typical Cross Section I of the railway embankment. Embankment Section I can be utilized where the railway is re-routed through the Precambrian terrain in order to found the embankments on rock. This is expected to be feasible between

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approximately Cha 0+000 and 10+000, 82+000 and 85+000 and 95+000 and 105+000. Section I consists of:

- A layer of sub-ballast material (i.e. crusher run granular material) to level the blasted bedrock. The thickness is expected to vary because the blasting is expected to produce an irregular surface. The minimum leveling layer thickness is 150mm.
- A ballast layer (Type 25) placed on top of the Type 26 leveling material. The detail design of ballast and sub-ballast layer should follow the standard railway drawing.
- The bedrock is expected to be massive; and as, such slopes of 8V:1H should be feasible with benches at 5m vertical intervals.
- There should be a 2000 mm off-set between the edge of the railway embankment and the toe of the rock slope to collect debris. Ideally, this zone should be sloped toward culverts to allow cross-drainage.
- Embankment Section 1 is recommended for the railway on bedrock in the Precambrian terrains.

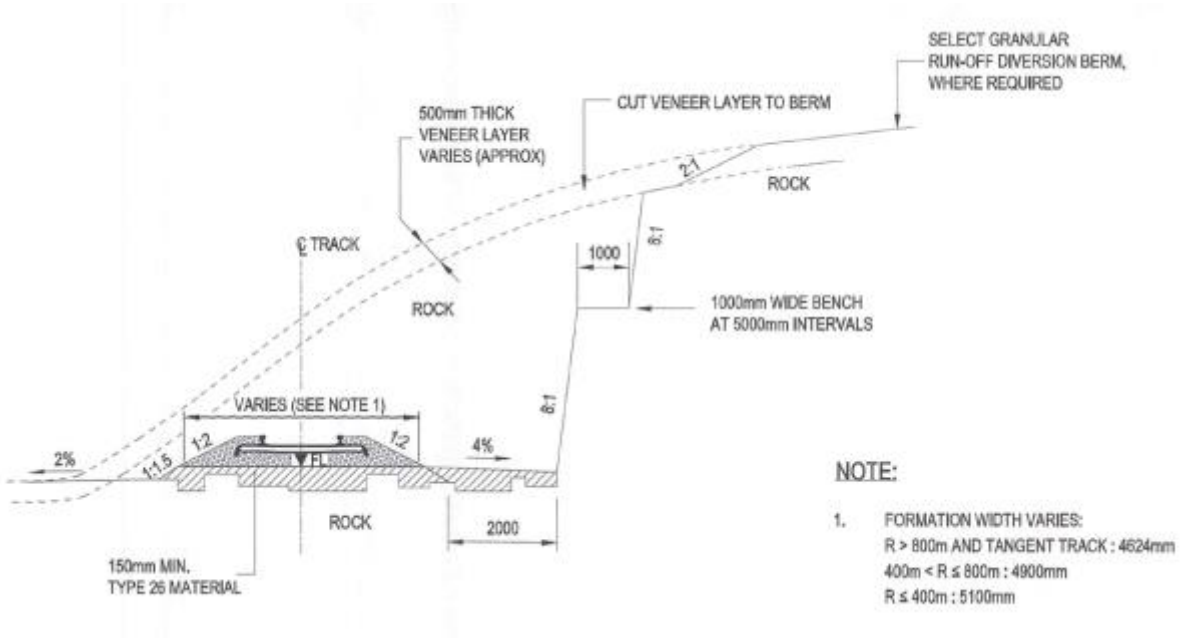

Figure 7-5: Typical Cross Section of Railway Embankment – Section I

7.4.3.2 Railway Embankment-Section II – Cuts in Limestone

Section II is proposed for the railway deviation between Cha 60+000 and 75+000 where the alignment can be situated to follow shallow or outcropping limestone beds, which show as small mesas or ledges in the terrain.

As shown in Figure 7-6, this type of embankment section consists of:

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- A layer of sub-ballast material (i.e. crusher run granular material) to level the blasted bedrock. The thickness is expected to vary because blasting is expected to produce an irregular surface. The minimum leveling layer thickness is 150mm.
- Ballast material (Type 25) placed on top of the Type 26 leveling material. The detail design of ballast and sub-ballast layer should follow the standard railway drawing.
- The bedrock is expected to be bedded and the depth of cut should be predominantly less than 5m. In most areas, the rock should remain stable if cut at 8H:1V.
- There should be a 2000 mm off-set between the edge of the railway embankment and the toe of the rock slope to collect debris. Ideally, this zone should be sloped toward culverts to allow cross-drainage.
- The soil veneer is expected to be less than a meter thick; but locally it could be thicker. The soil will need to be stripped and stored in quarries or used to construct diversion berms to route run-off toward creek and stream beds.

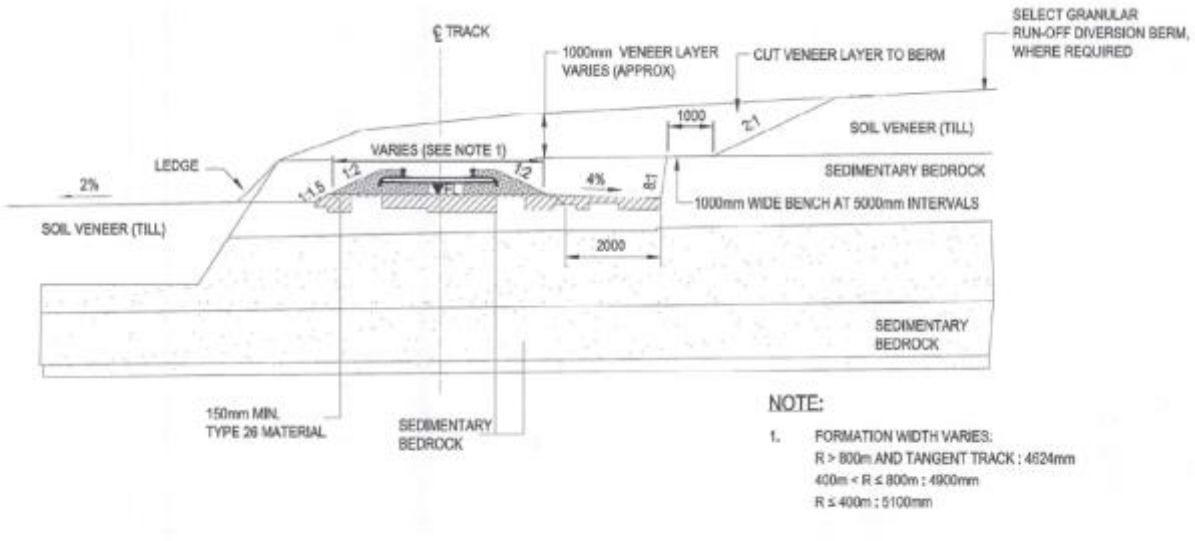

Figure 7-6: Typical Cross Section of Railway Embankment – Section II

7.4.3.3 *Railway Embankment Section III – Embankments on Permafrost Soil*

Section III is proposed for the railway on undisturbed (uncut) permafrost soil. As shown in Figure 7-7, this type of embankment consists of:

- A layer of compacted run-of-quarry rockfill (Type 12) founded directly on the undisturbed permafrost. A non-woven geotextile should be placed over the permafrost soil where the railway traverses ice-rich and fine-grained soils.
- A minimum 150mm thick sub-ballast layer (Type 26) on the Type 12 fill. The Type 26 material should be used to choke the rock fill embankment prior to placing the sub-ballast

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layer. Choking refers to using bulldozers, tired trucks and vibratory rollers to force the finer Type 26 material into the open pore space of the Type 12 rock fill until a stable base is achieved.

- The combined minimum thickness of the Type 12 and Type 26 materials should be 700mm for embankments on non-, potentially- and moderately - thaw susceptible permafrost. It should be increased to 1500mm on ice-rich soils or highly thaw-susceptible soils. Due to the sloping and undulating terrain, it is expected that the minimum thickness will occur only rarely at high-points in the sub-grade along the rail alignment. These high points should be assessed during detailed design.
- A ballast layer (Type 25) placed on top of the Type 26 leveling material. The detail design of ballast should follow the standard railway drawing.
- Type 12 fill is expected to comprise either run-of-quarry granitic blast rock or limestone blast rock. A side slope gradient of 1.5H:1V is considered suitable for estimating the fill quantities.
- The Type 25 and Type 26 materials should be placed with a 2H:1V side-slope gradient.
- A ditch or diversion berm can be used to manage run-off. The attached figure shows a ditch.

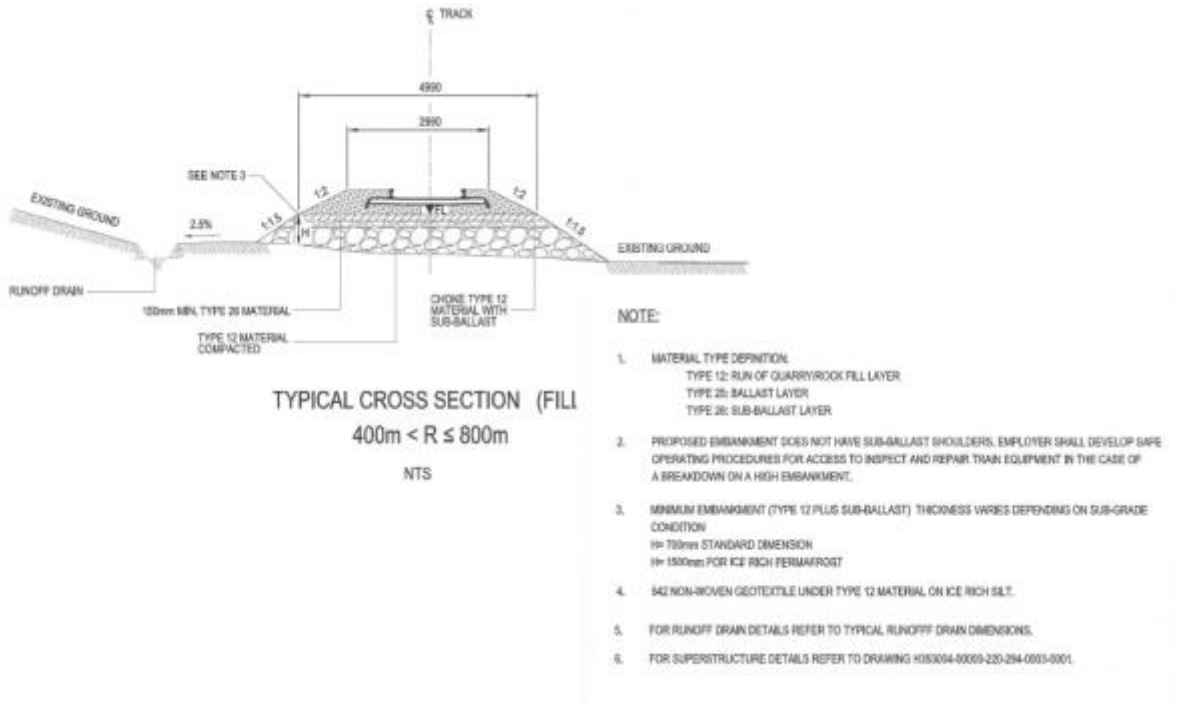

Figure 7-7: Typical Cross Section Railway Embankment on Soil – Section III

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7.4.3.4 Embankment Section IV – Cuts in Permafrost Soil

Lastly, Section IV is proposed for cuts in permafrost soil. Such cuts should be avoided to the extent possible; However, based on the behaviour of cuts made for the Tote Road, occasional cuts in permafrost soil can be managed using the cross-section illustrated in Figure 7-8. Boreholes should be advanced at cut locations to determine if ground ice is present and thermal modelling should be used for design and to assess the risk.

This type of embankment consists of:

- A 1500mm layer of compacted run-of-quarry rock fill (Type 12) underlain by a zone of insulation materials. For estimating quantities, the insulation can be assumed to comprise either an additional 1500mm thick layer of Type 12 fill underlain by non- woven geotextile (542 g/m^2) or 100mm thick rigid expanded polystyrene insulation board covered by non-woven geotextile (542 g/m^2).
- A minimum 150mm thick sub-ballast layer (Type 26) on the Type 12 fill. The Type 26 material should be used to choke the rock fill embankment prior to placing the sub-ballast layer. Choking refers to using bulldozers, tired trucks and vibratory rollers to force the finer Type 26 material into the open pore space of the Type 12 rock fill until a stable base is achieved.
- A ballast layer (Type 25) placed on top of the Type 26 leveling material. The detail design of ballast should follow the standard railway drawing.
- Type 12 fill is expected to comprise either run-of-quarry granitic blast rock or limestone blast rock. A side slope gradient of 1.5H:1V is considered suitable for estimating the fill quantities.
- The Type 25 and Type 26 materials should be placed with a 2H:1V side-slope gradient.
- The cut side-slopes should be covered with a 500mm thick layer of Type 12 material to retain the soil as it thaws.

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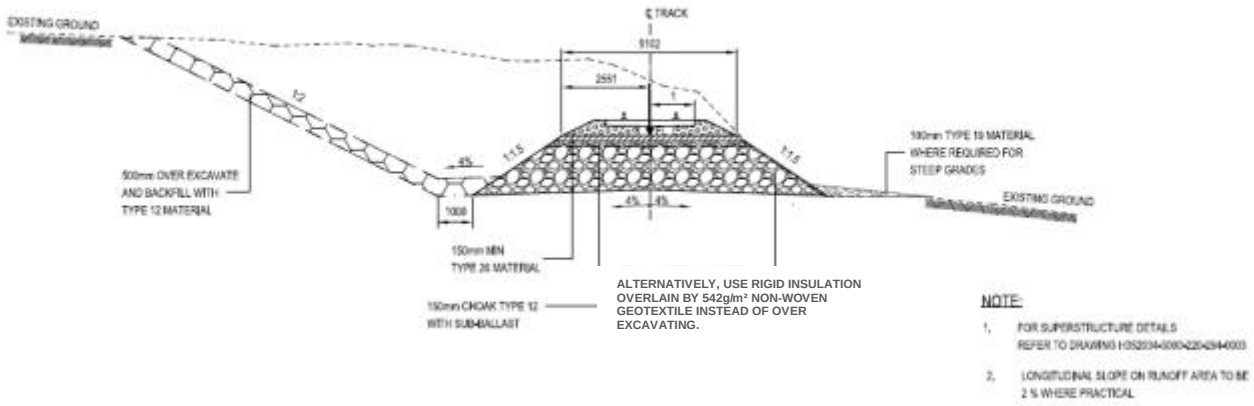

Figure 7-8: Typical Cross Section Railway Embankment in Soil Cut – Section IV

7.4.4 Preliminary Geotechnical Recommendation for Infrastructure

7.4.4.1 Overview

Geotechnical criteria for building foundations (refer Appendix A7-19) have been developed and preliminary geotechnical recommendations for different types of foundations of infrastructures at Milne Inlet, Mine Site and for the Railway Bridges have been provided (Refer Appendix A7-20).

Infrastructure foundations at Milne Port, the Mine Site and for the Rail Bridges are expected to be a combination of the following types depending on the specific requirements:

- Shallow foundation on rock.
- Shallow foundation on permafrost.
- Adfreeze pile.
- Rockfill Embankment with shallow foundation.

7.4.4.2 Shallow Footings

The allowable bearing capacity of different types of shallow foundation are estimated based on the following assumption.

- The existing subgrade soil is assumed non ice-rich permafrost in this preliminary design stage. It should be noted that, for footing placed on ice-rich soil, the serviceability of the foundation should be checked for secondary creep.
- The proposed shallow foundations at Milne port will be constructed on an engineered fill (granular pad) with a minimum thickness of 400 mm of Non Frost Susceptible (NFS) material. There will be no embedment considered for the foundations at this stage.

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- An internal friction angle of 32° and a cohesion of zero are assumed for the soil shear strength parameters. Soil bulk density is assumed 20 kN/m^3.
- The engineered fill is placed and compacted to meet required specifications. Surface drainage is maintained to prevent formation of ice lenses.
- Bearing capacity is estimated based on the generalized foundation equation described in the Canadian Foundation Engineering Manual, 4th Edition.
- A factor of safety of 2.5 applied to the ultimate bearing capacity.

The estimated bearing capacities for different types of shallow foundation are shown in the design charts listed as follows:

- Bearing capacity for square footing: Figure 7-9.
- Bearing capacity for rectangular footing: Figure **7-10**.
- Bearing capacity for strip footing: Figure **7-11**.

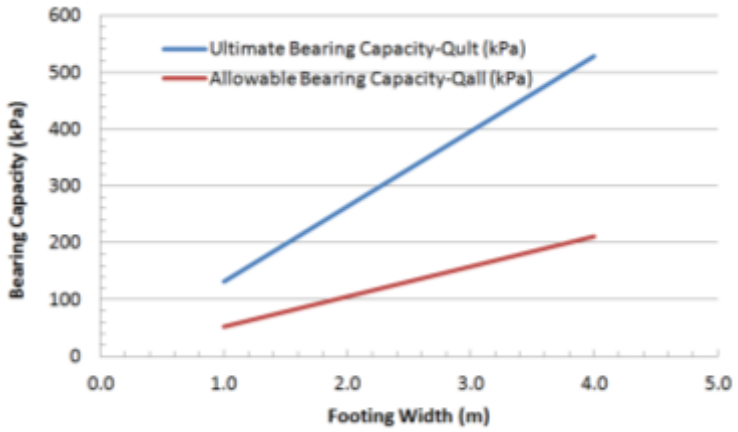

Figure 7-9: Bearing Capacity for Square Footing on 400 mm Granular Engineered Fill (L/B=1 with B=1 tm to 4 m)

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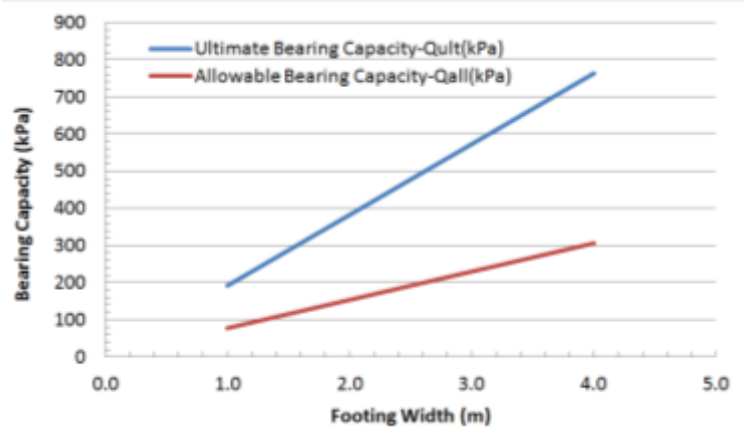

Figure 7-10: Bearing Capacity for Rectangular Footing on 400 mm Granular Engineered Fill (L/B=3 with B =1 m to 4 m)

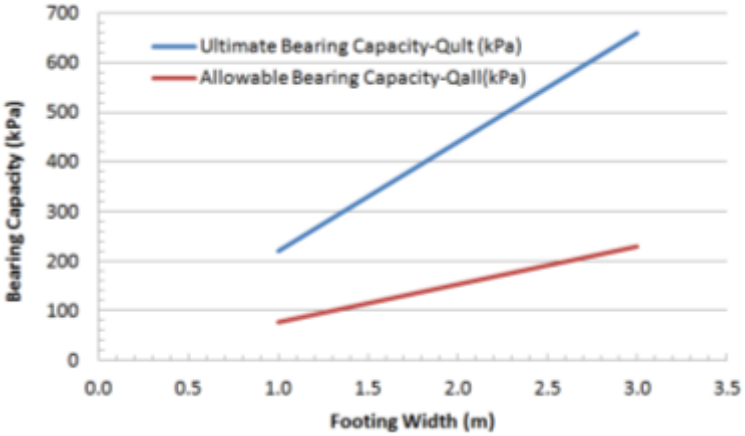

Figure 7-11: Bearing Capacity for Strip Footing on 400 mm Granular Engineered Fill (L/B>10 with B =1 m to 3 m)

Modulus of Subgrade Reaction was also investigated.

Considering the soil conditions at Milne Inlet sites, the modulus of subgrade reaction recommended by Knight Piesold (2007) are considered suitable Table 7-8 provides the modulus of subgrade reaction for foundations with different widths.

Table 7-8: Modulus of Subgrade Reaction

Foundation Width (m)	Modulus of Subgrade Reaction (MPa/m)
1.0	66.0
1.5	44.0
2.0	33.0
2.5	26.0
3.0	22.0
3.5	19.0
4.0	16.5

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- Slab on Grade: The building slab at Milne port site will accept loads from mobile equipment and maintenance activities. A modulus of 30 MPa and 20 MPa should be utilised for the Mine Site and Milne Port site respectively.

7.4.4.3 *Thermal Insulation Design Consideration*

To minimize permafrost related settlement and foundation failure, the foundation strata and fill materials under footings shall be maintained in its permafrost state. Protection from heat transfer shall be included in the construction.

The engineered fill (granular pad) shall include sub-grade insulation 150mm thick below the footprint of all slab-on-grade and similar buildings. Sub-grade insulation shall be covered by 400mm of compacted engineered fill (granular pad)

Building foundations installed above grade (such as pre-cast concrete foundations blocks placed on grade) shall be installed without insulation. Excavated building foundations shall be constructed with 100mm thickness of rigid insulation below foundation, and floor slabs shall be constructed with 100mm thickness of rigid insulation directly under the concrete.

The type of insulation to be used (refer Appendix A7-21) is to consist of extruded polystyrene with the following properties:

- Compressive Strength: 414 kPa.
- Thickness: 51mm, 102mm, 150 mm.
- Size: 0.6 m by 2.4 m.
- Edges: shiplapped (square if shiplapped not available).

7.4.4.4 *Embankment Berm for Rail Stacker/Reclaimer Machine*

Embankment berms for stacker/reclaimer machine are normally subjected to large static and dynamic machine loadings. The stability of these berms and acceptable deformation of machine foundations under working loads are of paramount importance to ensure a safe and cost effective mining operation.

The preliminary geotechnical recommendations for the embankment berm at Milne Inlet are summarized as the following:

- The embankment berm consists of a 200 cm thick compacted rock-fill (Type 8) material underlain a stiff geotextile on the existing ground. The side slope is 1.5H:1V. The maximum height of embankment depends on the design grade at the project site.
- The allowable capacity of the proposed compacted rock-fill embankment is 200 kPa.

It should be noted that the detailed geotechnical engineering assessment shall be carried out to confirm the preliminary design when the design loading and the site specific geotechnical data are available. The geotechnical engineering assessment consists of the following but not limited to:

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- Bearing capacity.
- Embankment stability (local and global) under machine loadings.
- Design of geosynthetic reinforcements.
- Foundation deformation under machine loadings.

7.4.4.5 Adfreeze Piles

Pile foundations in permafrost soil can normally be selected from adfreeze or rock-socketed piles depending on the characteristics of the site and bedrock depth. Since the bedrock depth at the Milne Port site and Railway bridge locations has not been established, for preliminary design stage, only the adfreeze pile option will be studied. In addition, it is assumed that steel pipe piles with nominal diameters ranging from 4” to 12” could be utilized in this project.

The pile capacity calculation has been carried out for pipe piles with diameters of 4”, 6”, 8”, 10” and 12” with embedment lengths ranging between 2 m and 20 m. It is of note that the embedment length corresponds to the length within the permafrost layer (ignoring the length of the pile within the active layer).

7.5 Railway Track and Operation

The optimised 110 km standard gauge rail line and railway system will be designed to allow year round railing of iron ore from Mary River Mine to Milne Port using the rolling stock and support equipment. A Railway Design Criteria and Design Rational has been developed (refer appendix A7-22) and applies to the civil engineering and operational design of the railway system. It has been developed based on the following assumptions:

- The primary usage of this railway is for transporting of primary crushed iron ore from the mine site loading facility to an off-loading facility above the stockyard for the crusher at Milne Port. No consideration has been made for passenger service.
- The operating speed for all trains, loaded or empty, will be 60km/h in both directions. The design speed will be 75 km/h. Operating speeds are unlikely to be adjusted upwards in the future. The geometric design criteria for safe operation is based on these operational requirements and loading factors. Where these geometric design criteria cannot be met, due to site conditions imposed by impacts of permafrost, topography and cost, minimum acceptable design criteria and mitigating operating rules like speed restrictions will be proposed.
- The typical heavy haul Diesel Electric Locomotives (4400 HP) that will be used on the line will have 33 tonnes axle loads (TAL), whilst the typical standard gauge gondola ore cars will have a practical capacity to carry 108 tonnes iron ore with a tare weight of 22 metric tonnes or 32.5 TAL.
- The railway will be operated and maintained by BIM as a privately owned railway system.

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7.5.1 *Railway Operations*

The operating requirements dictate the design parameters and criteria for the track, supporting infrastructure and systems that need to be developed inside the environmental and other constraints to support a sustainable operating model irrespective of the optimizing measures taken.

The ore trains will be unit trains dedicated to ore traffic configured to remain as a complete train-set throughout the operation cycle with at least one locomotive at each end. Trains will only be uncoupled for planned or emergency maintenance purposes on cars or locomotives. This consideration was made also due to climatic reasons in order to prevent the air pipe from freezing.

As part of the railway operations study, a rail operations static and dynamic model was defined (refer Appendix A7-23). Rolling stock fleet plan and train schedule options were developed to determine various aspects required for the export of a total of 12Mtpa iron ore. Hatch used various modelling tools for completion of the study; these include Rail Traffic Controller dynamic simulation software as well as static excel based tools developed in-house.

Table 7-9 summarizes of the findings and recommendations for the design criteria for Rail Operations.

Table 7-9: Operations

Item	Element	Design Criteria
1.	Ore Traffic	12 Mtpa (12.24 Mtpa – wet (2% moisture))
2.	Locomotive Axle Load	33 tonnes
3.	Car Axle Payload - Initially	30 tonnes
4.	Maximum Car Axle Load	32.5 tonnes
5.	Train Design Speed	75 km/h (for in train forces only)
6.	Operating Speed	60 km/h
7.	Locomotives per Train	2
8.	Cars per Train	72 up to 80
9.	Train Design Length (80)	900 m
12.	Gross Weight Loaded (72)	9750 tonnes
13.	Gross Weight Empty (72)	1974 tonnes
14.	Net Weight (72)	7776 tonnes
15.	Trainloads per day (72)	6 Loads/day

7.5.2 *Railway Alignment*

The design criteria for the rail alignment has been based on design criteria related to heavy haul railway operations and support infrastructure. The basic objective is to have the gradients as flat as possible and the radii as large as possible. To achieve these goals 3 deviations are required which take the railway outside the original lease area have been considered to divert around steep hills where the ice rich ground conditions and potentially deep excavations could not be avoided.

Table 7-10 below is summarizes the design criteria for the Railway Alignment.

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Table 7-10: Railway Alignment

Item	Element	Design Criteria
	Horizontal Alignment	
1.	Minimum off-set from Tote Road	15 m
2.	Curve Radius Target	≥ 1000 m
3.	Curve Radius Minimum Target	500 m
4.	Curve Radius Absolute Minimum	230 m
5.	Transition Curves R > 300 m	80 m
6.	Transition Curves R ≤ 300 m	60 m
7.	Tangent Length between Reverse Curves	20 m
	Vertical Alignment	
1.	Vertical Curve rate of Change	0.040 m/20 m/20 m; K=100
2.	Ruling Gradient facing Loaded	1.5% (1:67)
3.	Ruling Gradient facing Empty	2.0% (1:50)
4.	Exceptional facing Empty < 775 m	3.0% (1:33)
5.	Allowed Facing Empty > 775; G>1% to follow	2.2% (1:45)
6.	Grade Compensation for G=1:X in Radius (R)	1: 20/((20/X)-(14/R)).
7.	Gradients in Passing Track	0 to 0.25%
8.	Exceptional facing Empty < 775 m	0 to 0.125%
9.	Allowed Facing Empty > 775; G>1% to follow	0 to 0.1%

7.5.3 Railway Earthworks

The earthworks design criteria for the Railway was developed from the geotechnical findings previously discussed in section 7.4 of this report. Table 7-11 below summarizes the earthworks design criteria for the Railway. Proposed construction details and shown on drawings H353004-00000-220-294-0004-0001, H353004-00000-220-294-0005-0001 and H353004-00000-220-294-0006-0001 (refer to Appendices A7-44, A7-45 and A7-46 respectively).

7.5.3.1 Elimination of the sub-ballast shoulder

The provision of a shoulder on the sub-ballast requires a wider substructure to be constructed with increase in the associated costs. Implementing this with the substructure (embankment) specified in the geotechnical requirements, an embankment constructed largely as rock fill on permafrost, requires significantly more fill.

A sub-ballast shoulder is typically constructed to provide a working area for track repair crews, a walkway alongside the train if it stops on the embankment and additional width to build-up the ballast height to locally level the track in case of embankment settlement. Elimination of the shoulder will require specific safe work procedures and operating plans to be developed and may result in increased track maintenance and repair costs, particularly if local settlement of the embankment occurs.

Following review of the options, a rail cross section which eliminates the shoulder was selected by BIM.

Typical cross-sections for main track, siding and yard tracks are shown in the sections below Figure 7-12(also refer to drawing H352034-3000-220-294-0003, Appendix A7-43).

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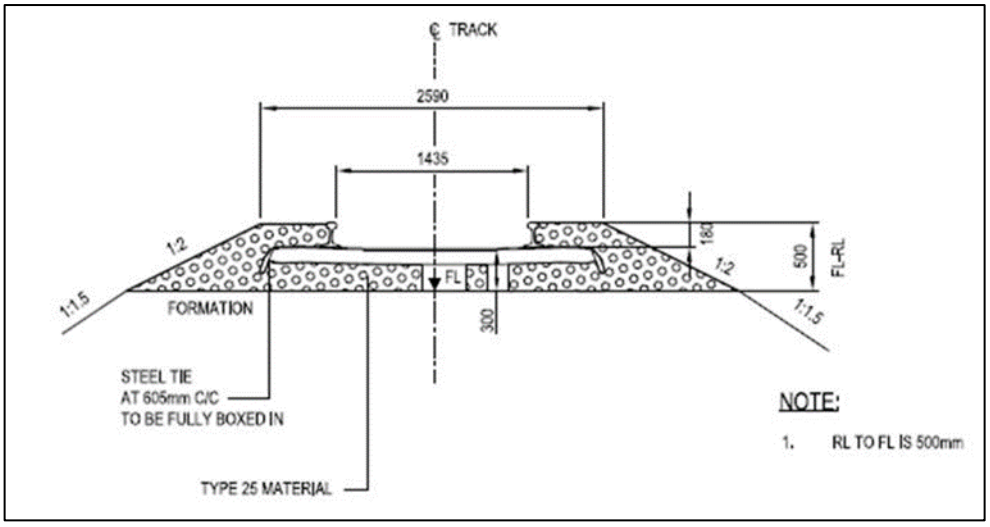

Figure 7-12: Typical Cross Section – Superstructure

The two aspects highlighted as cost reduction measures have been implemented on the project.

Table 7-11: Earthworks

Item	Element	Design Criteria
	Embankments	
1.	Typical Side Slopes	1V:1.5H
2.	Sub Ballast Layer 150 mm	Type 26 Crushed Rock
4.	2nd Layer 550 mm in Non-Susceptible & Potentially Susceptible to Ice soils, choked with Type 26	Type 12 run of quarry rock fill
5.	2nd Layer 1350mm in Moderately Susceptible & Highly Susceptible to Ice soils, choked with Type 26	Type 12 run of quarry rock fill
6.	Geotextile below 1350 mm layer	542 g/m² non-woven
	Sub-grade Cuttings	
1.	Cut side slopes in rock	1V:8H
2.	Cut side slopes ice rich soils	1V:2H (for pre feasibility)
3.	Layer Work, Geotextiles and Polystyrene Insulation	(Refer Section 6.2.2 Appendix A7-22)
4.	Grading Layer Works	(Refer Table 6-3 to 6-5 Appendix A7-22)
5.	Recovery of cut frozen ground for fills	Cut to spoil for STAGE 2 STUDY and investigate for Stage 3 Study

7.5.4 Railway Hydrology

The hydraulic characteristics were previously discussed in section 7.3 of this report. Table **7-12** below summarizes the hydrology design criteria for the Railway.

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Table 7-12: Hydrology

Item	Element	Design Criteria
1.	Design Peak Flows	Extrapolated from Tote study
2.	Flood Return Period	100 years
3.	Design Flows	Q100: V = 3m/sec
4.	Hydraulic Sizing	Factored from Tote for STAGE 2 STUDY

7.5.5 Railway Bridge and Culvert Design

7.5.5.1 Rail Bridge Design Parameters

The design requirements for all bridges required along the length of the railway are as follows:

- Number of tracks = 1
- Number of service roads = 0
- Design life = 50 years

A design criteria has been developed for the Rail Bridge (refer Appendix A7-24) to guide the design of the required rail bridges. It outlines the requirements for the rail bridge with regards to the following:

- Bridge Types
- Bridge Deck Types
- Bridge Modularisation
- Bridge Geometry
- Loading of Rail Bridge Structures
- Loading Combinations

The bridge design includes the design of both the bridge superstructure and substructure.

Requirements for the bridge superstructure design have been established (refer Appendix A7-25) and outlines the requirements for the bridge superstructure with regards to the following:

- Steel Spans
- Precast Concrete Spans
- Ballast Deck Structure
- Bearings
- Drainage
- Walkways

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- Access for Inspection and Maintenance

Requirements for the bridge substructure design have also been established (refer to Appendix 7-26) and outlines the requirements for the bridge substructure with regards to the following:

- Foundations
- Abutments and Piers
- Steel Towers at Piers
- Handrails and Walkways
- Access for Inspection and Maintenance

7.5.5.2 Culvert Design Parameters

In general, the major culvert structures design shall consider the following:

- Prevention of water accumulation on the sides of embankments.
- Diversion of water and ice away from the toe of the embankment.
- Provide cut-off drains or berms for dispersed flow and accumulate through appropriate culvert.
- Provide appropriate embankment protection where required.
- Provide appropriate inlet and outlet protection and treatment.
- The water shall be channelled with a down chute at such low spots in cuttings into the drop inlet or calming pond.
- Provide culvert barrel treatment, scour holes, wing walls and drop inlets where grades are too steep and water velocity >5m/s.
- Provide oversized culvert with weirs, cut-off collars both ends and natural stones inside culverts where water velocity<5, but >4m/s.
- Provide wing walls both ends where water velocity is <4, but >3m/s.
- Provide basic inlet and outlet protection where water flow velocity is subcritical (<3m/s).

Standard culvert details based on the project criteria and hydrology requirements are shown on drawings H353004-00000-220-294-0001-0001 and H353004-00000-220-294-0002-0001 (refer to Appendices A7-41 and A7-42).

An open for an open base concrete culvert was also developed and is shown in drawing H353004-00000-220-294-0007-0001 (refer to Appendices A7-47). This option was developed to potentially reduce costs associated with crossing at fish habitat locations where a gravel stream bed is required (in lieu of partial fill inside pipe culvert).

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7.5.6 *Railway Track*

The railway track selection for the railway between Mary River and Milne port is based on the following criteria:

- Design axle loads.
- Annual Tonnage.
- Alignment curvature and gradient.
- Maximum train design speeds.
- Extreme Climate Conditions.
- Type of rolling stock.
- Maintenance requirements are somehow compromised with the absence of sub ballast shoulder.
- Ease of welding.

Table 7-13 and Table 7-14 below provide a summary of the design criteria for the railway track.

Table 7-13: Track

Item	Element	Design Criteria
Track Superstructure – Rail		
1.	Mainline, sidings and yards	136 RE or UIC68 equivalent
2.	Mainline Joints	Welded
3.	Yard & Siding Joints	Jointed and Welded
4.	Mainline Ties	Steel H-12
5.	Yard & Siding Ties	Steel H-12
6.	Mainline Tie Spacing	605 mm
7.	Yard & Siding Tie Spacing	605 mm
8.	Curves < R400m Tie Spacing	550 mm
9.	Mainline, sidings and yards Fastenings	Pandrol “e”-clips
10.	Mainline Turnouts	AREMA No. 9 or UIC
11.	Yard Turnouts	AREMA No. 9 or UIC
Ballast		
1.	Ballast Shoulder General	300 mm
2.	Ballast Shoulder on outside of Curves < 350m	600 mm if LWR
3.	Ballast Volume	1600 m^3/km
4.	Sub Ballast Depth	150 mm
5.	Ballast cover between Sub Ballast & Tie	300 mm
6.	Ballast +Tie Height	312 mm
7.	Ballast Shoulder Slope	1:2
8.	Ballast Grading & Properties	Refer Table 9-1 and 9-2 Appendix A7-22

Table 7-14: Yards and Sidings

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Item	Element	Design Criteria
Milne Tippler Yard		
1.	Loading Lines	Part of Mainline km's
2.	Departure Loop	900 m
3.	Loco Run-around Loop	347 m
4.	Loco Workshop Spur	390 m
5.	Car Workshop Spur	215 m
6.	Bad Order Car Spur	205 m
7.	Good Order Car Spur	160 m
8.	Quarry Spur and Y	400 m
9.	Cross Over	120 m
Passing Loop (km's 56.017 to 57.490)		
1.	Siding	900 m
2.	Back Track	350 m
Mary River Mine Yard		
1.	Loading Line right through to Stop Block	Part of Mainline km's
2.	Departure Siding	900 m

7.5.6.1 *Use of steel ties instead of timber ties.*

Installing steel ties represents a capital cost saving of approximately $22M compared to an equivalent timber tie structure (combined saving on track superstructure and substructure). The use of steel ties in cold climate heavy haul operations has not been proven and their use was rejected in previous studies due to concern about brittle facture and longevity of the ties in extreme cold conditions.

As a partial mitigation of the risk associated with using steel ties, a revised timber tie track structure was developed which, includes a steeper ballast side slope angle and results in a footprint only slightly wider than that required for steel ties. The recommendation is to construct the sub-ballast marginally wider than what would be required for a steel tie sub-structure, this allows future installation of timber ties if required.

Following review of the options, installation of steel ties with sub-ballast constructed to allow future replacement with timber was selected by BIM. For details (refer Appendix A7-27) to project memo - Rail Tie Type Trade-off for Extreme Cold Weather Heavy Haul Operations.

7.5.7 *Rolling Stock*

7.5.7.1 *Locomotives*

The locomotives will be diesel-electric locomotives in order to be able to operate in the harsh and extreme cold environment. Locomotives that are successfully operated under these extreme cold conditions are the EMD SD70 ACEM and the General Electric (GE AC4400) locomotives. The new AC traction motor configuration provides more optimized energy consumption and will be the preferred locomotives for this application.

The locomotives are to be standard gauge configuration in order to run on 1435 mm gauge. They are to be equipped with dynamic braking capability as well as distributed power in order to run multiple locomotives on the train. Each locomotive to be connected with the back to the

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train and cab facing forward, as there is no balloon at the port or the mine sites for the train to turn around. The locomotives need to be equipped with F-type couplers that can absorb the maximum pull and compression force of 1600 kN. The locomotives to be equipped with an airbrake braking system.

7.5.7.2 *Cars*

The ore cars will be of standard gauge configuration with 1435 mm gauge and the open top gondola type car that can be tipped by means of a rotary tippler. The cars must be coupled by means of a rotating coupler on one side of the car and cars at the end of the train coupling to the locomotive will have couplers on both ends. This will enable the off-loading of a single car per cycle through the single cell rotary tippler.

Table 7-15 below provides a tabular summary of the Rolling Stock design criteria.

Table 7-15: Rolling Stock

Item	Element	Design Criteria
	Locomotives	
1.	Fleet Size	4+1 for exchange
2.	Locomotive Type	Diesel Electric
3.	Traction	AC Traction Motors
4.	Horsepower	4,400 Hp
5.	Special Specifications	Extreme Cold Weather
6.	Wheel Arrangment	Co-Co (two six-wheeled bogies with all axles powered, separate motor per axle)
7.	Minimum Axle load	32 tonnes/axle
8.	Maximum Axle load	32.5 tonnes/axle
9.	Maximum Length	23 m
10.	Vehicle Gauge	“Plate C” AAR S-2028 or latest AREMA Approved
11.	Loco Wheel track Gauge	Standard 1,435 mm
	Ore Cars	
1.	Fleet Size	152
2.	Car Tare Weight	22 tonnes
3.	Maximum Payload @ 32.5 t/axle	108 tonnes
4.	Coupler to Coupler Length	10.5 m (10.65m incl. Stretch)
5.	Car Width	3.2 m
6.	Maximum Car Height	7.01 m from top of rail

7.5.8 *Rolling Stock Facilities*

7.5.8.1 *Diesel-Electric Locomotive Depot*

The new locomotive maintenance depot facility will be located at the port of Milne and must be designed to perform all maintenance activities on the diesel-electric locomotives that will be used for the main line operation as well as for the shunt mobile located at the maintenance facility. The original designed facilities have been scaled down on floor space for the optimized operations, office requirements and other amenities which have been planned to be modular prefabricated units.

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7.5.8.2 *Main Workshop Facility for Diesel-Electric Locomotives*

The facility must provide for minor and major repairs which must include for A, B and C shedding that will include the following activities:

- Unscheduled repairs.
- Scheduled repairs.
- Unscheduled maintenance.
- Component exchange.
- Wheel cutting.
- Minor engine repairs.
- Fueling.
- Sanding.
- Attend to driver trip report faults.
- Oil top-up on sub-systems.
- Electronic cards/modules exchange.
- Toilet servicing.

The locomotive maintenance facility must be fully enclosed in a maintenance building/shed and one locomotive must be able to be serviced in the facility at any given time. The servicing line must be equipped with a pit that will allow maintenance staff to enter underneath the locomotive when stationary on the rail line inside the workshop. Access stairs to be provided at both ends of the pit and adequate lighting to be provided inside the pits. An extension of the locomotive workshop line is provided for on the outside of the shed to allow temporary storage space for a locomotive awaiting parts or further work.

Mobile scissor jack platforms will be provided to allow maintenance staff to obtain access to both sides of the locomotives and perform maintenance activities. The scissor jack platforms must also be able to lift small components (max 500 kg) that must be installed on the locomotive.

One overhead crane with a capacity of 15 tonnes must be provided to traverse both the locomotive and car workshop areas and move heavy components within the depot. A forklift with lifting capacity of 15 ton will be used for other lifting activities inside the workshop.

The locomotive inspection platforms and pit areas will be equipped with 380V and 220V power connections as well as compressed air sockets for electrical and pneumatic maintenance tools being used by the maintenance staff.

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The pits will be designed to allow for easy construction as well as allow the cleaning of the locomotive below deck equipment and bogies during inspection cycles. The floor design allows for the drainage and collection of effluent from the pit area which will then be treated on site. Adequate light to be provided inside the pits in order for staff to perform inspections. These lights must be waterproof and adhere to IP65 standards.

The locomotive maintenance facility must be able to maintain the dedicated locomotive fleet of 5 mainline diesel-electric locomotives and one shunt mobile.

The facility must have adequate space for storage of locomotive components in the prescribed manner and this facility must form part of the main shed structure.

Office provision must also be made to accommodate the required staff levels at the depot and must link to the main shed structure.

The locomotive daily servicing and provisioning will take place on the departure siding by means of mobile fueling, sanding and maintenance equipment.

7.5.8.3 Main Workshop Facility for Iron Ore Cars

The requirement for car maintenance on the dedicated gondola type fleet is that all maintenance activities will be conducted at the new Milne car maintenance depot. Designs of the car maintenance workshop have been scaled down to accommodate two ore cars per cycle in the workshop. An extension of the car workshop line outside the workshop has been provided for cars that await spares or further work.

The following ore car maintenance facility functional design criteria was used in the design of the facility:

- Light repairs.
- Scheduled maintenance.
- Unscheduled maintenance.
- The facility must be able to handle two ore cars in the enclosed area.
- The maintenance facility must be located such that quick turnaround time of cars to be serviced can be achieved.
- Calculations for workshops are based on 365 working days per year.
- Working of day time shifts only.
- Wheel set changes are required at 4 mm hollow wear limit.
- Maintenance on ore car components are based on an exchange principle and sub component repairs are send away for repairs.
- The ore car maintenance facility must be able to maintain the dedicated ore car fleet of 152 cars.

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- The facility must be designed to handle the 2, 4, 6, 8 year maintenance cycles for liftings on the cars and equipment must be able to conduct all these scheduled liftings in the depot.
- The depot must be equipped with lifting jacks that can conduct body and bogie lifts inside the main structure of the depot.
- A separate bogie repair area adjacent to the lifting line must be provided to conduct all maintenance on bogie frames, wheels, sub-assemblies, brake systems, couplers, draw gear and body repairs.
- Provision must be made for full brake system testing after the lifting process and must be conducted by means of a single car brake testing system.
- Provision must also be made in the maintenance depot for a wheel lathe that will be required to cut and profile car wheels of the ore car fleet. The locomotive wheel cuts will be performed by means of a portable wheel lathe which will not require a body lift of the locomotive.
- The facility must have adequate space for storage of car components in the prescribed manner and the facility must be linked to the main shed structure.
- Office provision must also be made to accommodate the required staff levels at the depot and must be linked to the man shed structure.
- Provision must be made for store of the following items: oil, rubber pipe, cleaning agents, small parts, coupler and draw gear, bearings, brake valves, knuckles, seals, gas bottles, lubricants and filters and must be linked to the main shed structure.

7.5.8.4 Rolling Stock Maintenance Facility Stores and Offices

The rolling stock maintenance workshop is designed as a single building that provides space for the locomotive repair and car repair. Stores and offices have been moved adjacent to the workshop in modular format for the optimizing process.

The stores for both locomotive and ore car spares are located on the ground floor of the workshop facility and offices are housed adjacent to the workshop. The stores layout is designed with separate areas for locomotives and cars. Provision must be made for parts received- and dispatch counters with the actual stores located in-between. Space allowance must be made based on the spares requirements of the cars and locomotives.

The bigger component store is equipped with wider doors to allow the delivery and collection of heavy parts by means of a forklift directly from the workshop area. An open area store for larger and heavier components is allowed for. The smaller store areas must be equipped with shelving to increase storage space of the smaller components. The store for small parts provides access for individuals only with no need for access for forklifts.

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Allowance must also be made for a dark and ventilated store room required for all the rubber pipes and seals. Provision must also be made for a locomotive battery store with battery recharging equipment and with suitable ventilation.

Provision is made for two compressor rooms that house a compressor for the car brake testing bays and a separate compressor that will supply air to the rest of the car and locomotive workshop areas. A spate gas and cleaning agent store must be provided and these are all situated outside the main building, approximately 25 m away from the main maintenance building. A run-off water collection treatment facility must be provided for the effluent generated inside the workshop area and must be disposed after treatment.

7.5.9 Wayside Conditioning Monitoring System

The extreme characteristics associated with the Baffinland export rail corridor indicate that the provision of defect detection systems will be of significant benefit. The key characteristics identified are heavy loaded trains, relatively steep and extended gradients, extremely cold conditions and alignment through remote areas. Design criteria has been established (Refer Appendix A7-28) with regards to defect detection systems.

The defect detection systems are limited to fixed track side systems employed to primarily reduce the operational risks associated with a heavy haul operation in extreme conditions, through selective measurements and the generation of early warning alarms. The secondary use of the alarms and the data is for the enhancement of availability and reliability of rolling stock and rail infrastructure.

A typical train defect detection site will consist of; equipment apparatus room, power supply to apparatus room, a car identification tagging system, a communication link to the train control centre, and defect detection system.

Defect detection systems include:

- Wagon Identification system.
- Systems targeting wheels.
- Systems targeting axles/bearing.
- Systems targeting wagons.
- Wayside communications.

7.5.10 Train Control System

The train control system for the 110 km single track railway line will be based on Canadian Rail Operating Rules and will not have line side signals nor track circuits. Functional requirements have been developed (refer appendix A7-29) and are detailed below. The train movements are to be controlled by rail traffic controllers using an Occupancy Control System (OCS) as outlined in the Canadian Rail Operating Rules (CROR) of July 27, 2015.

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The OCS rules that are of specific relevance to this form of rail traffic control are set out in subsections 301 to 3015 of the CROR. The infrastructure and systems to be designed and installed will facilitate this form of railway operation.

The system may consist of a control office located in the Milne Port area and all related telecommunications and train operational infrastructure needed to operate the required train service between the Milne Port Facility and the Mine Site Facility.

The mainline turnouts at the Milne Port, the mid-section passing loop and the departure loop at the Mine Side Facility shall be electrically driven and switched. Six switches located on the mainline shall be automated and machine driven for remote switches purposes by the locomotive driver. These switches are to have the ability to confirm to the locomotive driver, ahead of traversing the switch, the switch position. The remaining turnouts shall be hand operated sets.

The lie of any of the hand operated turnouts needed for a planned train movement is to be set and confirmed correct by local operating staff, ahead of the planned train movements being authorized over these turnouts. The train crew will be able to operate these hand operated turnouts in the absence of local operating staff.

It is proposed that hand operated derailing devices be provided at the ends of the back road that takes off from the mid-section passing loop and at the spur takeoff from the passing loop at the mine siding facility, to protect the mainline from the possible runaway of any unattended wagons staged on the back road and/or spur line.

The train control system, any other related equipment, train personnel and operational staff must be able to function in the extreme climatic conditions that occur in this corridor, namely, extended periods of darkness, intense storms with heavy snow falls, potentially strong winds, the occurrence of permafrost and periodically constrained access.

7.5.11 Road Crossings

Road and rail crossings are designs with visible waring systems only. This comprises of the relevant road and rail side signage as required by Transport Canada regulations. Due to the future decrease in the number of road vehicle trips the published regulations do not require any form of advance warning system to be installed i.e. flashing lights or gates.

7.6 Ore Dock

7.6.1 Ore Dock Elements

The ore dock shall have all necessary access and space required for the operation of the berth. All items necessary for the operation of the marine facilities and as required by the shiploader design shall be accommodated by the Ore Dock.

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7.6.1.1 *Vertical Quay and Dock Area*

The main berth face will consist of structure(s) that act as combined breasting and shiploader support platform. These structure(s) will accommodate fenders to absorb the energy of the berthing vessel, provide contact points for the moored vessel and mooring line points as required.

The main berth face will be equipped with a removable fender system which will provide an impact surface against which the vessel will make contact. The fender will absorb the impact energy so as to protect the vessel and the berth.

Mooring equipment will consist of bollards (or equivalent) spaced along the main berth face so as to facilitate the spring lines for the range of design vessels.

Removable ladder(s) will be provided on the main berth face as required, extending to three (3) rungs below the lowest low water level as a minimum.

7.6.1.2 *Access Causeway*

A causeway shall be constructed to support the conveyor system and provide access for pedestrians and service vehicles from the shore to the ore dock. Access for mechanical, conveyor and electrical systems will also be provided to the ore dock.

Double lane access to the ore dock will accommodate the following vehicles:

- All terrain loader for conveyor cleanup and snow removal.
- Pickup truck.
- Fire truck.
- Maintenance Boom Truck.
- Revetment maintenance vehicle – accessible to repair armour stone on both sides of the causeway.
- Mobile crane for ongoing maintenance.
- Mobile Crane.
- Manitowoc 2250 with MAX-ER attachment (and additional counterweight, rated to 300t capacity).

7.6.1.3 *Berthing and Mooring Infrastructure*

The berthing and mooring infrastructure shall as a minimum include the following items:

- Fender assembly, complete with chains.
- Mooring assembly (Bollards / Quick Release Hooks).
- Motorized capstans.
- Walkway / stairway supports.

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- Handrails.
- Adequate working and access space.
- Edge protection to prevent abrasion by mooring lines.
- Messenger rope reels.

7.6.1.4 Walkways and Quay Infrastructure

Clear pedestrian access to the walkway, stairways and ladders giving access to mooring infrastructure and the gangway shall be provided.

Walkways shall provide pedestrian access linking together all the berthing and mooring infrastructure to the quay area and shall also permit access for small-wheeled trolleys.

The walkways shall be designed for carrying the mooring lines from the vessels to the mooring assemblies and the grating level within the walkway shall not exceed a slope of 1 in 10 and there shall be no steps between walkway terminations and the connecting structures. The minimum clear width of walkways shall be 1.4m.

The structural form shall ensure that no obstructions are present on the seaward side of the walkway at a height greater than 1.2m above grating level to enable easy handing of lines. All members along the uppermost limit of the structure shall be rounded so as not to chafe or abrade lines being passed along. Ends of handrails shall be detailed so that mooring lines cannot catch on the handrail.

7.6.1.5 Access Tower / Gangway

Access Tower / Gangway are to be provided on the quay to allow boarding of personnel. The access tower / gangway design needs to take into consideration the range of design vessel sizes. The access towers / gangways and its components shall comply with national manned elevator codes, lifting appliance codes and shall meet all national working at heights requirements where applicable.

The location of the gangway shall be designed for safe access from the design vessels to the quay areas and should be located at a safe distance from any carrier mooring line or any equipment. The position shall be optimised from the "Spotting Line" with regard to the vessels to use the berthing facilities. The end steps from the gangway (i.e. on board the carrier) shall ensure safe step-down at all times on to the carrier's main deck.

If self-levelling steps are not to be used, the maximum safe gradient of the gangway is taken as 35 degrees, unless the local authorities use a smaller angle.

7.6.2 Site Data

7.6.2.1 Bathymetry

Three sets of bathymetric data are available for Milne Inlet.

- Terra Remote Sensing Inc. (TRSI), September 15-16, 2008.

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- Logistec Stevedoring, 2010.
- Monteith and Sutherland, September 9, 2011.

7.6.2.1.1 Terra Remote Sensing

The TRSI crew at Milne Inlet located a survey control pin and transferred it to a temporary marker near the waterline. The survey vessel was mobilized with the multibeam; single beam and side scan sonar systems. All bathymetric and side scan sonar survey operations were then conducted.

7.6.2.1.2 Logistec Stevedoring

Details of the survey are as follows:

- The depth was obtained with the help of an echo sounder “ODOM HYDROTRAC” with a 0.05 meter precision and was adjusted at a fix depth with a steel plate.
- The positions of the depth and the water level was obtained with a DGPS ”Leica SR530” system used with the differential mode and real time (RT-K) giving a 0.02 meter precision.

7.6.2.1.3 Monteith and Sutherland

The hydrographic survey data was recorded and georeferenced to the NAD83 UTM mapping system. Water levels related to the CGVD28 datum were measured at each survey site throughout the course of each survey. The measured water levels were reduced to Chart Datum by applying the separation between CGVD28 and Chart Datum. The resulting water levels were used to reduce the soundings to Chart Datum.

7.6.2.2 Marine Conditions

Marine conditions to be considered during the design of the Ore Dock have been previously discussed in section 7.1.5 of this report.

7.6.2.3 Marine Geophysical Study

Refer to Appendix A7-48 for details of geophysical surveys conducted in the region of Mary River Dock #1.

7.6.3 Ore Dock Functional Requirements

The ore dock will serve two primary functional objectives which consist of the following:

- Provide a safe, efficient and secure deep-water berth for a range of design vessels including Panamax and Cape Size bulk ore carriers.
- Provide a means of support for the shiploaders, conveyors and associated mechanical equipment used for loading the vessel.

The design of the Ore Dock is guided by the Ore Dock Functional Specification (refer appendix A7-30) which includes the following:

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7.6.3.1 *Operational and Survival Conditions*

The ore dock shall be design to withstand the following operational and survival conditions.

- **Survival:** The ore dock and associated revetments shall be designed to resist an extreme storm event with a return period of 50 years.
- **Operational Shut Down:** Extreme limiting environmental conditions during which the ore send out may be shut down and shiploaders retracted, but with the Capesize Vessel remaining moored to the ore dock. When forecast environmental conditions exceed the Capesize Vessel extreme limiting environmental conditions the Capesize Vessel will sail away and seek shelter. These limiting condition shall be determined by the Design Build Contractor (CG001 – Ore Dock).
- **Installation:** The 10 year return period storm conditions are the design limit for transportation, towing and other marine installation activities.

7.6.3.2 *Annual Operational Periods*

The ore dock will be used to load vessels from during the open water season, which is nominally expected from July 25th to October 15th of each calendar year. Consideration will be given to the possibility that BIM may consider operating beyond the open water season in the future, however this does not constitute a functional requirement.

7.6.3.3 *Ore Dock and Shiploading*

Design operating windows for ore ship loading and expected number of ships to be loaded at Milne Port is summarized in Table 7-16

Table 7-16: Ship Loading Operations Summary

Period	Dates	Ship Type	Ships Loaded Dock #1	Ships Loaded Dock #2
Early Season	Jul 25 – Aug 14	Ice Class	14x Supramax	24x Panamax
Mid-Season	Aug 15 – Sep 20	Non-ice class	22x Panamax	28x Cape Size
Late Season	Sep 21 – Oct 15	Ice Class	8x Supramax*	24x Panamax

7.6.3.4 *Arctic Shipping*

Navigation in coastal waters within Canadian jurisdiction north of latitude 60°N (which includes all shipping access to the Mary River project) is governed by the Arctic Shipping Pollution Prevention Regulations (ASPPR).

Under Canadian legislation ships may enter these waters:

- In accordance with the Zone/Date System (Z/DS) which stipulates opening and closing dates based on Type of ship (ice classification) for each of the zones into which Canadian Arctic waster are divided; or
- In accordance with the Arctic Ice Regime Shipping Systems (AIRSS). AIRSS was introduced as a more flexible system that uses the actual ice conditions to determine whether entry is allowed in an ice regime.

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AIRSS provides flexibility in operations, however for general planning purposes the entry and exit dates listed in the Z/DS are recommended by Transport Canada. Entry and exit dates for Zone 13, in which Milne Inlet and Eclipse Sound are located, are listed in the Table 7-17.

Table 7-17: Permissible Vessel Entry/Exit Dates for Milne Inlet and Eclipse Sound

Canadian ASPPR Category	Equiv. Polar Class[1]	Equivalent International Ship Classifications				Milne Port Entry/Exit Dates	
		ABS Ice Strengthening Class (A1 AMS)	Bureau Veritas Ice Class (1 3/3 E)	Det Norske Veritas Ice Class (1 A 1 ICE)	Lloyd's Register Ice Class (100 A1 LMC)	Z/DS Zone 13 Stipulated Dates	Pre Feasibility Study Basis - Dates Based on Z/DS and BIM Experience
Arctic Class 6+	PC1-2	-	-	-	-	All Year	Polar Class Vessels[4]
Arctic Class 4	PC3-4-5 operating under AIRSS[2]	-	-	-	-	Jun1-Feb15	
Arctic Class 3		-	-	-	-	Jun10-Dec31	
Arctic Class 2		-	-	-	-	Jun25-Nov22	
Arctic Class 1A		-	-	-	-	Jul15-Oct31	
Arctic Class 1		-	-	-	-	Jul15-Oct15	
Type A	PC6[3]	AA or 1A	1A Super	A or 1A	1A Super	Jun25-Oct22	Ice Class Vessels Jul 25 – Oct 15
Type B	PC7[3]	A or 1A	1A	A or 1A	1A	Jul15-Oct15	
Type C	n/a	B or 1B	1B	B or 1B	1B	Jul15-Oct10	
Type D	n/a	C or 1C	1C	C or 1C	1C	Jul30-Sep30	
Type E	n/a	n/r	n/r	n/r	n/r	Aug15-Sep20	No Ice Classification Aug 15 – Sep 20

[1] General equivalence only, refer to Transport Canada regulations for details;

[2] Specific access dates for PC3, PC4 and PC5 vessels are not defined in the regulations and have not been assessed;

[3] As an interim measure for navigation purposes, Transport Canada considers that PC 6 and 7 vessels are allowed to operate as Type A and B vessels respectively;

[4] Operation of polar class vessel constrained by permitting limits.

7.6.3.5 Design Life

The following design life is to be considered for the different components of the Ore Dock facility:

- 20 years for Ore Dock (including causeway).

The ore dock must have sufficient durability to provide the minimum specified lifespan with respect to corrosion, ice abrasion and loading.

Where this requirement cannot be reasonably met with certain vulnerable components, the design will be such as to permit ready replacement of such components (for example, fenders, ladders and any hardware components that are attached in the ice zone).

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A regular inspection and maintenance program should be implemented to repair damage and deterioration as required.

7.6.3.6 *Design Vessels*

The ore dock will accommodate a range of design vessels from Panamax to Cape Size. Design vessel parameters for the new ore dock, Panamax and Cape Size are listed in Table 7-18 (refer to drawing H353004-00000-220-272-0019)

Table 7-18: Ore Dock Design Vessel Parameters

Description	Panamax	Cape Size
Tonnage (DWT)	74,000	230,000
Length Overall, LOA, m	225.0	316.0
Beam, B, m	32.5	50.0
Moulded Depth (m)	18.9	27.0
Fully Laden Draft, m	13.9	18.4 (Max 19.0)
Ballast Draft, m	7.5	9.9
Number of Hatches	7	9
Box Length, m	180	240
Box width, m	18.0	25.0

7.6.3.7 *Berth Location*

The berth location has been selected, based on the local bathymetry, to provide the minimum depth of marine structures while still providing adequate water depth at the berth face without dredging. Furthermore, the berth location has been selected to maintain a safe distance between the existing and new berth, by allowing adequate separation during berthing and avoiding the crossing of mooring lines. The orientation of the causeway has been selected to accommodate the orientation of the reclaim conveyor feeding the shiploaders. The centres point of the fenderline and causeway are located along coordinates as defined in the layout drawings listed in H353004-CG001-200-026-0002, Drawing Index. These coordinates shall be maintained for the Design-Build solutions.

7.6.3.8 *Water Depth*

An underkeel clearance of 10% of the largest vessel's fully laden draft will be provided at the berth. The berth shall be been oriented parallel to the natural bathymetry.

Table 7-19: Minimum Water Depth

Description	Value
Maximum Design Draft	19.0 m
10% Underkeel Clearance	1.90 m
Total Depth Required	20.9 m

7.6.3.9 *Vessel Berthing Orientation*

The ore dock structure shall be arranged according to recommended principles used in the industry such as PIANC and British Standard 6349.

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Vessels will predominantly berth against the ore dock on their starboard side in the open water season (summer). Alternatively vessels may berth on their port side if this is preferred by the pilots due to wind, wave, current, or ice conditions.

7.6.3.10 Navigation Criteria and Constraints

The navigational design requirements of the ore dock shall be limited to the safe and efficient berthing and de-berthing operations. The requirements generally include:

- Quay layouts.
- Mooring and Berthing Infrastructure.

The design requirements relating to the safe and efficient navigation of vessels to and from berths is excluded from the scope of this contract. The requirements generally include:

- Tug requirements and procedures.
- Anchorage.
- Aids to navigation.
- Protection zones.
- Pilot procedures.

7.6.3.11 Design Water Level

The design water level shall be calculated based on three components, namely tidal levels, surge and sea level rise. This elevation will be used for the definition of the ore dock and causeway elevations.

7.6.3.12 Deck Elevation

The deck level of the facility shall be determined based on extreme water level analysis. The average elevation of the ore dock has been set at the same level as the existing ore dock, namely: +5.3 m CD. However, the adequacy of the deck level to protect the ore dock from ice build-up and extreme storm events shall be the responsibility of the Design Build Contractor (CG001 – Ore Dock). With provision of suitable protection measures for ice build up a lower dock elevation may be selected during detailed design work, subject to award of the design build contract for the dock.

7.6.3.13 Drainage

Containment areas shall be provided around equipment especially hydraulic pumps that may give rise to contaminated liquid on the quay area. These containment areas shall be drained to individual blind sumps to permit manual removal of contaminated run-off or wash-down water during normal quay maintenance. All other areas shall be drained directly to the sea.

7.6.3.14 Site Grading

Finish grading and yard grading shall be set to slope away from planned structures at a minimum of 0.5% to 2%, and drain to a storm drainage collection system. For very long-run

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and localized areas, the slope shall be reduced or increased, depending on the existing ground slope and the grading around the buildings and facilities.

Site grading shall produce a useable and easily maintainable ground surface, not subject to flooding or erosion. The rough grades and finish grades shall ensure that the final road and site grades provide suitable pedestrian and vehicular access to buildings and facilitate adequate drainage of the site.

7.6.3.15 Scour and Slope Protection

Scour protection will be provided as required at the base of the marine structures. Both propellers and bow/stern thrusters shall be considered as appropriate for the design vessels.

Slope protection along the foreshore will be designed to resist appropriate environmental conditions, with some maintenance to be required. The slope protection will be developed using the following consideration:

- Slopes to be between 1: 1.5 (V:H) and 1:2 (V:H).
- Rock armour layers will be designed for both wave and ice action criterion, ensuring that less than 5% of armour rocks are displaced for the design wave condition as well as ice action. Minor maintenance may be required from time to time.
- Causeway toe berm will be designed for an “Intermediate Damage” criterion assuming that the reshaped section will require repair/maintenance after design wave action.

All scour & slope protection work shall be done in accordance with the relevant standards and comply to the following:

- Fine grade area to be armoured to uniform, even surface. Fill depressions with suitable material and compact to provide firm bed.

7.7 Production Systems

7.7.1 Mining

Mining heavy mobile equipment required to implement the Expansion Project was carried across from the Stage 2 Study mine planning work. No further analysis of the requirements was completed.

7.7.2 Bulk Materials Handling and Processing

The purpose of the bulk materials handling and processing system is to produce and load onto ships 12 Mtpa of lump ore and fine ore product, including:

- Receive run of mine (ROM) ore (delivered by mine haul truck), process to Primary Crushed Ore and load the ore into rail cars at the Mine Site.
- Receive primary crushed ore from the rail system, unload, crush and screen the ore to produce lump and fines product, and stockpile at Milne Port

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- Load all lump ore product at Ore Dock No 2 (new) onto Panamax and Cape Size ships during the prescribed loading season.
- Load all fine ore product at Ore Dock No 1 (existing) onto Supramax and Panamax ships during the prescribed loading season.

The following systems and facilities have been included in the project scope to achieve the required production:

- Primary Crushing System (including rail loading)
- Rail Unloading System
- Crushing and Screening System
- Lump Stockpile System
- Fines Stockpile System (existing stockpile and reclaim system modified)
- Ship Loading System (ore dock No 2)

The overall process is summarized in Figure 7-13 below.

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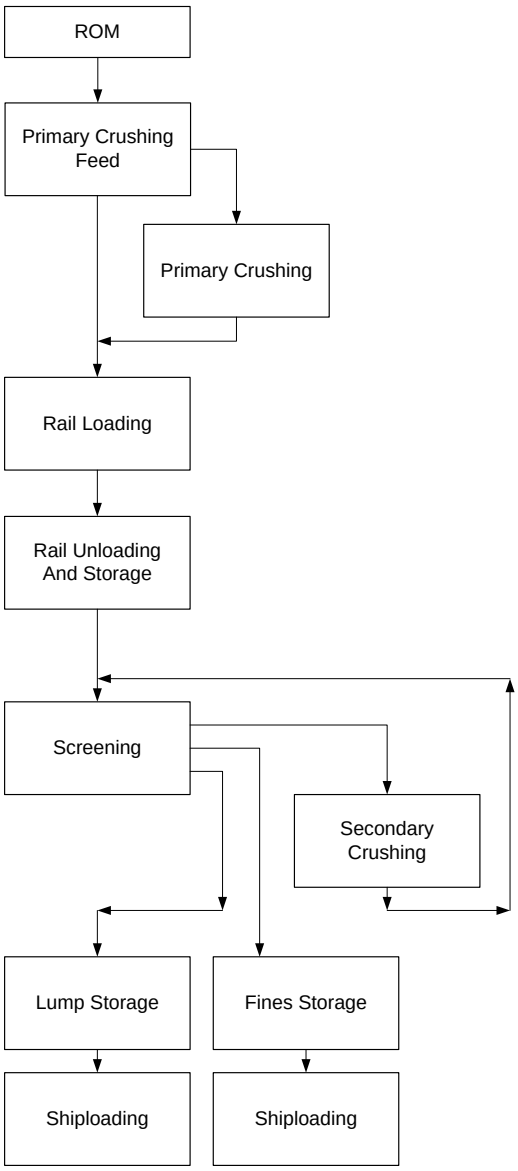

Figure 7-13: Process Block Flow Diagram

Process design development associated with the bulk materials handling systems is discussed in Section 6 – Process Definition. Engineering design of these systems for the Definitive Study was incorporated into design-build contracts PM007 Primary Crusher Upgrade and CM001 Bulk Materials Handling and Processing.

7.7.2.1 Primary Crusher System

Process assessment and preliminary design was carried out by Masaba (original equipment manufacturer of the existing mobile crushing equipment which is planned to be partially re-

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used for the new primary crusher system) based on ROM sizing and Primary Crushed Ore size requirements defined by Hatch.

7.7.2.2 Port Bulk Materials Handling and Processing

A comprehensive functional specification was developed and issued for bid during the Study. The specification defined the parameters for the systems at Milne Port with particular detail with regard to interfaces at Rail Unloading and Ship Loading. Proposed system design was developed by the bidders and documented in their proposals.

7.7.3 Production Mobile Equipment

Mobile equipment is required to support production at:

- Primary Crusher area to feed the primary crushers, manage the rail loading stockpile, and to load trains.
- Handling fine ore product at the Port including reclaim from the intermediate fines stockpile, transport to Stockpile No 1 (modified existing stockpile), stacking at Stockpile No 1, and reclaim for feeding ore to Ship Loader No 1.
- General stockpile management at the Port.

Mobile equipment requirements for new and significantly modified activities were assessed during the study and the equipment previously identified during the Stage 2 study were validated.

Equipment required to feed Ship Loader No 1 was assumed to be existing as there is no change to the existing operation.

7.8 Utilities and Support Infrastructure

7.8.1 Camps and Accommodation

Operations accommodation requirements were defined and incorporated into the future camp sizing.

Construction accommodation requirements were assessed during the study based on a combination of estimates by the Hatch construction management team and specific details provided by Contractor with their bids.

7.8.2 Power Generation

Each of the two principal permanent sites will have a dedicated power plant comprising reciprocal diesel engine units for primary power generation (refer Appendix 7-33 for design philosophy). Each power plant will have installed spare capacity, serving as a redundancy to ensure continuous operation during an outage of a duty generator.

Optimization of the power generation for the Expansion Project is based on the following principles:

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- Assessment and benchmarking of actual operating loads and operating conditions to accurately estimate maximum load on the power plant.
- Reduced power generation redundancy especially under peak operating loads.

7.8.2.1 Electrical Load List

An electrical load list was develop for the Study generally based on:

- Normal and peak power demand for existing facilities and equipment, summer and winter, as advised by email from BIM Operations management
- Assumed installed power based on similar and reference equipment for all new facilities
- Power demand and diversity factors based on Hatch reference values for similar facilities

The most significant electrical power consumers for the Expansion Project are the electrically heated construction camps and the new port bulk materials handling and processing equipment (per CM001 package). Construction camp power was cross checked to Hatch reference values and the BMH equipment power was cross checked to the received CM001 bids; both systems are believed to be representative of the final configuration however both require validation when final loads are available from vendors / contractors.

7.8.2.2 Port Site

The currently installed generator design allows for a N+2 generator quantity design. This implies that two generators may be out of service without the requirement to shed any facility load. This design was implemented to allow for a standby generator while another generator is out of service for an extended period such as an engine rebuild.

For the new expanded port infrastructure, the generating capacity to shall be adequately sized for the maximum load envisaged during the Cape ship loading period without any additional installed capacity and redundancy on the generators. This would be referred to as N+0 installed generators at peak load.

Assessment of the average electrical loads at the Port Site has considered the following operating parameters:

- Rail car unloading:
  - Actual operating unloading trains is typically 5.3 times per day for 90 minutes each time (i.e. operates only 33% of the time otherwise idle).
- Crushing, screening and stacking:
  - Operating utilization (actual operating time divided by calendar time) approx. 70%.
- Fines ship loading rate (existing ship loader):
  - Peak rate 6 000 tph.
  - Average operating rate 4 800 tph.

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- Operating utilization (actual operating time divided by calendar time) approx. 50% of the operating period.
- Operating period 83 days per annum.

- Lump ship loading at Ore Dock No 2 (Cape):
  - Peak rate 16 000 tph.
  - Average operating rate 12 480 tph.
  - Operating utilization (actual operating time divided by calendar time) approx. 75% of the operating period.
  - Operating period – 37 days per annum.
- Lump ship loading at Ore Dock No 2 (Panamax):
  - Peak rate 8 000 tph.
  - Average operating rate 6 640 tph.
  - Operating utilization (actual operating time divided by calendar time) approx. 50% of the operating period.
  - Operating period – 46 days per annum.

The resulting power generation configuration recommended for the Expansion Project is addition of 4x new 1350 kW generators similar to the existing and interconnected with the existing. To facilitate this interconnection and to provide the required power distribution systems a new power generation e-house (switchgear building) is also proposed.

Use of matching generators from the same manufacturer as the existing has been recommended to facilitate efficient load balancing between existing and new generators and to allow control system integration of the systems. Preliminary design of the new generation equipment and integration with the existing was carried out by Cummins and included with their PE002 budget quote package,

7.8.2.3 Mine Site

The original (currently installed) generator design allows for a N+2 generator quantity design. This implies that two generators may be out of service without the requirement to shed any facility load and was implemented to allow for a standby generator while another generator is out of service for an extended period such as an engine rebuild.

For the upgrades to the mine primary crushers and expanded mine infrastructure, the generating capacity is adequately sized for the maximum load envisaged during peak periods, with two additional generators installed as redundancy to the running generators. This would be referred to as N+2 installed generators.

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For the permanent condition, no major fluctuations would occur on the demand at the mine site during summer and winter periods, barring the effect of seasonal heating loads in the accommodation camps.

Power demand is expected to peak during the construction period, given the load requirements envisaged for the construction camps which utilize electric heating systems. For this interim phase, an N+1 will be acceptable during peak winter periods of construction, with the required N+2 during normal operation.

To ensure continuous mining and primary crushing throughout the year, the following mitigation factors are considered in the event of a generator failure:

- Mobile 600V generating equipment are available on site. During abnormal events, these generators may be used to supply general facility loads by connecting the mobile generators directly to power distribution E-Houses and removing the associated E-House load from the central power generation system.

Start-up of equipment would be managed and sequenced such to minimize the peak currents drawn and limit instantaneous maximum demand on the generators.

Following review of the electrical loads no upgrade of the Mine Site power generation systems is proposed.

7.8.3 Power Distribution

Power distribution systems at the Mine and Port were assessed to match the new plant and facilities. Re-use of existing systems and equipment was utilized where possible, particularly at the Mine Site.

Modification of the Mine Site power distribution system consists of relocating and existing e-house and connecting new loads to existing e-houses. The resulting design is documented in the project Facility Description and associated engineering deliverables.

Modification and upgrade of the Port Site power distribution consist to two primary components:

- Power distribution to new support infrastructure including construction camp, PSC expansion and rail workshop. Preliminary design completed by Hatch and documented in the project Facility Description and associated engineering deliverables.
- Power distribution for the new bulk materials handling and processing systems. Initial concept design developed by Hatch and documented in the project Facility Description and associated engineering deliverables; however revised and final design is the responsibility of the CM001 contractor. The contractors final design will supersede design shown in the Study documents.

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Preliminary assessment of the modified power distribution systems was completed however detail design and power systems analysis is required when final loads and the CM001 power distribution design are available.

7.8.4 Fuel Systems

7.8.4.1 Fuel Storage Analysis

Implementation of the Expansion Project will result in a change to fuel consumption particularly for power generation, mining equipment and transport (rail instead of truck). During the Study a detailed fuel consumption analysis was carried out to estimate fuel consumption during construction, ramp-up and into operations for the new configuration.

Fuel consumption estimate is based on:

- 2017 BIM operating budget, assumed to continue as-is until start-up of new plant and equipment, with future adjustments as applicable for decommissioned facilities and equipment
- Project electrical load list; for fuel required by power generation after project implementation
- Fuel for power generation to heat construction camps, benchmarked to existing facilities
- HME fuel consumption from STAGE 2 STUDY mine planning work
- Rail fuel consumption from RTC analysis based on GE locomotive performance curves
- Earthworks contractor fuel consumption as provided by EBC (lowest fuel consumption estimate of those received with CC002 and CC003 bids)
- Other facilities / equipment generally referenced from existing plant.

Based on the fuel consumption estimate two additional Arctic Diesel tanks are proposed for the Milne Port tank farm, increasing the total nominal tank farm capacity to 64 ML Arctic Diesel:

- 15 ML tank installed in the location previously identified for a future 12 ML tank.
- 3 ML tank installed at the north end of the fuel containment.

In addition to the Arctic Diesel tanks one new 750 kL Jet A-1 tank is proposed to increase the total Jet A-1 fuel storage to a total of 3 ML.

Due to only a marginal increase in fuel consumption at the Mine Site there are no changes proposed to the Mine Site fuel storage as part of the Expansion Project (however an allocation has been made in sustaining capital in recognition of the future fuel consumption increase associated with ramping up the mine equipment fleet).

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7.8.4.2 Fuel Systems Design Development

Design of the tank farm upgrade is generally based on the existing tank farm with adjustments as required to ensure compliance with relevant Canadian codes and standards. Tanks are specified as API650 and piping to comply with applicable Canadian and ASME standards.

In addition to the tank farm upgrade the existing marine manifold building has been relocated with associated modification of the marine offload pipeline.

As part of the fuel systems work a power generation refuelling pipe system will be implemented as originally proposed during the Early Revenue Phase Project. The piping system will connect from the existing generator refuelling pump in the Arctic Diesel Fuel Module (currently unused) to the existing power generator modules.

Fuel system detail design has been included in the contract package TM001 with fuel system supply, fabrication and installation.

7.9 Infrastructure Earthworks

Design and engineering has been detailed (refer appendix 7-32) with regards to site development, road design, and stormwater management.

7.9.1 Site Development

Site development refers to construction of civil infrastructure to support construction and operation of facilities. The following sections list the site development activities and establish criteria that shall be adhered to when carrying out site development design works.

Design requirements have been developed with respect to the following:

- Site Preparation.
- Earthworks.
- Site Grading.
- Infrastructure Facilities, Pads and Laydown Areas.
- Milne Port Stockpile area.
- Milne Port Design High Tide.
- Retaining walls.
- Erosion and Sediment Control.
- The software package AutoCAD Civil 3D was used to create the 3D model with which the bulk earthworks cut / fill volumes were calculated. A separate model was created for each terrace area and later integrated with the overall 3D model for the mine area. The survey information was obtained from the Lidar survey completed in August 2016. The grid of the survey points are set at $1m^2$.

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- Based on the Stage 2 Study concept design and layout, each terrace / road location and its functionality was workshopped with Baffinland and the design team before being modelled. The layer works required for each terrace / road were in accordance with the Civil Design Philosophy document H353004-00000-100-146-0001-SE07.
- The bill of quantities was calculated for the various terraces and infrastructure components using the 3D modelling software. The layer works described in the Civil Design Philosophy (H353004-00000-100-146-0001-SE07) for the specific terrace / road were used to quantify the layer material quantities.

7.9.2 Road Design

The access roads at the two project sites may be temporary or permanent. An access road is defined as temporary if it will be used only during the construction period including site predevelopment or site capturing. Permanent roads are defined as roads that are required for operations. Permanent roads may be primary, secondary, or tertiary depending on frequency and type of traffic.

The design of mine haul roads, access and internal site roads at the project sites shall provide a safe environment for construction, operations and maintenance personnel, and shall facilitate the mining operations, ore transport and port operations in an efficient manner.

All road design is governed by design requirements with respect to the following:

- Road Category.
- Design Vehicles.
- Geometric Design.
- Pavement Thickness.
- Parking.
- Signage.
- Bollards.
- Shoulder Barriers.
- Utility Beams.

7.9.3 Stormwater Management System

A stormwater management system has been investigated based on design requirements with respect to the following:

- Internal Surface Drainage.
- External Surface Drainage.
- Rainfall Intensity.

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- Sedimentation Ponds.
- Culverts, Roadside Ditches and Berms.
- Drainage Interceptor/Collector Berms.

Storm water drainage design was completed based on the approved Civil Design Philosophy setting out the storm water design criteria. AutoCAD Civil 3D modelling software and 3rd party software; IDAS (which integrates with the Civil 3D package) were used for calculation of the water runoff. The program uses the SWMM and rational methods to calculated runoff and the SWMM model to route the water through the identified water courses and ponds.

7.9.4 Mine Site Earthworks

The Mine bulk earthworks infrastructure design executed during the feasibility study design phase (Feasibility Study) include the development of the following:

- New terrace for the expansion of the permanent accommodation
- New terrace for the HME workshop including an access ramp to the existing terrace
- New terrace for the ROM stockpiling, crushing and train loading station
- New access road adjacent to the rail line for servicing the line as well as serving as access to the sewer outfall point
- Deviation of the Tote haul road to cross the rail and allow access to the quarry
- New terrace for the construction accommodation camp together with access to the terrace / camp
- Deviation of the routing of the potable water supply berm intersected by the new construction accommodation camp
- Laydown area for the contractor
- Storm water management for the new terrace for the product stockpile and train loading. This includes:
  - Cut-off berms (Separating clean and polluted water catchments
  - Pollution control pond
  - Culverts for cross drainage on the access road
  - Cross drainage on the deviated Tote road.

Catchments were identified based on the survey provided. Demarcation of the catchments between sedimented and clean water catchments was enabled through the placement of berms. The main new sedimented water area was identified as the new terrace for ROM stockpiling, primary crushers and train loading area. The catchment water is directed to a sedimentation control pond downstream of the terrace, see Figure 7-14. Cut-off berms on the

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side of the terrace convey the water to the pond which has a volume of 2.1Ml. The terrace is graded to facilitate storm water drainage to the pond.

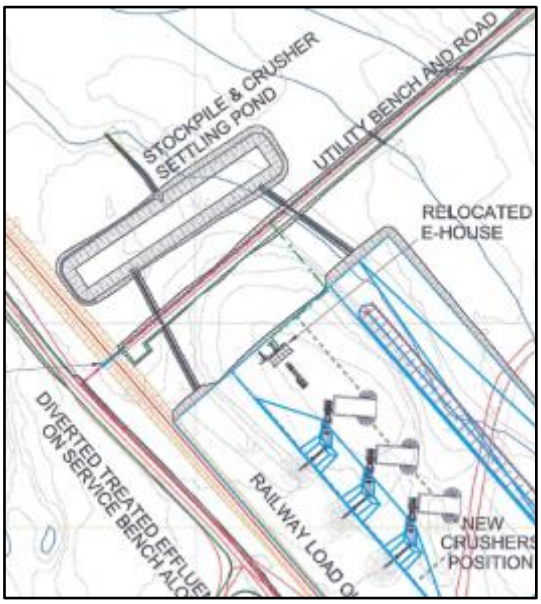

Figure 7-14: Stormwater Control Pond

Cross drainage of creeks & identified drainage points at road intersections were catered for through appropriately sized culverts and detailed according to the Civil Design Philosophy and previous Baffinland Mary River culvert details.

The drainage berm material quantities as well as the excavation volumes and general bill of materials for the pond were calculated using the 3D model. The various layer works and linings required were in accordance with the approved Civil Design Philosophy.

7.9.5 Port Site Earthworks

The Port bulk earthworks infrastructure design executed during the Stage 3 design phase includes:

- New permanent accommodation terrace
- New terrace for the Rail Locomotive workshop with an access road from the existing Tote road
- Rail Car Dumper excavation for installation of the Dumper for offloading of product
- New crushing feed stockpile terrace for the product received from the rail unloading conveyor
- New terrace for the crushing building
- New terrace for the screening building

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- New terrace for the fines stockpile adjacent to the screening building
- New terrace for the transfer tower for the lump product onto the stacker reclaimer conveyor belt
- Terrace / platform for Stockpile No 2 (12 Mtpa Lump Ore) based on the pre-feasibility concept design
- Service / access road for the new Stockpile No 2 – including drainage consideration (this is regarded as polluted water)
- Layout of the Temporary Offloading Dock & road
- Stockyard No 1 (Fines product) terrace modification and access road
- Stockyard Reclaim Conveyor No 1 terrace platform for realigned conveyor belt section
- New berm for the relocated fuel offloading facility & pipe line
- New terrace for the construction accommodation camp together with access to the terrace / camp
- Storm water management for the new port facilities This includes:
  - Cut-off berms (Separating clean and polluted water catchments
  - Pollution control dams – 4 off (PCD)
  - Culverts for cross drainage on roads.

The rail dumper facility cut was designed based on the Stage 2 study phase and materials handling information obtained from contractors at the time. The excavation and development of this feature of the design will be finalised once the bulk materials handling execution contract has been awarded. This also applies to the Stockpile No 2 stacker reclaimer terrace / berm.

Storm water catchments were identified based on the survey provided. Demarcation of catchments between polluted and clean water catchments were enabled through the placement of berms to separate the contaminated water from the clean water.

At the Port, emphasis was placed on limiting the volume of clean water runoff that will naturally accumulate at the Stockpile No 2 road berm at the low point in the natural ground. The approach was to drain the natural runoff of clean water by gravity to existing creeks or rivers. In the central low point of the stockpile 2, clean water will accumulate without being able to drain naturally to the sea/ river/or creek. The stockpile road and services berm height was designed in such a manner that it can contain the yearly rain flow & runoff from the small catchment. The philosophy is that operations will have to drain the water from this “dam” that is formed by pumping the clean water to a canal or tanker and in order to dispose of it (during summer), refer to “Block Plan -Overall Layout - H363004-00000-220-272-0001-0001”.

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Four polluted water dams were designed for the various identified polluted areas:

- Sedimented water run-off from the west side stockpile terrace service road (155.4 kl)
- Sedimented water run-off from the crushing fee stockpile terrace (429 kl)
- Sedimented water run-off from the fines stockpile and screening terrace (337 kl)
- Sedimented water run-off from the east side stockpile terrace service road(115 kl).

Drainage from approximately the centre of Stockpile No 2 service road is towards the existing polluted water pond. The roads are graded at a 1:800 slope to the north and south from approximately the centre of the stockpile No 2.

A new storm water containment berm was designed for the revised footprint area of Stockpile No 1 (existing stockyard). This sedimented water will link with the existing polluted water drain into the existing sedimentation water pond. (see Block Plan - Overall Layout - H353004-00000-220-272-0001-0001).

Cross drainage of creeks & identified drainage points at road intersections were catered for through appropriately sized culverts and which were detailed according to the design philosophy and previous Baffinland Mary River culvert details.

The drainage berm material quantities as well as the excavation volumes and general bill of materials for the ponds were calculated with the 3D model. The various layer works and the lining required were in accordance with the approved Civil Design Philosophy.

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8. Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-200-078-0008	Site Conditions Specification	0	2016-12-14	A7-1
H353004-CG001-200-242-0031	Metaocean Data – Standard Specification	0	2016-12-15	A7-2
H349000-2200-12-124-0004	Milne Metaocean Conditions – Milne Inlet	A	2013-10-10	A7-3
NB102-181/30-7	Hydrology Baseline Report		2012	A7-4
E349000-2200-12-124-0002	Mary River Mine Dock Site Ice Engineering Study Final Report	1	2014-02-10	A7-5
NB102-181/6-A.01	Hydrology for Tote Road Design		2006	A7-6
H352034-3000-228-030-0001	In-Principle Review of Previous Tote Road Hydrology Assessments	0	2016-08-18	A7-7
NB102-00181/39-A.01	Updated Design Peak Flow Assessment		2016-12-01	A7-8
H352034-1000-229-230-0002	2016 Milne Port Geotechnical Investigation Data Report	0	2017-02-17	A7-9
H352034-1000-229-230-0001	2016 Rail Geotechnical Investigation Factual Data Report	0	2017-02-03	A7-10
NB102-00181/3-2	Mine Site Infrastructure, Pit Overburden and Waste Dumps – 2006 Site Investigation Summary Report		2007-02-28	A7-11
NB102-00181/3-2	Mine Site Infrastructure, Pit Overburden and Waste Dumps – 2007 Site Investigations and Foundations Recommendations Summary Report		2007-12-14	A7-12
NB102-181/24-1	Mine site infrastructure, pit overburden and waste dumps – 2008 site investigations summary report		2010-05-04	A7-13
E349000-1000-00-236-0002	Geotechnical, Geochemical and Quarry Sourcing Investigation		2010-12-01	A7-14
E349000-2000-15-124-0001	Steensby Inlet and Milne inlet Port Offshore Geotechnical Investigation Summary of Results	0	2011-11-09	A7-15
H353004-00000-229-078-0002	Site Geotechnical Summary	0	2016-12-15	A7-16
H352034-1000-220-230-0001	Preliminary Geotechnical Site Investigation Report	0	2017-02-17	A7-17
H352034-3000-229-230-0001	Preliminary Geotechnical Recommendation for Railway Embankment (Between Milne Inlet and Mine Site)	2	2016-12-09	A7-18
H353004-00000-229-078-0001	Geotechnical Criteria for Building Foundations	0	2016-12-15	A7-19
H352034-3000-229-230-0002	Preliminary Geotechnical Recommendation for Infrastructures and Milne Inlet	1	2017-01-10	A7-20

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Document Number	Title	Revision	Date	Appendix Number
H353004-00000-221-078-0002	Board Insulation	0	2016-12-14	A7-21
H352034-3000-200-210-0001	Railway Design Criteria and Design Rational	1	2016-11-02	A7-22
H352034-3000-200-230-0001	Rail Operations Static and Dynamic Modeling	1	2017-01-10	A7-23
H353004-CC003-230-078-0001	Rail Bridge Design Parameter Requirements	0	2016-12-13	A7-24
H353004-CC003-230-078-0003	Rail Bridge Superstructure	0	2016-12-13	A7-25
H353004-CC003-230-078-0002	Rail Bridge Substructure	0	2016-12-13	A7-26
H352034-3000-224-030-0003	Rail Tie Type Trade-off for Extreme Cold Weather Heavy Haul Operations	1	2016-12-09	A7-27
H353004-TR001-224-078-0001	Wayside Monitoring Equipment Specification	1	2017-01-26	A7-28
H353004-TR001-224-078-0002	Train control System Specification	1	2017-01-26	A7-29
H353004-CG001-200-242-0033	Ore Dock – Functional Specification	0	2016-12-14	A7-30
H353004-TM001-240-248-0001	TM001 - Fuel Storage - Fuel System Scope of Work	0	2017-02-22	A7-31
H353004-00000-200-210-0001	Civil Design Philosophy	0	2017-03-23	A7-32
H353004-00000-260-210-0001	Power Generation and Distribution Design Philosophy	0	2017-02-27	A7-33
H353004-00000-200-078-0017	Basic Electrical Requirements	0	2017-01-20	A7-34
H337697-0000-15-124-0002	Geotechnical Recommendations for Airstrip	0	2012-04-19	A7-35
H337697-0000-15-124-0004	Geotechnical Data Report - Infrastructure	C	2012-04-05	A7-36
H337697-3000-15-124-0001	2013 Geotechnical Site Investigations - Ports and Marine	A	2012-04-17	A7-37
H340960-1000-15-124-0004	Geotechnical Data Report - Infrastructure	0	2012-04-27	A7-38
H349000-2200-15-124-0003	Milne Ore Dock Geotechnical Investigation Factual Report	A	2014-02-21	A7-39
H349000-2200-15-124-0001	Ore Dock Geotechnical Design Report	0	2014-02-28	A7-40
H353004-00000-220-294-0001-0001	Rail Site Standard Drawing – Typical Cross Section Multiple Barrel Pipe Culverts	0	2016-12-07	A7-41
H353004-00000-220-294-0002-0001	Rail Site Standard Drawing – Typical Cross Section Single Barrel Pipe Culverts	0	2016-12-13	A7-42
H353004-00000-220-294-0003-0001	Rail Site Standard Drawing – Typical Cross Section Sheet 1 of 4	0	2016-12-13	A7-43
H353004-00000-220-294-0004-0001	Rail Site Standard Drawing – Typical Cross Section Sheet 2 of 4	1	2017-02-02	A7-44

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Document Number	Title	Revision	Date	Appendix Number
H353004-00000-220-294-0005-0001	Rail Site Standard Drawing – Typical Cross Section Sheet 1 of 4	1	2017-02-02	A7-45
H353004-00000-220-294-0006-0001	Rail Site Standard Drawing – Typical Cross Section Sheet 1 of 4	1	2017-02-02	A7-46
H353004-00000-220-294-0007-0001	Rail Site Standard Drawing – Typical Cross Open Base Culvert	0	2017-03-22	A7-47
	Geophysical Seismic Survey for a Proposed fixed Dock, May River Project, Milne Inlet, Nunavut – Geophysics GPR International Inc. – T12615		Feb 2014	A7-48

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 8 – Project Layout

2017-05-01	0	Approved for Use	R. Goosen	J. Cleland	N. Mason	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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8. Project Layout

8.1 Introduction

Layouts for the Mine, Rail and Port sites developed during the previous Stage 2 Study were further optimized during the Stage 3 Definitive Study to achieve the most efficient and cost effective solution.

This document defines the background to the layout developed during the Stage 2 Study and explains further enhancements made during the Stage 3 Study.

8.2 Mine Site Layout

8.2.1 Overview

The proposed mine site layout is shown in Appendix A8-1.

Expansion Project layout of the Mine Site is primarily based on optimization of the rail earthworks, particularly due to the flat gradient required along the loading track. Following from the optimized rail alignment:

- Rail loading zone selected with optimization of the rail
- Primary crushers located at the loading zone as per approved process design
- Roads and utilities modified as required to facilitate construction of the optimized rail

Optimization of the rail alignment is discussed in Section 8.3.

Locating the primary crushers on a new pad at the rail loading area facilitated the use of the existing crushing pad for a new ROM stockpile area. The new mine truck workshop was located with direct access to the ROM stockpile area which provided:

- Segregation of heavy mining equipment (HME) from general traffic. HME will generally be limited to the mine haul road, ROM stockpile, primary crusher area and new truck workshop apron. Only mine operations light vehicles are expected to share these areas with the HME.
- Direct access for light vehicles and pedestrians between maintenance facilities.

Following from optimization of the operating facilities the construction camp was located to on existing Laydown #1, extended as required to suit the camp installation.

8.2.2 Explosives Facilities Clearances

The proximity that infrastructure can be in relation to explosives magazines and explosives plants within Canada is set out by Natural Resources Canada (NRCan) in the Quantity-Distance (Q-D) tables. An assessment of the Expansion Project facilities was completed based on the emulsion plant parameters set out in the ERP Project Explosives storage clearances drawing (refer to Appendix A8-2), and on the basis that the magazine location

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near the emulsion plant is not used for explosives magazines (therefore, only the distance from the emulsion plant is considered).

The primary crusher control room is considered an “inhabited building” and the primary crusher pad is considered as equivalent to a “heavy traffic public route”, which both require a D7 distance. The primary crusher pad is entirely located outside the D7 limit and, therefore, complies.

The rail track is considered equivalent to a “light traffic public route” based on the fact that a loco with a driver will only pass into the area 5-6 times per day with a similar number of entries of a service vehicle to pick up the loco driver. This same classification was previously used for the treated effluent road. This requires a D4 distance. The rail track and modified treated effluent road are outside this limit and therefore comply.

It is worth noting that to further mitigate risk, the rail operating procedures should minimize the time a loco driver is within the D7 zone. This is readily achieved by running the train through to the end of the track when it first arrives and immediately picking up the driver(s) and transferring them to the North end of the train.

8.2.3 Primary Crushing, Stockpiling and Train Loading

Layout of the three jaw crushers was developed to match the operating clearances required for crusher feed and maintenance, and to spread the product stockpile(s) along the length of the rail loading zone. The proposed layout is shown in Figure 8-1.

Each crusher will be fed with ROM by a CAT 988 FEL. The crushers are laid out in a staggered position with 35 meters between centers. The FEL’s will access the crushers by ramps created with pre-cast concrete blocks.

ROM will be delivered by haul trucks to the new crusher pad. The trucks will access the crusher area via the extended haul road and dump the ROM ore before leaving via the same road. The dumped ROM will be spread by the front end loaders (FEL’s) between train loading.

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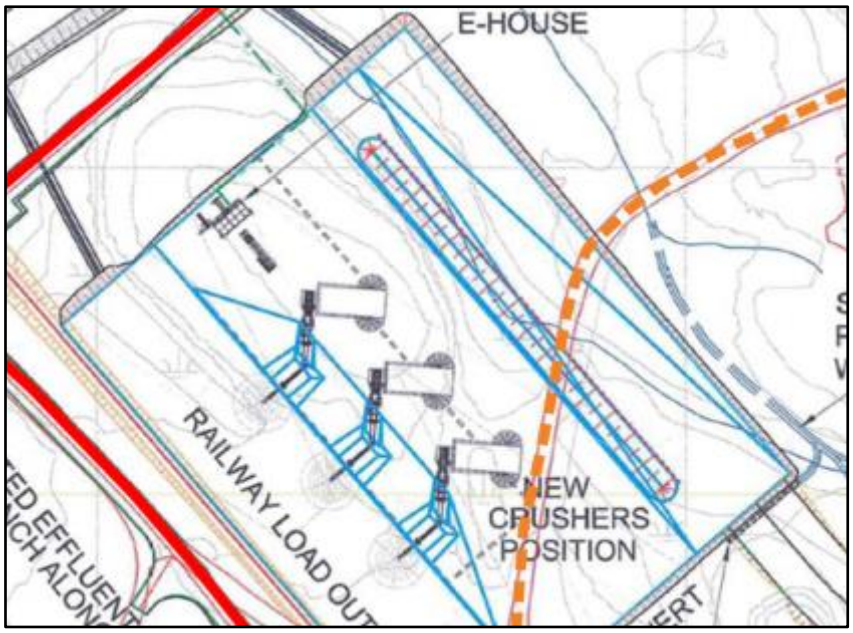

Figure 8-1: Primary Crushing Layout

8.2.4 Mine Truck Workshop

A new Mine Vehicle Workshop is included for the Mine. The workshop building will consist of two bays, 16.5 by 32 meters long. The workshop is located to:

- Provide direct access from the ROM stockpile where the equipment will be operating.
- Provide relatively direct and safe access for light vehicles and personnel between the new workshop and existing.
- Allow future expansion of the building (with associated expansion of the earthworks / pad).
- Minimize earthworks required to construct the pad.

8.2.5 Mine Camp

New 800 man hard-walled camp will be built at the mine to accommodate the operations and construction personnel.

The camp location was selected based on minimization of the associated earthworks to construct a nominally flat pad. Other considerations related to the camp location include:

- Clearance to the CMR2 runway approach was verified for non-instrument approaches as documented on drawing H349000-4400-10-041-0009 (refer to Appendix A8-3).
- An significant ice lens underlays much of the pad however using a raised building with free air flow under should minimize the risk of significant changes to the permafrost heat balance.

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- The camp is located adjacent to the rail loading track which may result in excessive shunting noise in rooms along the east side of the camp.
- Operations and maintenance personnel will require bussing to their work location.

8.2.6 Roads

The tote road will be deviated in order to cross the new rail line before the mine camp site, this is shown in Figure 8-2

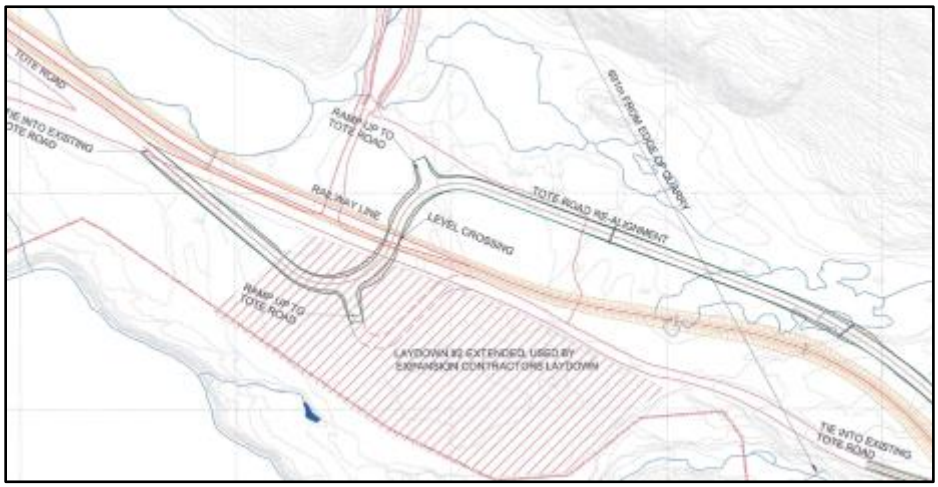

Figure 8-2: Tote Road Rail Crossing

The mine haul will be extended to allow the mine haul trucks to dump ore at the new primary crushing area. This road will be 24m wide to allow two-way traffic of the mine haul trucks; refer to Figure 8-3.

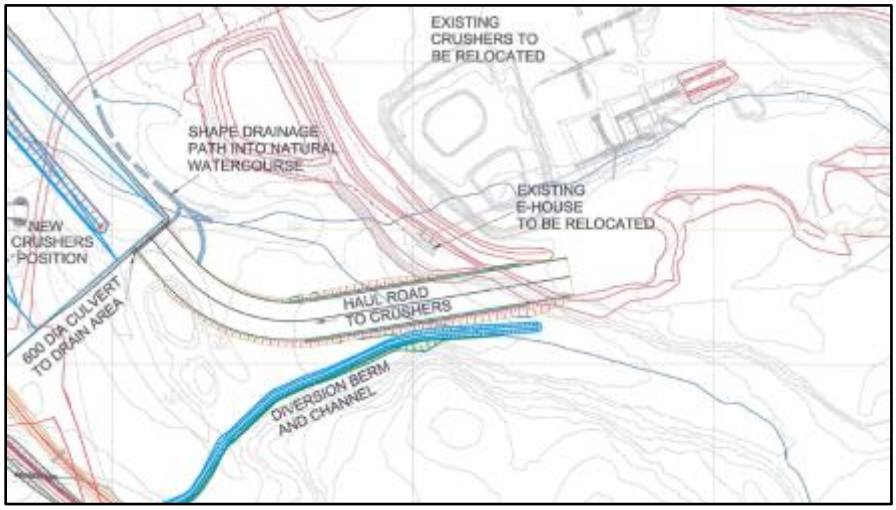

Figure 8-3: Mine Haul Road Extension to new Crushing Pad

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The service road leading to the treated effluent discharge point will be realigned to be next to the rail line.

An access point for the train drivers swop out will be provided adjacent to the Tote road and the new construction camp.

8.2.7 Utility Systems

8.2.7.1 Power Supply and Distribution

At the Mine Site the present power generation facility will remain unchanged. The medium voltage reticulation network arrangement will not change, except for the re-routing of cables to avoid new facilities:

- Re-route 5kV power feed to E-House #8 to avoid new mine truck workshop.
- Re-route 5kV power feed to the runway area to avoid new construction camp.

E-house #11 currently feeds Crusher C and will be relocated to feed the three modified crushers installed in their new position as shown in Figure 8-4.

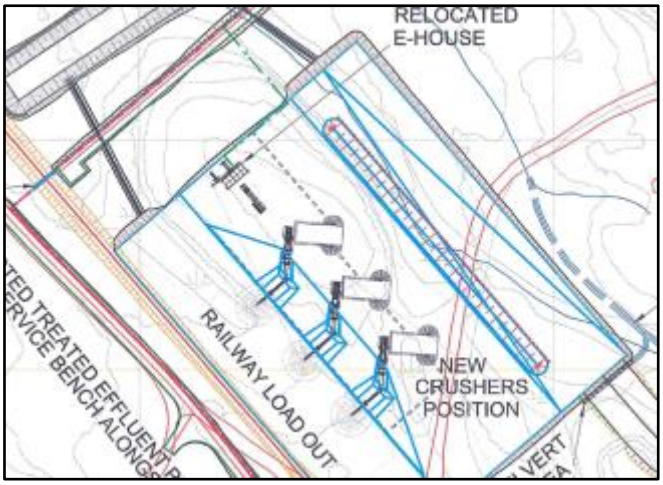

Figure 8-4: New Crusher Arrangement

8.2.7.2 Water Supply

The water supply to the mine water treatment plant is currently via a heated HDPE pipeline from the water pump station to the east of the aerodrome. This pipeline will be rerouted as the construction camp pad will encroach over the existing pipe. The water pipe will be rerouted to run along the south edge of the construction camp pad; see Figure 8-5.

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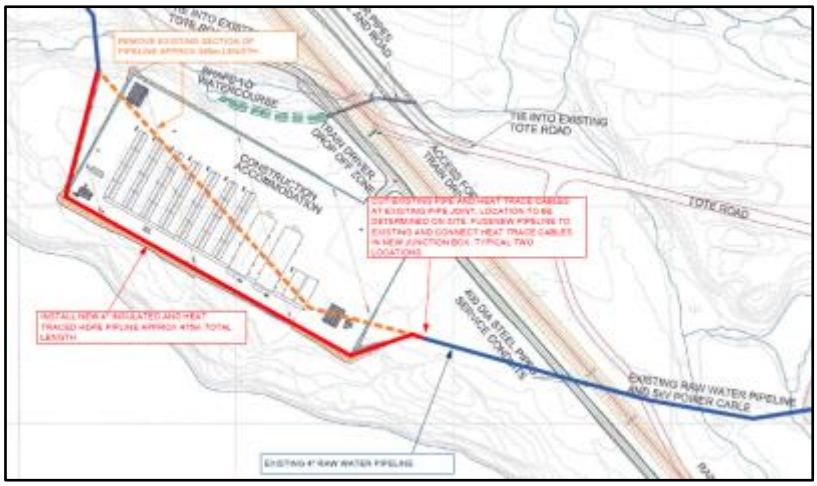

Figure 8-5: Rerouting of services around the Construction Camp Pad

8.2.7.3 Communications and IT Infrastructure

New fiber optic cables are to be installed from the communications hub to the relocated E-house #11 and the new Mine Vehicle Workshop, refer to Figure 8-6. The Fiber will be installed on berms constructed for the routing of utilities.

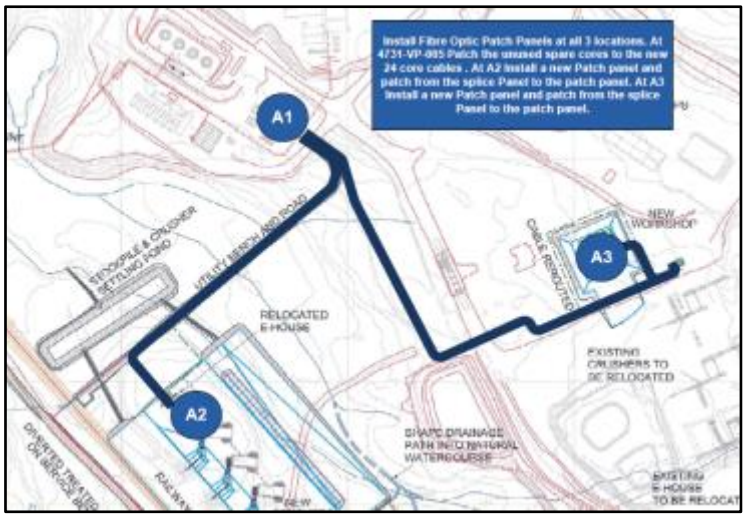

Figure 8-6: Mine Fiber Optic Cable

8.3 Rail Layout

8.3.1 Overview

Rail layout was mutually developed during the Stage 2 study and further optimised during Stage 3. The proposed rail track diagrammatic layout is shown on Appendix A8-8 and the plan/long section is shown on Appendix A8-9.

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8.3.2 *Mine Terminal*

The Mine track facilities are represented in Figure 8-7.

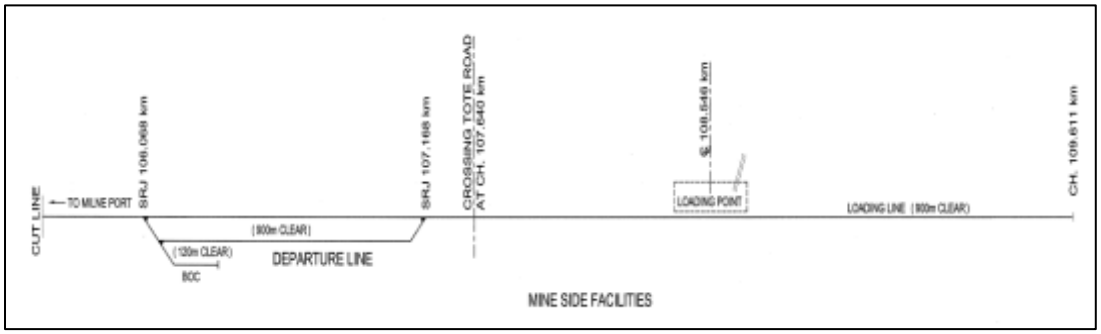

Figure 8-7: Mine Track Diagram

- Loading staging line for empty train 900 m. (mainline chainage)
- Loading pull through line to stop block 900 m. (mainline chainage)
- Departure Siding 900 m.

8.3.3 *Port Terminal*

The port terminal and yard layout is presented in Figure 8-8

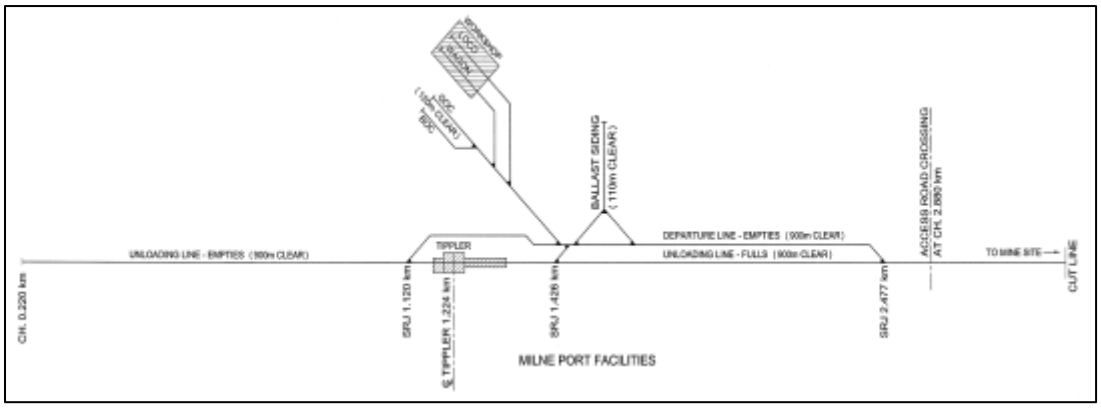

Figure 8-8: Port Side Track Diagram

- Unloading lines 2800 m (mainline chainage)
- Departure Siding 900 m
- Locomotive Run-around loop 347 m
- Locomotive Workshop Spur 390 m
- Ore Car Workshop Spur 215 m
- Bad Order Car Spur 205 m

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- Good Order Car Spur 160 m
- Ballast Spur 400 m
- Triangle Link 375 m
- Cross Over 120 m.

8.3.4 Mainline CH 2.80km to CH 106.00 km

The mainline chainage starts at zero at the stop block of the push through line for unloaded trains at the Milne Port tippler and terminates at CH 110.661 km at the stop block beyond the Mary River Mine loading bank. For train operations and track maintenance purposes the mainline is defined as starting at CH 2.8 km and ending at CH 106.00 km. This is from just south of the mainline switch entering the Milne Port facilities to just north of the mainline switch entering the Mine Terminal.

The mid-way passing loop is located between CH 55.883 km and CH 56,936 km, providing a clearance of 900 m, fit for maximum 80 car train length.

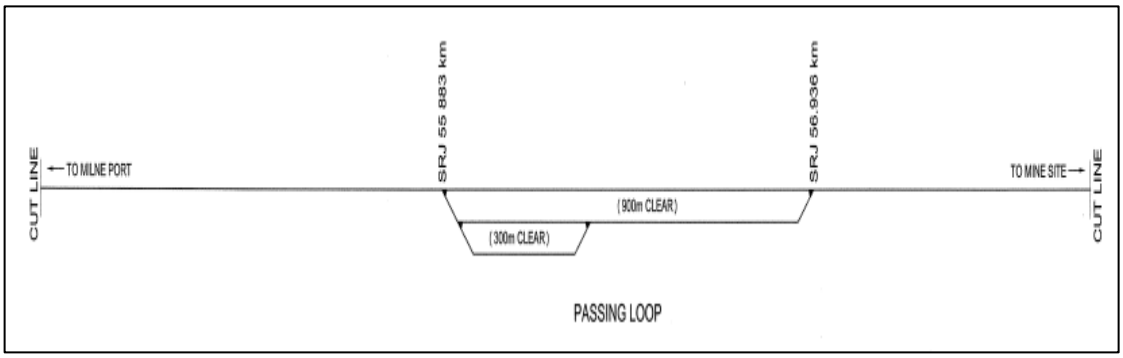

Figure 8-9: Midway Passing Loop and Backtrack

Routing of the main rail line between the Mine and the Port is a critical project activity due to rail operational constraints, the interface with project permitting and the impact on earthworks volumes (and therefore project capex).

Track and gradient design criteria are discussed in detail in Section 10 of this Report (Site Development and Infrastructure) and have been applied to the rail alignment development.

Routing criteria used during the Stage 2 Study included:

- Rail alignment to remain within existing commercial lease and impact area boundaries as far as possible (nominally within 100 m of the existing Tote Road centerline);
- Deviations required outside the existing boundaries to be constrained as close to the existing road as practical (with a target of being within 1km of the road)
- The permitting criteria was carried forward to this study however to optimize the rail design the number and length of deviations outside the existing boundary and the

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maximum distance from the existing road were increased compared to the original High Level Option Study routing, particularly for the deviation at “km67 hill” as discussed below

- Detail design of the rail alignment has a significant impact on the earthworks volumes to construct the rail substructure (embankment) particularly in areas of varying sub-grade (permafrost and rock). Routing criteria was applied to minimize project capex and provide a stable substructure include:
  - Route rail on/through areas of rock sub grade where available. Utilize rock cuts to level track and as a quarry source for areas where rock fill is required
  - Avoid ice-rich permafrost where practical
  - Utilize permafrost excavation sparingly but as required to minimize overall capital cost
  - Align rail to minimize fill volumes. Utilize deviations outside the permitting boundary where significant benefit can be realized.

8.3.5 Routing Optimization

8.3.5.1 General Optimization

Development of the rail alignment during the Stage 2 study was completed using 3D engineering design tools applying the developed geometric criteria and external constraints. Where available LiDAR data obtained by Baffinland in 2008 was used for the existing terrain; where the rail was routed outside the available LiDAR data, GIS information publically available from Natural Resources Canada (NRCan) was utilized. Design was further supported by field inspection of the initial alignment.

During the Stage 2 study a new LiDAR survey was commissioned and completed after the High Level Option Study alignment was further developed and optimized. This LIDAR survey was incorporated into the 3D engineering design. Minor adjustments were made to the optimized alignment as the updated LIDAR included the current Tote road alignment, including Tote road modifications that were made since 2008. The section where the Tote road and rail alignment clashed were eliminated as far as practically possible. However, a total of 11 grade crossings remained after the optimization process. A total of 9 of these grade crossings will require minor Tote road realignments so as to ensure compliance with Transport Canada grade crossing specifications for grade crossings that only have visual warning systems in the form of road and rail signage. The design currently allows no advance warning system with either flashing lights or gates as these are not required for future operations based on the number of trains and road vehicles which will make use of the grade crossings.

8.3.5.2 Geotechnical Optimization

Early study alignment development assumed permafrost for the full length of the rail route with significant distances of moderately to highly frost susceptible soils (refer to Knight

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Piesold report NB-102-0018/10-1 Road Upgrade Design Summary). However, during the study a site visit by Hatch's lead Geotechnical engineer identified substantial opportunities to realign the rail into adjacent areas of rock sub grade and to optimize the vertical profile to construct the rail substructure on rock beds that exist as sedimentary layers in the permafrost along the km 67 hill deviation (refer to Appendix A8-11)

Based on field observations, the following geotechnical optimizations were incorporated into the rail design:

- From Milne Port to CH 8.000 km the rail has been routed through granitic rock to the north-east of the existing Tote Road. Elevation of the rail has been set to below grade. The resulting excavated rock will be used as a quarry source for bulk fill required toward the south (rock fill embankment constructed over permafrost)
- Alignment from CH 10.000 km to CH 11.500 km adjusted to avoid ice rich permafrost (and excess fill required)
- Alignment from CH 60.000 km to CH 80.000 km adjusted to align, where practical, on sedimentary rock shelf and utilize local cut-to-fill construction methodology at gully's
- Alignment at CH 77.000 km adjusted to minimize crossing over ice rich permafrost.
- Alignment at CH 88.000 km to 92.000 km adjusted to avoid ice rich permafrost and maximize construction over rock sub grade
- Realign CH 99.000 km to CH 104.000 km through rock sub grade.

8.3.5.3 Deviation at km 67 Hill

The existing Tote Road climbs over a hill between the CH 62.000 km and CH 80.000 km, with its crest at approximately CH 67 km. The total elevation gain/loss and associated gradient profile is not suitable for a rail track following the road. The locomotives would be unable to climb the hill in the loaded direction and braking requirements down the hill loaded would be excessive.

During the High Level Option Study a concept alignment was developed deviating away from the road and bypassing the peak of the hill, but still generally climbing up and over the hill. Following field inspection of the terrain along the proposed route, particularly deep gully's on the west side of the hill, and considering the operational impacts of a long uphill climb / downhill decent, alternative deviations were investigated. The Tote Road, initial concept alignment and alternatives routes assessed are illustrated in Figure 8-10.

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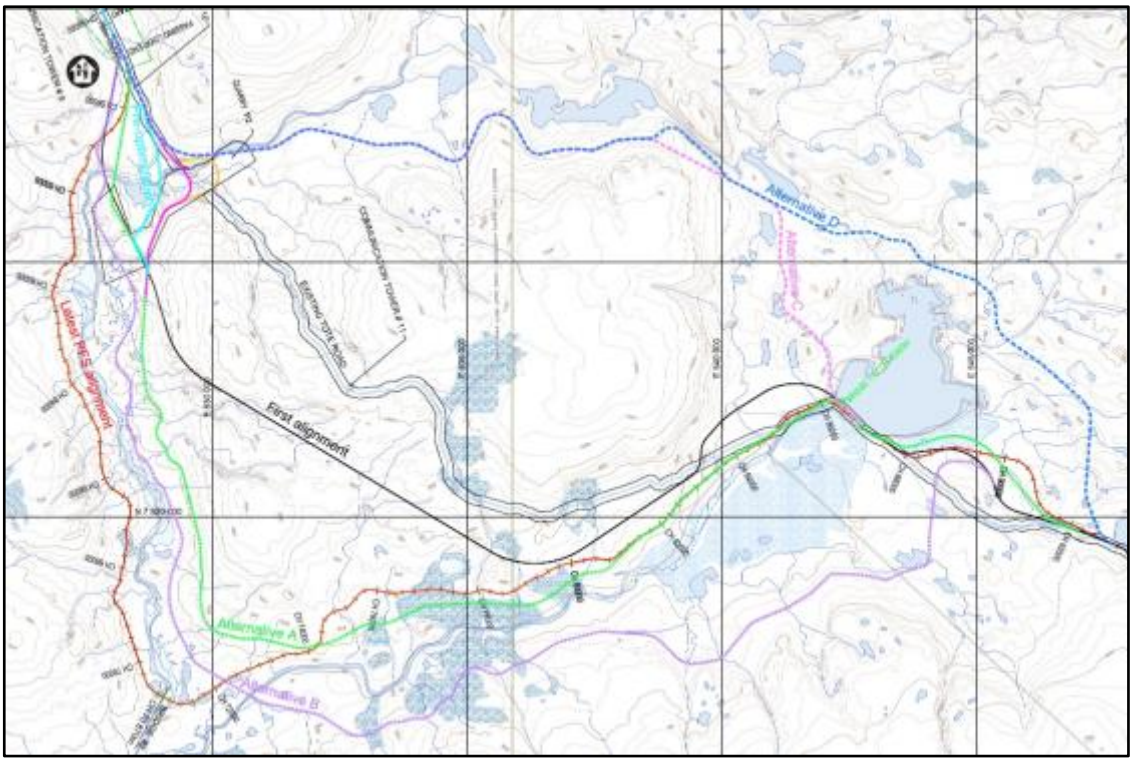

Figure 8-10: Potential Alternative Deviations Around km 67 Hill

Considering the terrain (and resulting fill requirements), gradients and potential for a rock cut ledge rail embankment, alternative A was initially selected, however, a suitable location for a rail over river bridge, with reasonable earthworks volumes and bridge structural requirements, could not be identified.

Final optimization of the alignment in the area of km 67 Hill was to relocate the rail bridge approximately 12 km downstream from the existing road bridge resulting in the final layout.

8.3.5.4 Final Alignment Summary

The final alignment developed for the study is shown on the rail plan and long section drawings, included in Appendix A8-9, and the formation cross section drawings included in Appendix A8-10.

Figure 8-11 Figure 8-12, Figure 8-13 indicate the track alignment as developed during the feasibility study.

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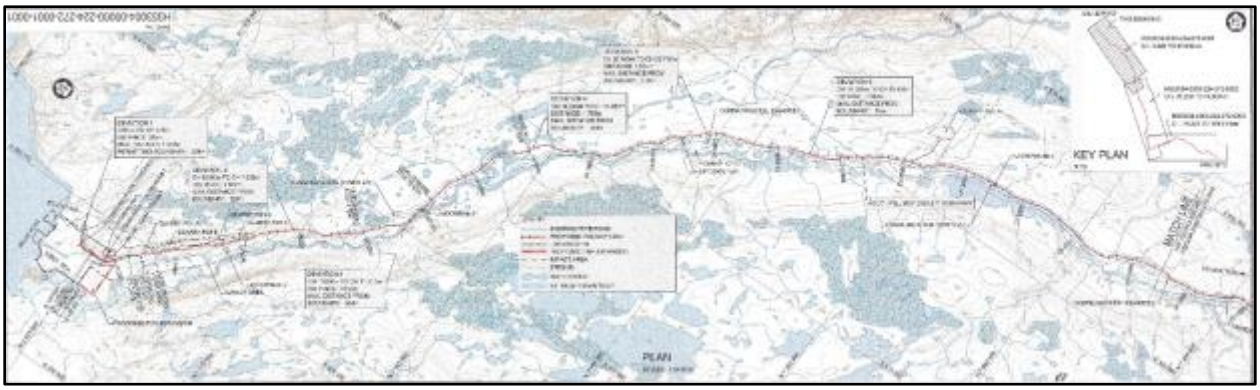

Figure 8-11: Layout Section CH 0.220 km to CH 37.250 km

Figure 8-12: Layout Section CH 37.250 km to CH 74.250 km

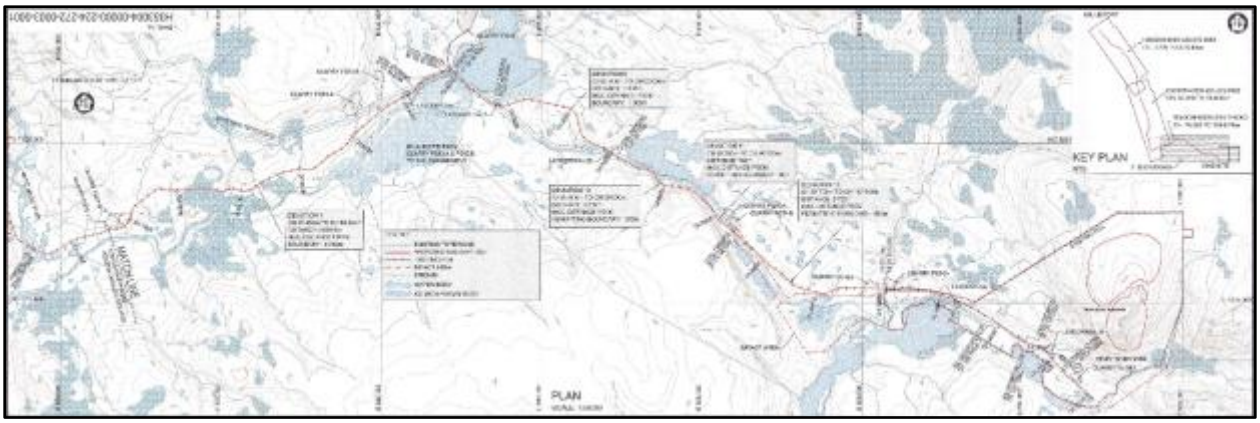

Figure 8-13: Layout Section CH 74.250 km to CH 110.611 km

Key parameters are summarized in Table 8-1. A summary of deviations outside the current permit boundary is provided in Table 8-2.

In addition to the listed deviations, some sections of the rail line are very close to the existing permit boundary and the toe of fill/crest of cut may extend beyond the boundary.

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Table 8-1: Rail Alignment Parameters

Item	Value	Comment
Total main line length	110.6 km	
Maximum gradient – loaded uphill	1.5%	
Maximum gradient – loaded downhill	3.0%	
Number of deviations outside permit boundary	10	
Total distance of deviations outside permit boundary	46.6 km	A total of 12 deviations have been identified
Total length constructed on rock sub grade	23 km	Approximate, pending final geotechnical verification
Total length constructed on ice-rich permafrost	4 km	
Number of bridges	4	
Number of level crossings	11	Excluding yard track

Table 8-2: Summary of Deviations Outside Existing Permit Boundary

Deviation Number	Rail Chainage		Distance of deviation* (m)	Max distance from existing permit boundary* (m)	Reason for Deviation
	Start (km)	End (km)			
1	-	315	315	339	Unloading track alignment
2	6,250	7,932	1,682	229	Rock cut foundation
3	10,080	11,912	1,832	254	Gradient
4	15,238	16,943	1,705	359	Horizontal alignment
5	20,946	22,760	1,814	128	Gradient
6	24,791	25,090	309	19	Gradient
7	46,304	46,391	87	17	Gradient
8	57,490	84,334	26,884	7,042	Gradient and bridge location
9	87,800	92,006	4,206	1,284	Gradient
10	93,800	95,000	1,200	390	Gradient
11	95,780	96,525	745	168	Gradient
12	97,750	103,542	5,792	903	Rock cut foundation

* Distances based on rail centerline. Toe of fill / crest of cut will exceed values listed.

8.3.6 *Sidings*

One siding was identified during the prefeasibility phase of the study. To allow loaded and empty trains travelling north and south respectively to cross one another the design identified the requirement for “midway siding”. The location of the “midway siding” was between CH 55.883 km and CH 56.936 km from stock rail joint to stock rail joint. The siding was positioned on the West of the mainline alignment during the previous phase of the study. However, during the final rail alignment optimization it was noted that an existing operational building was located on the Western side of the rail alignment in the same location as the proposed rail siding location.

Thus, it was decided to move the “midway siding” and to locate it to the East of the mainline. The siding is able to accommodate 80 ore railcar trains with two locomotives and has a

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clearance distance of 900m. The siding also includes a 300m maintenance and staging siding where on-track maintenance equipment can be staged and bad order wagons can be shunted off the main train consist in emergency cases. Refer to Figure 8-16 for the diagrammatic layout.

8.3.7 Bridges

The number of rail over river bridges have remained unchanged from that which, was identified in the Stage 2 phase. A total of 4 rail over river bridges are required along the entire rail alignment to cross major water crossings. During the Stage 2 study these rail over river bridges were located at the following locations:

- 4 span crossing 15.100m per span, located at CH 15.839 km
- 2 span crossing 20.235m per span, located at CH 70.869 km
- 2 span crossing 20.235m per span, located at CH 86.355 km
- 4 span crossing 15.200m per span, located at CH 92.255 km.

With the integration of the final LIDAR topographical survey information and making adjustments to optimize the rail alignment as set out elsewhere in this section of the report. The final rail over river bridge locations have been determined to be located at:

- 4 span crossing 15.100m per span, located at km 15.839 (H353004-3330-230-270-0001-0001)
- 2 span crossing 20.235m per span, located at km 70.690 (H353004-3330-230-270-0001-0002), this bridge moved northeast from the previous study location
- 2 span crossing 20.235m per span, located at km 86.355 (H353004-3330-230-270-0001-0003)
- 3 span crossing with one centre span of 20.100m and two outside spans of 20.235m per span, located at km 102.217 (H353004-3330-230-270-0001-0004), this bridge moved north from the previous study location.

The final extent of the rail over river bridges is such that there was no reduction in the overall length of bridges required along the rail alignment after making the final adjustments to incorporate the alignment changes that were implemented. Bridge spans have been based on the existing normal flow river bank and the adjacent Tote road bridges. Detailed hydrological design will be carried out by the successful contractor as part of the overall bridge design of the project.

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8.4 Port Layout Development

8.4.1 Overview

The proposed port site layout is shown on Appendix A8-4.

Expansion Project layout for the Port Site was primarily driven by optimization of the bulk materials handling equipment within the existing Project Development Area (PDA) boundary, and with consideration of the associated rail track infrastructure. Facilities were generally constrained to the existing PDA to remove any schedule risk associated with timeline for approval of the proposed PDA expansion.

Key aspects of the selected bulk materials handling and rail layout include:

- Locating the rail unloading system on the natural bench adjacent to quarry Q1 in a natural depression. This location optimized the design of the unloading system and the rail track:
  - Unloading system founded on rock (valley floor at Milne is deep permafrost)
  - Excavation for unloading basement is reduced (relative to typical deep pit excavation for an unloading system)
  - Unloading basement can be “day-lighted” with vehicle (small equipment) access through the conveyor tunnel into the basement.
  - Unloading conveyor is nominally horizontal through to discharge onto primary crushing stockpile.
  - Rail track is maintained at a higher elevation and does not need to decent to the Milne valley floor elevation.
- Locating the new ore dock east of the existing to optimize it’s position for efficient ship access and potential future ice breaker access.
- Aligning the new yard conveyor and stockpile to:
  - Maximize length within the existing PDA (therefore maximizing stockpile capacity)
  - Directly feed the new ship loader without intermediate conveyor (for proposed dual quadrant ship loading utilizing a flow splitter and single link conveyor)
  - Construct the stockpile on the flat river delta plain which minimized associated earthworks.
- Aligning the crushing and screening system to link the rail unloading and stockpile systems with the minimum possible conveyor lengths.

Other facilities required at Milne were positioned after the above optimization was complete and were generally located:

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- Facilities to support rail operations and maintenance were grouped adjacent to the rail unloading system and arranged to minimize associated rail track lengths. Rail workshop was also able to be founded on rock.
- Facilities to support crushing and screening operations and maintenance were located adjacent to the crusher building.
- Operations camp and utility system were optimized to be expansions of existing systems and located to facilitate expansion rather than constructing new independent facilities.
- Construction camp was located centrally to the construction work and to minimize earthworks.

8.4.2 Bulk Materials Handling

8.4.2.1 Introduction

Layout of the bulk materials handling system was developed during the Stage 2 study. Further optimization of the layout during Stage 3 was delegated to the CM001 Bulk Materials Handling and Processing Contractors to consider with their bids. A battery limit drawing (included in Appendix A8-7) was issued with the package to define the available footprint for optimization. All bids received effectively aligned with the Stage 2 layout and this was carried forward as the basis for the Stage 3 study.

8.4.2.2 Rail Unloading

Ore transported from the mine by rail reports to the rail dumper at the port for offloading. The dumper consists of a single rotary dumper. The dumper is located on the incoming rail line at an elevation of approximately 57 meters. The natural ground level will be used to the advantage of the rail unloading conveyor which daylights at a lower level and thus not having to first be elevated to above ground level.

The dumper basement size is approximately 16.525 by 15.725 meters and 21 meters deep.

An access road will be constructed to allow access to the rail unloading conveyor. The rail unloading conveyor will be in a tunnel constructed from a prefabricated steel section over which the excavation would then be backfilled.

The tunnel will have an internal clearance height of approximately 2.7 metres which will be sufficient to allow forklift access for maintenance of equipment inside the dumper.

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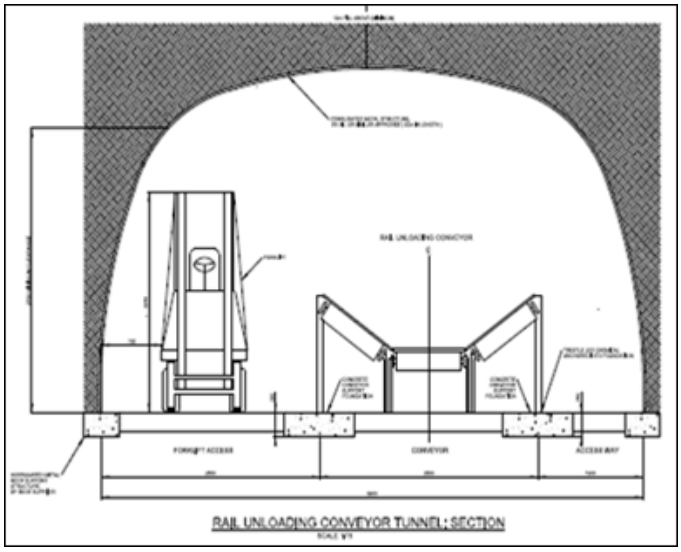

Figure 8-14: Rail Unloading Conveyor Tunnel Section

The rail unloading conveyor will discharge ore on the crusher feed stockpile.

8.4.2.3 Secondary Crushing and Screening

A general arrangement of the system is shown in Figure 8-15. The arrangement is proposed to optimize the associated interconnecting conveyors.

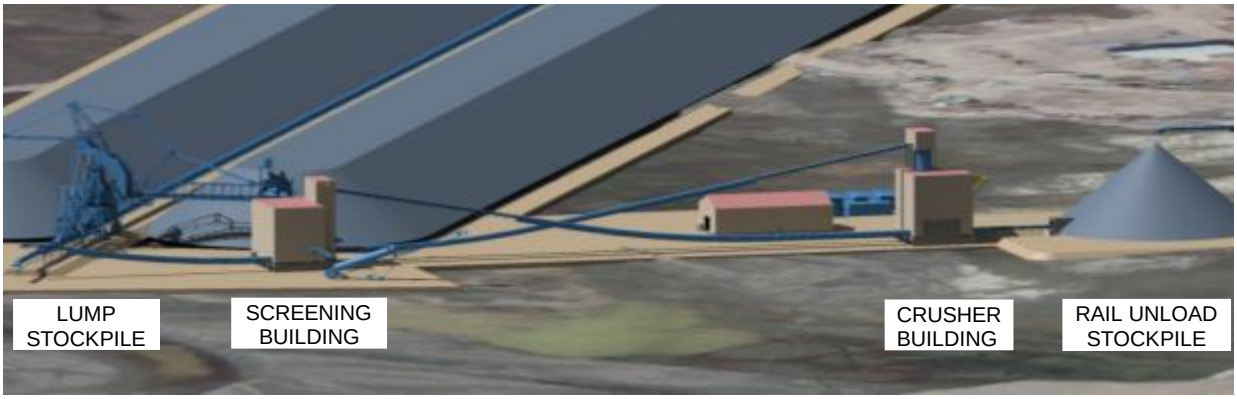

Figure 8-15: Secondary Crushing and Screening Arrangement

8.4.2.4 Stockpile

Lump ore from the screening plant will be conveyed direct to a new lump stockpile with dedicated reclaim and feed to Ship Loader No. 2.

Required stockpile live capacity for average year production and shipping is 7.2 Mt. The proposed reclaimer for the stockpile is a 60m boom. To achieve the required storage capacity within the topographical and permitting constraints and with a single yard conveyor (and associated stacker and reclaimer) an over-built stockpile is proposed as described in Section

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6 - Process. The orientation of this stockpile was optimized to fit within the existing PDA and to feed directly to the new ship loader.

To facilitate construction of the new lump stockpile the existing reclaim conveyor will be modified as shown in the site layout drawings. The existing stockpile, used only for fine ore in the expansion project, will the modified to include the west side piles only.

Ore will be trucked to the stockpile from the intermediate pile adjacent to the screening plant and will be stacked using the existing mobile radial stackers supplied by others.

8.4.3 Marine Structures

The project requirements of shipping 12Mt of product during the prescribed open water season requires significant expansion to the wharf and marine infrastructure of the Milne Port, which includes the construction of a second ore export terminal (Ore Dock No. 2).

The introduction of Ore Dock No. 2 at the Milne Port has two primary functional objectives which consist of the following:

- Provide a safe, efficient and secure deep-water berth for a range of design vessels including Panamax and Cape Size bulk ore carriers
- Provide a means of support for the shiploaders and associated mechanical equipment used for loading the vessel
- Enable the export of lump iron ore at a rate of 16,000t/h.

The proposed ore dock layout and configuration is shown on Appendices A8-5 and A8-6.

To achieve these objectives Ore Dock No.2 consists of the following facilities:

- A new ore dock suitable for berthing Cape Size ships (up to 230,000dwt, 316m LOA and draft of 19.0m). The new dock is located east of the existing ore dock (Ore Dock No.1) at a minimum design depth below LLWD of 21m for berthing of the proposed ships. The new dock includes the following elements:
  - Symmetrical breasting and mooring points, a fender system and mooring hardware. Furthermore, the ore dock has all the necessary access and space required for the operation and maintenance of the berth and its associated infrastructure
  - The main berth face consist of structure(s) that act as combined breasting and shiploader support platform. These structure(s) accommodates fenders to absorb the energy of the berthing vessel, provide contact points for the moored vessel and mooring line points as required
  - A causeway that supports the conveyor system and provide access for pedestrians and service vehicles from the shore to the main berth face, as well as access for mechanical, conveyor and electrical systems

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- Dual quadrant ship loader installed on the new dock. Each quadrant ship loader is capable of operating at up to 8,000 t/h and both loaders can operate simultaneously for a combined rate of up to 16,000 t/h.

The berth location has been selected, based on the local bathymetry, to provide the minimum depth of marine structures while still providing adequate water depth at the berth face without dredging. Furthermore, the berth location has been selected to maintain a safe distance between the existing and new berth, by allowing adequate separation during berthing and avoiding the crossing of mooring lines. The orientation of the causeway has been selected to accommodate the orientation of the reclaim conveyor feeding the shiploaders.

An underkeel clearance of 10% of the largest vessel's fully laden draft has been provided at the berth and the berth has therefore been oriented parallel to the natural bathymetry. The average elevation of the ore dock has been set at the same level as the existing ore dock, namely +5.3 m CD. In the execution phase, options for lowering this elevation will be considered to minimise capital expenditure (refer to Appendix A8-12).

8.4.4 Roads

Berms will be constructed for utility services including MV cables, fibre optic cables and HDPE pipelines. The berm on the east side of Stockpile No. 2 will allow cables to be run to feed the crushing and screening plant area and provide a redundant power and communication network. A berm will be constructed to enable the marine fuel intake pipeline to be routed to connect back to the tank farm.

An area will be prepared for receiving pre-cast foundations for the crusher and screening buildings. These building will be brought to site as complete modules and will be transported by SPMT's from the offloading dock. The final layout of the foundations will suit the preferred BMH contractors building modular design.

A new access road to the dumper is included, this road will link in from the existing tote road and be constructed with a culvert under the rail line, see Figure 8-16.

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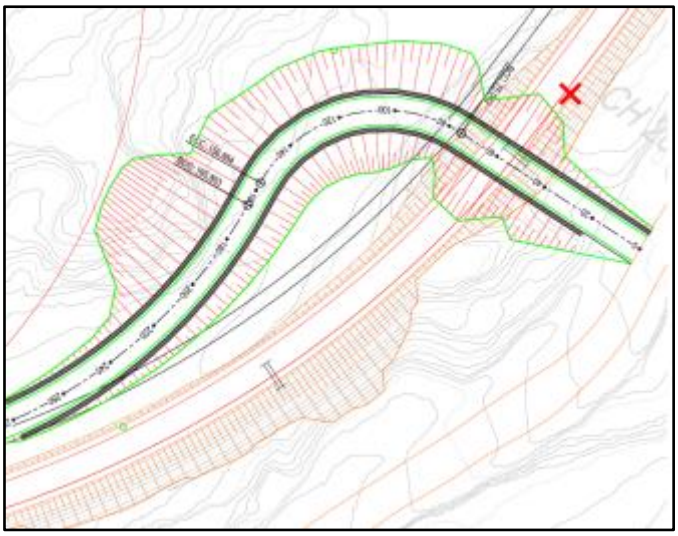

Figure 8-16: Rail Dumper Access Road

A road is included to extend the tote road where the existing road is encroached by the new stockyard No 2 on the eastern side.

A road from the temporary barge dock is included to enable large modules to be offloaded at the dock and transported up to their final positions at the crushing and screening area as well as the tippler area.

A road is included to allow the haul trucks transporting fine or to stockyard No.1 to travel between the fines stockpile and the realigned stockpile No.1.

8.4.5 Utility Systems

8.4.5.1 Power

At the Port Site, all generators will be centralised at the current generation facility. This applies to new generator additions and the main distribution E-house extension to be provided as part of the project expansion; see layout in Figure 8-17.

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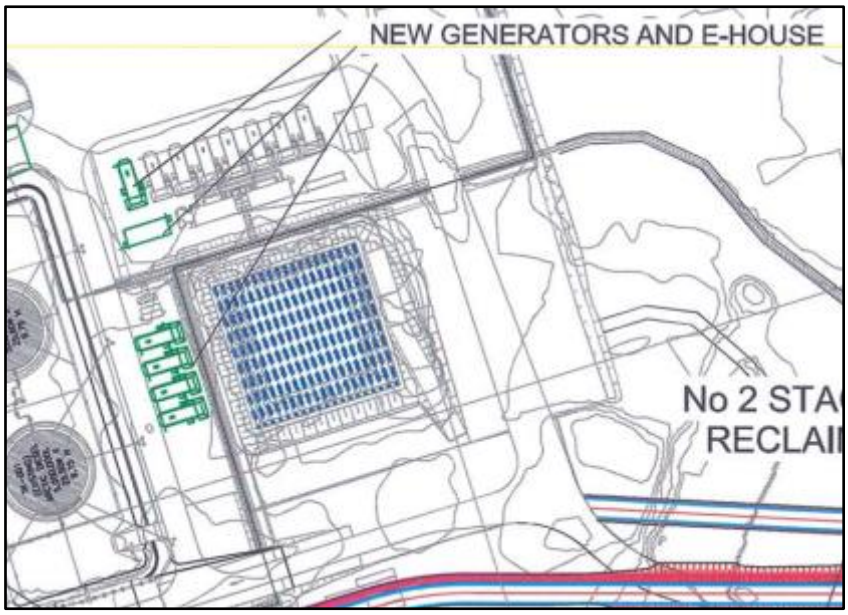

Figure 8-17: Layout of the generating Station

Power cables will be routed on top of earth berms which will be created or extended as needed to facilitate the Port power distribution network.

From the main generation distribution E-house, three Point of Supply (POS) termination points will be served. From these three termination points, the CM001 BMH Contractor will tie-in his equipment. Refer to Figure 8-18 showing the power cable layout.

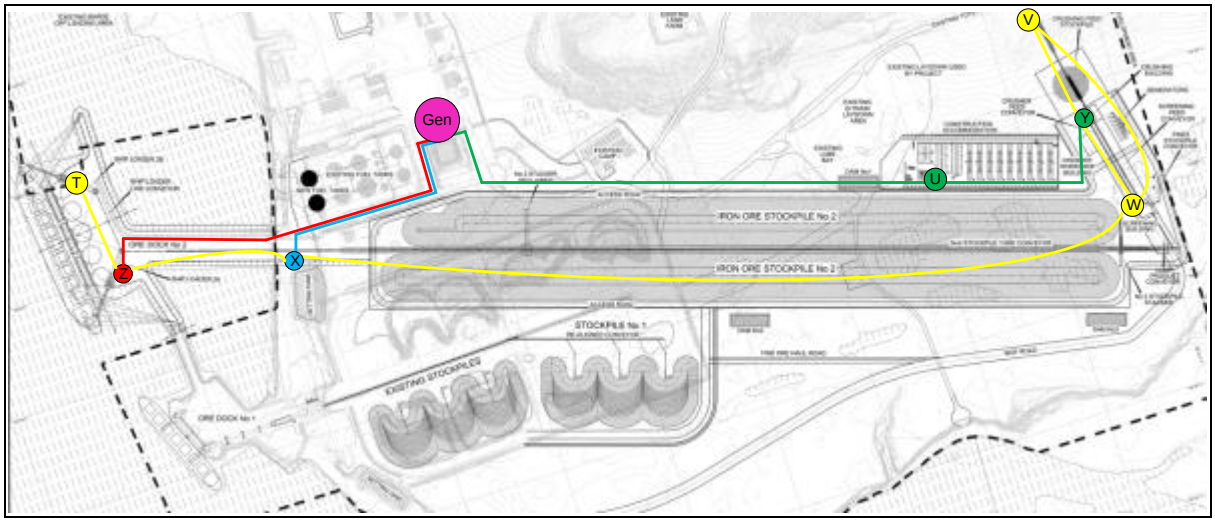

Figure 8-18: Port Electrical Power Distribution Layout Diagram

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The Yard Conveyor E-House is located at position X. The blue cable route will serve the new Stockyard No. 2 yard conveyor and the stacker/reclaimer machines. This cable route will include redundant point to point cables and switchgear for the total electrical load supplied.

The Crusher Building E-house at point Y will serve the new rail unloading and yard system, screening, crushing and associated conveyors. The green cable route will include non-redundant point to point cables and switchgear for the total load at Y. The same cables will also feed the construction camp on route to the Crusher Building E-House.

The Shiploader #2A E-House at point Z and is intended to serve the new Shiploaders #2A & #2B. The red cable route will include non-redundant point to point cables and switchgear for the total load at Z.

Fully redundant power cables between the facilities would be provided by the yellow cable route. The cable supply and installation would be packaged in the BMH contractor's scope of works (CM001).

8.4.5.2 Fuel Systems

Three new fuel tanks will be installed in the existing fuel containment berm, including a 0.75Ml Jet-A1 tank, a 15 Ml arctic diesel tank and a 3 Ml arctic diesel tank. The tanks will be connected to the existing pipe system at the fuel tank farm.

The tank farm is supplied by floating hose connected to a marine manifold building at the north end of the tank farm. Due to interference of the new ore dock with the existing fuel ship and floating hose operating area, the marine manifold building will be relocated adjacent to the existing barge offloading area. A berm will be constructed for routing of the pipeline to the marine manifold.

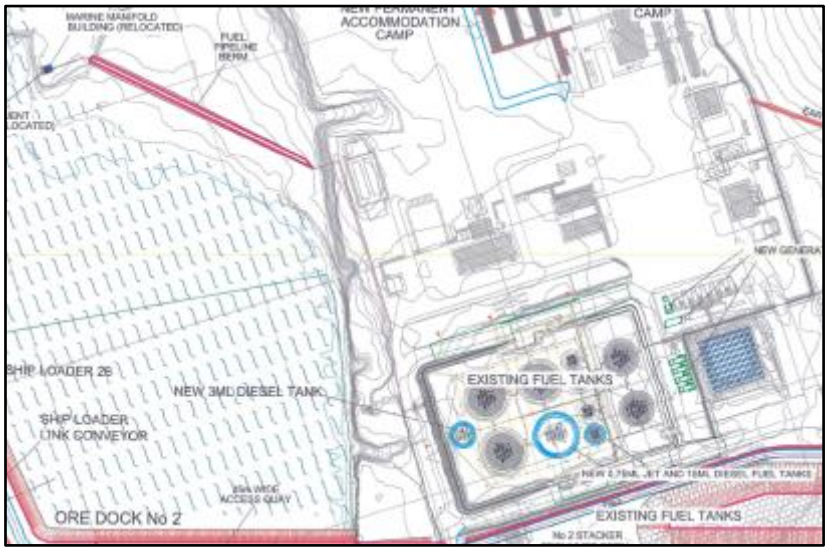

Figure 8-19: New Fuel Tanks and Relocated Marine Manifold

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8.4.5.3 *Treated Effluent Pipeline*

Treated effluent is currently discharged near the existing marine manifold building at the north end of the fuel tank farm however construction of the new ore dock will effectively form an open bay around this location. To improve natural water flow at the point of discharge, and reduce the risk of forming a zone of brackish water, the discharge will be located adjacent to the existing barge offload ramp (alongside the relocated marine manifold building).

8.4.5.4 *Communication and IT Infrastructure*

Fiber optic cable will be routed as shown in Figure 8-20, to enable plant-wide communications and control. Existing fiber cable will need to be cut and spliced to allow the installation in culverts where the No2 stockpile yard conveyor intercepts the existing cable.

Redundancy in the network will be provided by a fiber optic cable that will connect from the power generation E-house to the crusher building. The BMH system installed by the contractor will connect to the fiber network at the crusher building and the No.2 stockpile yard conveyor drive house (A6 and A5 respectively in Figure 8-20).

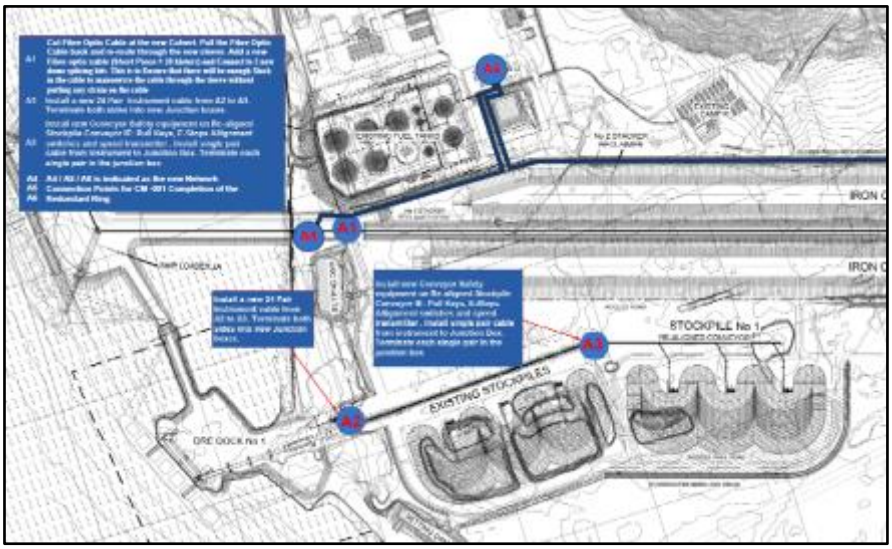

Figure 8-20: Fibre Optic routing at the Port

8.4.6 *Operations and Construction Accommodation*

The operations camp at the Port Site (the PSC) is to have three additional 30 bed dormitory wings (total of 90 additional beds), an extension to the existing arctic corridor and one new locker room added.

The exiting pad is sufficient for this expansion with minor grading works.

To support the expansion project a new construction camp will be built. The camp is located central to the construction works and positioned to optimize associated earthworks.

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8.5 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-220-272-0005-0001	Mine Site – Block Plan - Layout	0	25/03/2017	A8-1
H349000-4000-00-014-0014	Mine Site Explosives Storage Clearances General Arrangement	0	13/01/2015	A8-2
H349000-4400-10-041-0009	Mine Site Aerodrome Obstacle Limitation Surfaces Non-Instrument	0	11/04/2014	A8-3
H353004-00000-220-272-0001-0001	Port Site – Block Plan – Overall Layout	0	10/03/2017	A8-4
H353004-00000-220-272-0010-0001	Port Site Ore Dock No 2 Layout	0	14/12/2016	A8-5
H353004-00000-220-272-0019-0001	Port Site Ore Dock No 2 Sections	0	15/12/2016	A8-6
H353004-00000-220-272-0017-0001	Port Site CM001 Contract Interface Overall Layout	0	15/12/2016	A8-7
H353004-00000-224-262-0001-0001	Rail Site Diagrammatic Layout Milne Port to Mine Site	0	13/12/2016	A8-8
H353004-00000-224-272-0001-0001	Rail Site Plan and Longitudinal Section Ch. 0.220km to Ch. 37.000km	1	10/02/2017	A8-9a
H353004-00000-224-272-0002-0001	Rail Site Plan and Longitudinal Section Ch. 37.250km to Ch. 74km	1	10/02/2017	A8-9b
H353004-00000-224-272-0003-0001	Rail Site Plan and Longitudinal Section Ch. 74.250km to Ch. 109.61km	1	10/02/2017	A8-9c
H353004-00000-224-260-0001-0001	Rail Site Formation Cross Sections Ch. 220m to 2500m	0	03/02/2017	A8-10a
H353004-00000-224-260-0002-0001	Rail Site Formation Cross Sections Ch. 2600m to 4100m	0	03/02/2017	A8-10b
H353004-00000-224-260-0003-0001	Rail Site Formation Cross Sections Ch. 4200m to 6600m	0	03/02/2017	A8-10c
H353004-00000-224-260-0004-0001	Rail Site Formation Cross Sections Ch. 6700m to 10300m	0	03/02/2017	A8-10d

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Document Number	Title	Revision	Date	Appendix Number
H353004-00000-224-260-0005-0001	Rail Site Formation Cross Sections Ch. 1040m to 21000m	0	03/02/2017	A8-10e
H353004-00000-224-260-0006-0001	Rail Site Formation Cross Sections Ch. 25200m to 36700m	0	03/02/2017	A8-10f
H353004-00000-224-260-0007-0001	Rail Site Formation Cross Sections Ch. 36800m to 39500m	0	03/02/2017	A8-10g
H353004-00000-224-260-0008-0001	Rail Site Formation Cross Sections Ch. 39600m to 49200m	0	03/02/2017	A8-10h
H353004-00000-224-260-0009-0001	Rail Site Formation Cross Sections Ch. 49300m to 59400m	0	03/02/2017	A8-10i
H353004-00000-224-260-0010-0001	Rail Site Formation Cross Sections Ch. 59500m to 62500m	0	03/02/2017	A8-10j
H353004-00000-224-260-0011-0001	Rail Site Formation Cross Sections Ch. 62600m to 67500m	0	03/02/2017	A8-10k
H353004-00000-224-260-0012-0001	Rail Site Formation Cross Sections Ch. 67600m to 70760m	0	03/02/2017	A8-10l
H353004-00000-224-260-0013-0001	Rail Site Formation Cross Sections Ch. 70780m to 76100m	0	03/02/2017	A8-10m
H353004-00000-224-260-0014-0001	Rail Site Formation Cross Sections Ch. 76200m to 86460m	0	03/02/2017	A8-10n
H353004-00000-224-260-0015-0001	Rail Site Formation Cross Sections Ch. 86480m to 95700m	0	03/02/2017	A8-10o
H353004-00000-224-260-0016-0001	Rail Site Formation Cross Sections Ch. 95800m to 101500m	0	03/02/2017	A8-10p
H353004-00000-224-260-0017-0001	Rail Site Formation Cross Sections Ch. 101600m to 103500m	0	03/02/2017	A8-10q

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Document Number	Title	Revision	Date	Appendix Number
H353004-00000-224-260-0018-0001	Rail Site Formation Cross Sections Ch. 108500m to 109500m	0	03/02/2017	A8-10r
H352034-1000-220-068-0001	Site Visit Report – Sept 7-14 2016	0	04/21/2017	A8-11
	Ore – Deck Elevation Review	A	02/14/2017	A8-12

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 9 – Facilities Description

2017-05-01	0	Approved for Use	N. Mason	J. Cleland	S. Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
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9. Introduction

9.1 General

The Facilities Description document is a key communication document with the primary function of being a consolidated general description of the Mary River 12 Mtpa Expansion Project in Nunavut, Canada, referred to as the Project.

The Facilities Description has been written to describe 'what' will be installed in each area of the project to a level of detail that will enable the reader to get a quick and accurate understanding of project scope.

This document is not the master document of design information or criteria that is used to develop the project design. The relevant design criteria, specifications, equipment lists and associated documents must be referred to for detailed information.

This document has been developed to align with the approved budget prepared for the Stage 3 Definitive Study Report.

9.2 Work Breakdown Structure

The Facilities Description has been developed on an area by area basis that is aligned with the project Work Breakdown Structure (WBS). Refer to the PEP Section C Appendix A (WBS H354004-00000-103-120-0002-AP0A).

The Level 1 descriptions in this document are as listed in Table 9-1.

Table 9-1: Work Breakdown Structure – Level 1

Area	Title
1000	MINE
2000	IRON ORE PROCESS PLANT AND ONSITE INFRASTRUCTURE
3000	RAIL
4000	PORT
5000	OTHER OFF SITE INFRASTRUCTURE
6000	CONSTRUCTION FACILITIES AND SUPPORT
7000	IMPLEMENTATION CONTRACTOR'S SERVICES
8000	OWNER'S COST
9000	CONTINGENCY/ESCALATION/RISK

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9.3 Project Descriptions

9.3.1 Area 1000 – MINE

Definition of WBS elements related to mine development, mining of ore, waste management, mine hydrology and mine operations to produce and deliver ore to Area 1500 is developed and discussed in Section 5 of the Definitive Stage 3 Study Report.

Area 1000 includes:

Area 1500 – Site Development

Site development related to stripping, development of new haul roads in the mine is detailed within Section 5 of the Definitive Stage 3 Study Report.

Area 1600 – Services and Utilities

Services and utilities to directly support mining operations are described within Section 5 of the Definitive Stage 3 Study Report.

Area 1700 – Mobile Equipment

Area 1800 – Mine Ancillary Facilities

Area 1900 – Mine Materials Handling

9.3.2 Area 1500 – Site Development

9.3.2.1 Area 1510 – Site Development and Plant Roads

Appendix A-1 provides layouts and arrangements aligned to the scope described below.

Tote Road Realignment

a) Installation of the railway requires redirection of the Tote Road to provide an alternative route which does not interfere with the rail alignment at the mine. The realignment includes construction of a new Tote Road from a point adjacent to the existing Laydown #1 to a point between the Quarry Access Road and the south end of the runway. The re-alignment includes provision of a single road crossing for the rail line which will be fitted with safety signage on both the road and rail track to advise of protocols for crossing either road or track. No other safety devices will be installed.

   The re-alignment contains provisions for two ramps to provide access to grade, one located either side of the rail crossing. The southern off ramp will be graded into the extended Laydown #2 for access to the Laydown area and the service road to the Construction Camp, Landfill, Emulsion Plant and Railway (see below).

New Service Road

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b) Due to interference with the railway alignment, the existing landfill/emulsion plant and treated effluent road will be replaced by a new service road constructed along the south side of the railway alignment. The new service road will tie into the existing Tote Road near Laydown #2 which enables access to the Tote Road realignment (above). The southern end of the new service road will tie into the existing treated effluent road approximately 300m back from the effluent discharge area.

   The road will not be sealed.

c) The new service road will provide access to:

   - Train driver drop off and pick up areas
   - Construction Camp
   - Existing landfill
   - Existing emulsion Plant
   - Existing effluent discharge area

   The new road will tie into a new access for the construction camp and existing roads to the landfill and emulsion plant.

d) A turn out area will be provided at the northern and southern end of the service road to provide safe parking for vehicles for train driver changeout. Safe man access from the service road to the rail track will be provided. This access is to allow train operators to mount and demount locomotives and provide a safe platform for off track train roll by inspections.

e) Steel pipe utility crossing for the water pipe and electrical supply cables for the camp.

f) A utility bench will be provided along the road between the road and the rail track for installation of the re-aligned treated effluent discharge pipe.

g) Four drainage culverts will be provided to connect existing drainage channels beneath the road.

Haul Road to Crushers

a) An extension to the existing haul road system will be provided to provide HME access from the existing crusher pad to the new crusher pad. A haul road of about 300m length will be installed. The road will not be sealed.

Diversion Berm and Channel

a) A single diversion channel and berm will be installed south of the new Haul road to divert an existing stream to culverts installed in the rail and new service road.

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Stockpile and Crusher Sedimentation Pond

a) A new granular walled HDPE lined sedimentation pond will be constructed to capture run off from the newly constructed primary crusher pad. The settling includes and emergency overflow spillway to an existing water course. During normal operation the pond is pumped empty using mobile pumps and hoses (existing equipment).

Shape Drainage Path into Natural Watercourse

a) To the North of the new primary crusher pad, a drainage ditch will be provided to redirect existing stream channels to flow to the North of the crusher pad into an existing stream flowing to the North West.

Earthworks for Construction Accommodation, Permanent Mine Accommodation, New workshop

New pads are required to allow for construction of a new construction camp and truck shop. The scope includes:

a) Construction pad camp will be a pad 300m x 150m. Construction of the pad will require relocation of an existing power line and water supply pipeline to the edge of the new pad. Refer to Appendix A2 and A12. The layout in Appendix A12 defines the arrangement driving the size of the accommodation pad. Appendices A2 and A12 will require revision to reflect the final scope of the accommodation facility acquired for the project.
b) Construction of a pad for a new truck shop notionally 30m x 30m in size. Refer to Appendix A -9.

Rail Embankment within the Mine Area

Definition of the scope of the rail system is contained within WBS 3000 descriptions.

9.3.3 Area 1600 – Services and Utilities

9.3.3.1 Raw Water Pipeline

a) The existing raw water pipeline is to be re-routed and extended in length to suit the new construction camp pad. Refer to Appendix A-4. Final layout of this pipeline will be required upon selection of the accommodation camp contractor.

To minimize down time and execution risk the strategy is to construct a new length of pipeline along the new route and cut / splice it to the existing.

The pipeline is a 100mm HDPE pipe with heat tracing and insulation. The pipeline needs to be secured from movement due to thermal cycling by placing granular fill on top of the pipeline and strategic points.

Modification of the pipeline to the new discharge location includes:

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- Supply and install pipeline (100mm dia. HDPE DR11 with 50mm insulation, butt fused) along new route around the planned construction camp. Pipeline to be guided and anchored using steel pegs driven into ground and crushed rock placed over pipe as required.
- Supply and install series constant watt heater cable along new length of pipeline, 2 circuits, Thermon TEK as per existing. Installation details to match existing Port Treated Effluent Pipeline including splice and termination details (external junction box).
- Cut existing pipeline and heat trace cable at specified locations (two locations).
- Fuse existing pipe to new pipe and splice heat trace cables at two (2) connection locations.
- Complete pipe insulation at pipe joints as per existing Port Treated Effluent Pipeline details.
- Demolish 385m of existing pipeline.

9.3.3.2 Treated Effluent Pipeline

a) The existing treated effluent pipeline is to be re-routed and extended in length to suit the new primary crushing and railway layout and laid on an earth pipe bench constructed along the new service road. Refer to Appendix A-4.

To minimize down time and execution risk the strategy is to construct a new length of pipeline along the new route and cut / splice it to the existing. 1305m of new pipe is estimated to be required.

The pipeline is a 50mm HDPE pipe with heat tracing and insulation. The pipeline needs to be secured from movement due to thermal cycling by placing granular fill on top of the pipeline and strategic points.

Modification of the pipeline to the new discharge location includes:

- Supply and install pipeline (50mm dia HDPE DR11 with 50mm insulation, butt fused) along new route. Pipeline to be guided and anchored using steel pegs driven into ground and crushed rock placed over pipe as required.
- Supply and install series constant watt heater cable along new length of pipeline, one circuit, Thermon TEK as per existing. Installation details to match existing Port Treated Effluent Pipeline including splice and termination details (external junction box).
- Cut existing pipeline and heat trace cable at specified locations (two locations).

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- Fuse existing pipe to new pipe and splice heat trace cables at two (2) connection locations.
- Complete pipe insulation at pipe joints as per existing Port Treated Effluent Pipeline details.
- Demolish 1105m of existing pipeline.

9.3.3.3 Area 1610 – Mine Power Supply and Distribution

Refer to Appendices A5 and A7 for details of the scope described below.

Mine Construction Camp (Appendix A5 Items B1 and B2)

a) Install two (2) new 5kV power cables between power generation E-House and Construction Camp E-house - route length of 580m.

b) Cut existing 5kV cable at construction camp. Re-route cable to new construction camp E-House.

c) Terminate three (3) cables (two new plus one existing) in the construction camp E-House.

d) Terminate two (2) new cables in the power generation E-House.

e) Install new length of 5kv cable to extend existing cut end (feed to Aerodrome and Weatherhaven) to the new Construction Camp E-House – estimated length 280m.

f) Splice new length of cable to cut end of existing. Terminate new cable in the Construction Camp E-House.

g) Modify existing ground conductors and install new dual ground conductors along power cable route between E-Houses (joint onto existing conductors).

h) Supply and install grounding system accessories as required.

Relocate E-house #11 (Appendix A5 reference B3 and B4 (A&B))

a) Decommission E-house #11 and disconnect existing power cables (ref B4B)

b) Relocate modular E-House to new primary crushing pad (ref B4A)

c) Supply and install E-House grounding system including ground rods and copper conductor.

d) Disconnect two existing 1000A MV junction boxes in 5kV feeders to E-Houses #8 and #11 (three terminations in each junction box). Splice existing 5kV cables for power feed to E-House #8. Two (2) splices required.

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e) Relocate two existing 1000A MV junction boxes to new position along existing power cables (ref B3).

f) Cut two (2) existing 5kV power cables at junction boxes. Terminate cables in junction boxes (four terminations).

g) Install two (2) new 5kV power cables from relocated junction boxes to new E-House #11 location.

h) Terminate cables in junction boxes and in E-House #11. Four (4) terminations.

i) Install dual ground conductors along power cable route between JB and new E-House position. Connect ground conductors as required to complete network.

Modify Feeders to E-House #8 (Appendix A5 reference B5)

a) Cut two (2) existing 5kV power cables to E-House #8

b) Disconnect power cables from E-House #8, re-route existing cable and install new length of cable as required to for installation of the new truck workshop.

c) Splice new cable to existing (two splices)

d) Terminate new cables in E-House #8 (two terminations)

Truck Workshop 600V Feeder, (Appendix A5 reference B5)

a) Install 600 V cable between existing E-house #8 and new Truck Workshop.

b) Terminate cable in E-house #8 (other end termination by TX003).

Rail Signalling 600V Feeders, including

a) Install two (2) 600 V cables from existing Aerodrome E-house to Rail System Signalling Equipment (switches, two locations).
b) Install 600V cable from power generation E-House to Rail System Signalling Equipment (weigh bridge).
c) Terminate cables (x2) in Aerodrome E-house and cable (x1) in power generation E-House (other end terminations by TR001).

9.3.3.4 Area 1650 - Communications and IT Infrastructure

Fibre optic cable networks will be extended per;

Re-located E-House for Crushers –Refer to Appendix A6 items A1 to A2

a) Install new Cable from position A1 to position A2. Provide sufficient patch leads to connect fibre cable to control system.

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New Mine Truck Workshop – Refer to Appendix A6 items A1 to A3

a) Install new fibre cable from A1 at 47310VP-005 and then to the New Mine Truck Workshop reference A3. Splice and Patch the cables as required. Provide sufficient patch leads to connect fibre cable to control system. Test the cables and commission.

9.3.4 Area 1700 – Mobile Equipment

Area 1700 consists of the following sub-sections:

- Area 1710 – Mining Production Mobile Equipment
- Area 1720 – Production Support Mobile Equipment
- Area 1730 – Services Mobile Equipment

9.3.4.1 Area 1710 – Mining Production Mobile Equipment

Mine production equipment requirements are divided into two categories;

- Equipment required for 2019, which will be shipped in the 2018 sealift and form part of the capital phase of the project.
- Equipment required for 2020 and beyond which will begin delivery on the 2019 sea lift and will be managed from a sustaining capital budget. Table 9-2 defines the planned mine mobile equipment requirements.

Table 9-2: Mine Mobile Equipment Requirements

Equipment Type	Size Classification	Quantity purchased from Capital Budget (12 Mtpa Project Scope (2018 Seal lift)	Quantity purchased from sustaining capital budget (2019 sealift and beyond)
Off Highway Haul Trucks	~ 220 tonne (CAT 793F or equivalent)	One (1)	Nine (9)
Hydraulic face shovels	~ 61 tonne bucket capacity	Nil	Two (2)
Wheel Loaders (FEL)	~ 40 tonne bucket capacity (CAT 994 K or equivalent)	One (1)	Nil

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Equipment Type	Size Classification	Quantity purchased from Capital Budget (12 Mtpa Project Scope (2018 Seal lift)	Quantity purchased from sustaining capital budget (2019 sealift and beyond)
Blast Hole Drilling Rigs	(drill diameter 152-270mm, to suit bench depth of 20m)	Nil	Five (5)
Tracked Dozer	Blade capacity 19 to 22 m^3 (CAT D10 or equivalent)	One (1)	Two (2)
Road Graders	24 ft blade width. (CAT 24M or equivalent)	Nil	One (1)

9.3.4.2 Area 1720 – Production Support Mobile Equipment

See Table 9-2

a) 2 off water/sander bodies on CAT 777 truck bodies

b) 1 off tow haul tractor and trailer to suit haul trucks

9.3.4.3 Area 1730 – Services Mobile Equipment

c) Purchase and delivery to site of one (1) fuel lube truck based upon a CAT 740B articulated dump truck chasis.

d) Purchase and delivery to site of one (1) stemming front end loader typically matching Cat IT28 specification.

9.3.5 Area 1800 – Mine Ancillary Facilities

Area 1800 consists of the following sub-sections:

- Area 1810 – Explosive Storage
- Area 1820 – Mine Maintenance Facilities
- Area 1830 – Mine Accommodation Area

9.3.5.1 Area 1810 – Explosive Storage

This area has no scope.

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9.3.5.2 Area 1820 – Mine Maintenance Facilities

A new mine truck shop will be provided shown in Appendix A8. The truck shop will be provided on design build basis. The scope that follows represents the scope of the design build contractor TX003.

Mine Truck Workshop includes two truck bays: a dual-purpose wash and lube bay, and a general repair and maintenance bay. The building and generally includes concrete floor, overhead crane, external tool crib, parts storage and HVAC modules.

Civil and Earthworks

a) Reinforced concrete building foundation, floor slab and sump(s), maximizing the use of precast concrete, including:

- Floor slabs and sump(s) for truck wash system.
- Supply all materials required to construct foundations, floor slab and sump(s).
- Place fill and final grade base of excavation for sump(s), construct sump and backfill with aggregate provided by others.
- From finished grade constructed by others, place structural fill as required to achieve levels for construction of foundations and floor slab.
- Backfill around foundations and at slab edges to achieve final finished grade.

Building structure and enclosure, including:

a) Design building structure, cladding / flashing, doors / openings including specified truck doors, stairs, platforms, walkways and awnings as required to provide safe access to man doors and safe access to electrical panels and other equipment.

b) Design equipment and utility modules connected to primary workshop building.

c) Design opening in primary workshop building for modular lunchroom and washroom designed, supplied and installed by others.

d) Supply all materials and equipment to construct building structure and enclosure including doors and associated controllers.

e) Construct building structure and enclosure supported from Contractor installed foundations.

f) Supply timber, steel, grating, roofing, associated fixtures and other materials and hardware required to construct safe access.

g) Commission and bring into operation the truck doors

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h) Decommission and relocate the existing "Aerodrome Office" at Milne to the Mary River and connect into the Truckshop via an arctic corridor to create a Mine Workshop Service Building. Included in this scope of work;

- Construct timber cribbing and place module on cribbing
- Design, supply and install an arctic corridor for connecting the building to the workshop building.
- Connection of sewage tanks, plumbing, heat tracing and construction of an insulated timber enclosure around the sewage tank.
- Connection of 208V power, data and fire alarm systems to the Mine Truck Shop.

Electrical service entrance and electrical services, including:

a) Design service entrance including step-down transformer(s), distribution panels and fused disconnects; with provision to connect Employer specified 600v power supply cable.

b) Design electrical services including power supplies to fixed workshop equipment, internal / external lighting, receptacles, emergency lighting, exit lights and cable routing and raceway.

c) Design all earthing, grounding and bonding systems.

d) Supply all electrical equipment and materials required to construct the electrical service entrance and electrical services including panels, cable, raceway, fittings, fixtures and receptacles.

e) Construct the electrical service entrance and electrical services.

f) Commission and bring into operation the electrical service entrance and electrical services.

Building heating and ventilation (HVAC) system, including:

a) Design building heating and ventilation system including diesel fired heaters, make-up air units, diesel tank and diesel supply / distribution system; preinstalled in an external modular unit and pre-commissioned to the maximum extent possible.

b) Design building exhaust fans and recirculation (ceiling) fans.

c) Supply all equipment and materials required to construct the building heating and ventilation system including unit heaters, make-up air units, diesel tanks, diesel pumps, HVAC control panel, pump control panel, power and control cables, flue vents, ductwork, piping, valves and associated equipment, materials and hardware.

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d) Construct the building heating and ventilation system including, where applicable, modification of existing building heating and ventilation system.

e) Commission and bring into operation the building heating and ventilation system.

Overhead Crane, 15 tonne capacity, Class ISO M3 including:

a) Design overhead crane including girder crane, crane rails, maintenance platform with ladder access, power supply, controls and support structures.

b) Supply all equipment, power and control cables / rails, structures and other materials required to construct the overhead cranes.

c) Construct overhead crane and associated structures, systems and equipment.

d) Commission and bring into operation the overhead cranes including load testing.

Truck Wash System, preassembled and pre-commissioned in a modular building or similar, including:

a) Design recycled water truck wash system suitable for manual washing for CAT 793 haul trucks and similar equipment.

b) Supply all equipment, structures and electrical and control systems for the complete truck wash system.

c) Construct the truck wash system.

d) Commission and bring into operation the truck wash system.

Tool Crib and Parts Storage modules consisting of three (3) 40' ISO shipping containers, including:

a) Design modules with internal shelving for parts and tool storage and internal access from the workshop.

b) Supply complete modules.

c) Install modules on concrete block foundations.

Utilities Module, including:

a) Modular building (potentially a shipping container), preassembled and pre-commissioned with specified equipment.

b) Air compressor with accumulator for operation of workshop hand tools and similar.

c) Oil and grease distribution system.

d) EVAC system.

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Utility piping system, including:

a) Design utility piping distribution with hose reels for all Utilities Module systems.

b) Supply pipe, pipe fittings, pipe supports, hose reels and other materials to construct system.

c) Construct piping system with hose reels.

d) Pressure test and flush clean piping system ready for service.

Fire alarm system, including:

a) Design addressable fire alarm and detection system.

b) Supply all equipment, cabling, materials and documentation required to construct the system.

c) Supply fibre optic patch cable and conduit for connection of the fire alarm control panel to the communication network cabinet.

d) Install all equipment and cabling.

e) Program and configure fire alarm control panel and devices, including communication link to the main fire alarm panel located in the Port Site Complex (PSC).

f) Commission and bring the system into operation.

g) Supply fire alarm system verification report.

Communications and IT systems, including:

a) Design, supply and install a wireless communication system for use in the workshop. The wireless network will interface directly with the client supplied fiber optic backbone. The client will supply fibre optic cable between buildings as part of the data and voice networks. There is a requirement for a VoIP handset in the workshop for voice communication.

b) Supply wireless communication equipment (Routers and wireless access points) that shall conform to 802.11n, to enable the wireless network to operate at Link Speeds of: minimum 300Mbps and maximum of 600Mbps.

c) Supply Category 6 Ethernet cable for connection of RJ45 outlet to the communication cabinet for VoIP handset.

d) Power and test communication equipment and cabling.

e) Supply inspection and test reports.

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9.3.5.3 Area 1830 – Mine Accommodation Area

Operations personnel will be accommodated in a new 800 man camp. Refer to WBS 6110. The new camp will replace both the MSC and the mine site Weatherhaven camps.

Project scope includes:

a) Decommission and relocate to Milne Port (3) dormitory wings (90 rooms) from the existing Mine Site Complex (MSC), including associated sewage, plumbing, electrical, fire, and IT systems.

b) Relocate the arctic corridor and locker room modules as required. Refer to WBS 4920 for installation of relocated facilities.

c) Make safe and winterize unused sections of the MSC Camp.

d) Purchase and install a complete hard walled camp facility comprising but not limited to:

- Single accommodation rooms with ensuite bathrooms to house 800 people. The Project has a limited exposure USD 12.2m for supply of this facility as this facility will be used to house relocated operations personnel.
- Food storage, preparation and dining areas.
- Camp laundry and linen storage areas.
- Personal laundry facilities.
- Recreation facilities.
- Water tanks and distribution.
- Waste water treatment plant and waste disposal.
- Power generating plant it is expected that the final contract will include for supply of 4MW of generating capacity. Integration of this power supply into the mine grid will be determined after award of contract for camp supply.

The camp will be purchased second hand and relocated Newfoundland to the minesite and installed on a pew pad south of the rail alignment and located between the airport and the current mine operations area.

9.3.6 Area 1900 – Mine Materials Handling

Area 1900 consists of the following sub-sections:

- Area 1910 – Inloading
- Area 1920 – Primary Crushing and Stockpiling.

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9.3.6.1 Area 1910 – Inloading

Three (3) existing Cat 998 loaders will be used to feed the primary crushers.

9.3.6.2 Area 1920 – Primary Crushing and Stockpiling

The overall arrangement of the Primary Crushing and Stockpile area is shown in Appendix A1 and schematically in Figure 9-1.

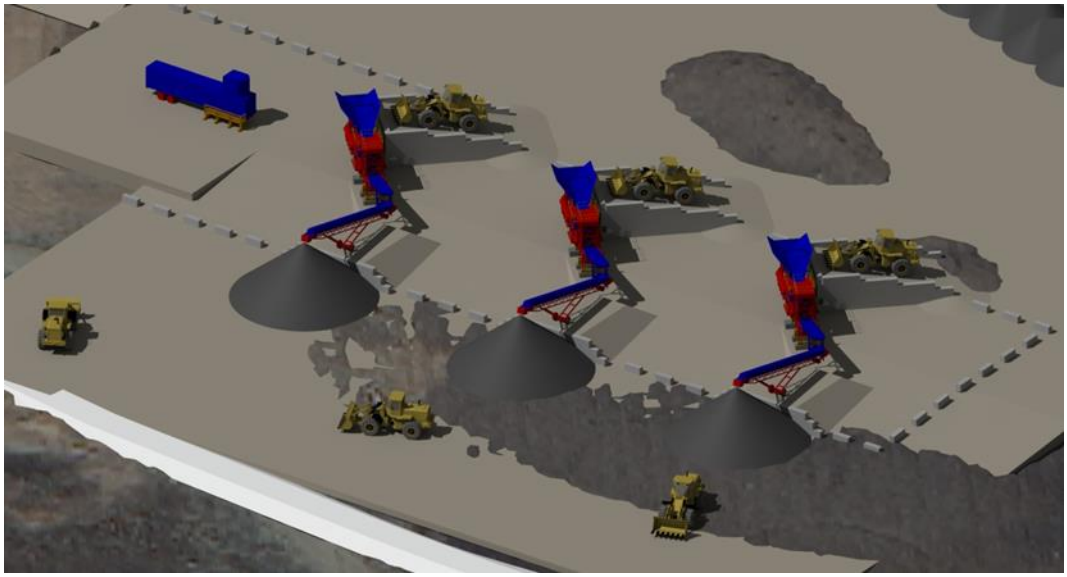

Figure 9-1: Primary Crushing and Train loading Schematic

Civil

a) Construction of a new pad for the installation of three relocated jaw crusher units, and allow installation of discharge conveyors and creation of a pad to receive primary crushed ore and load trains. The unsealed pad is nominally 200m x 100m.

b) Construction of three crusher feed ramps. The ramps will be formed using pre cast concrete sections and earth filled. Refer to Appendix A9.

c) Installation of pre cast foundation blocks (five per crusher string) to found the relocated crushers and discharge conveyor. Refer to Appendix A10.

d) Installation of pre cast concrete sections to build three retaining walls adjacent to the discharge of the primary crusher mobile conveyor units. Refer to Appendix A11.

e) Install old truck tyres and pre-cast concrete barriers as required to limit large mobile equipment movement in operating areas and provide safe access for personnel to the crushers ref Figure 9-1.

f) Construction of drainage channels running North West to a new sedimentation pond.

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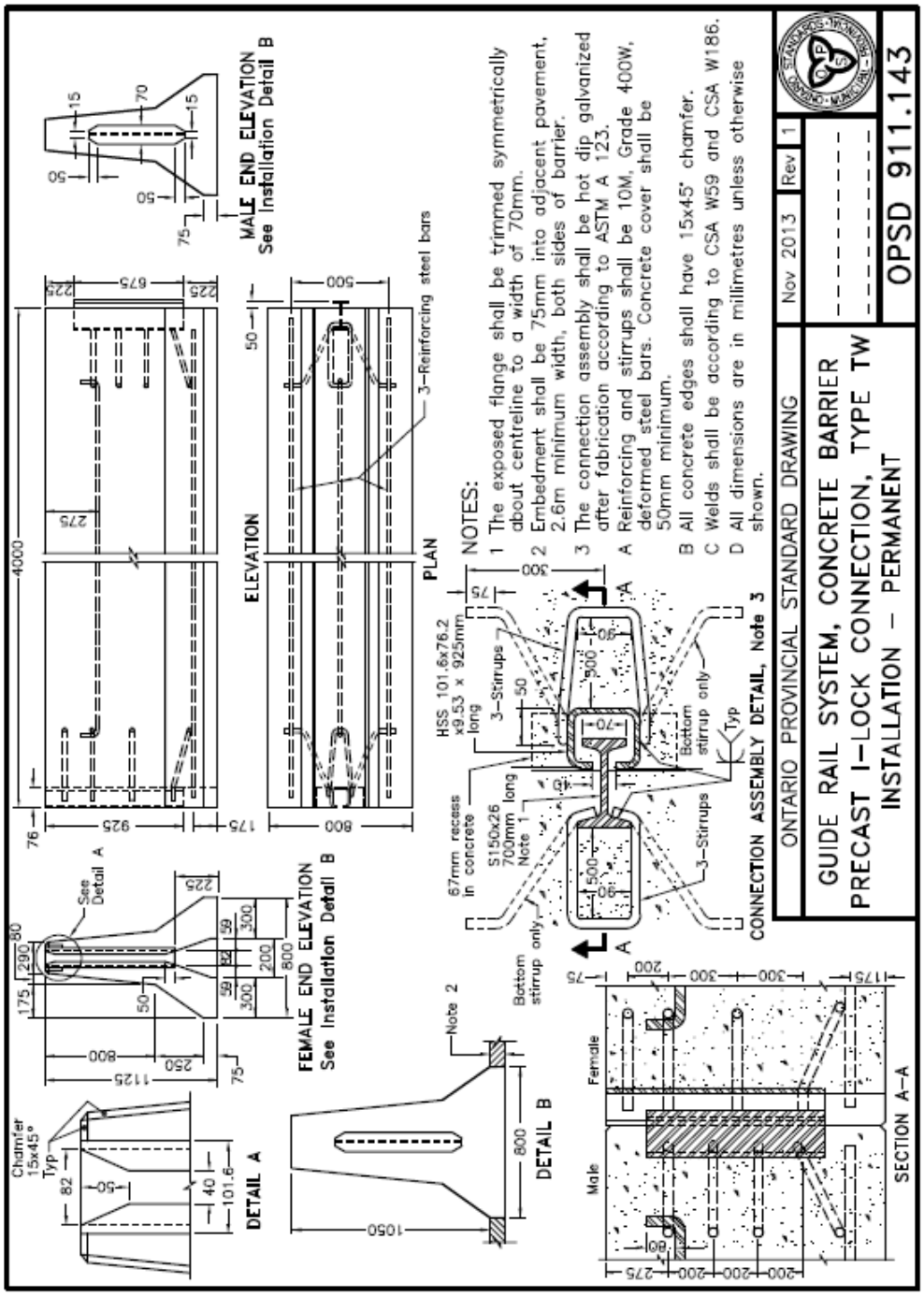

Figure 9-2: Primary Crusher Area Barriers

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Mechanical

Refer for Appendix A1 for details.

a) Decommission three existing crusher and screening spreads located at the existing crusher pad.

b) Relocate the jaw crusher trailer including feed hopper, grizzly and conveyor to the new crusher location shown on drawing Appendix A1.

c) Modify crusher strings A & B to become rear feed, see **Figure 9-3**.

d) Modify the jaw crusher trailer conveyor to lower the conveyor angle and the head pulley.

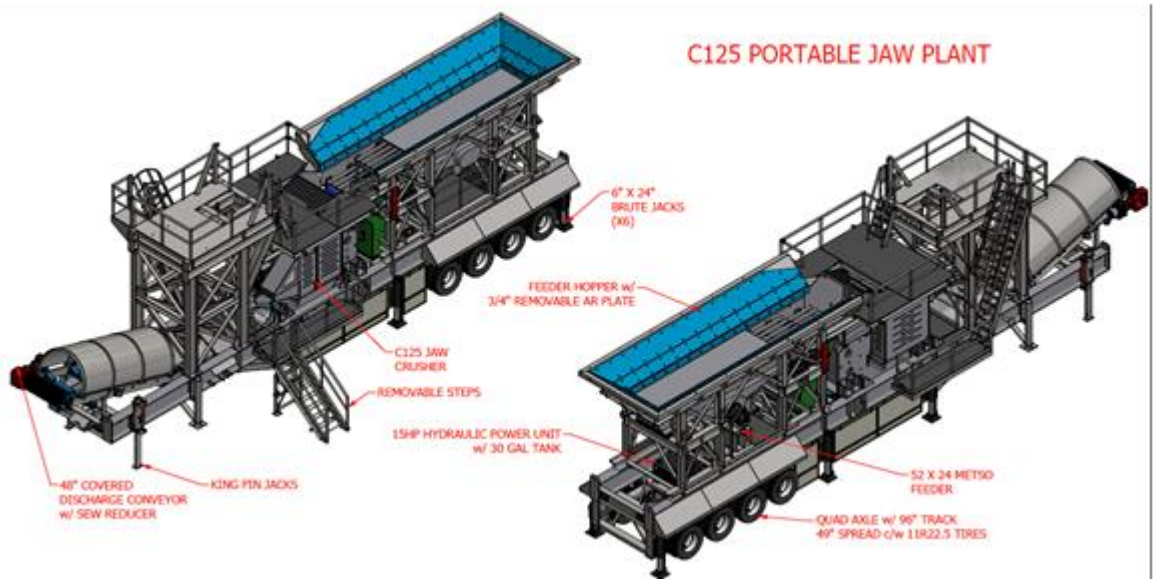

Figure 9-3: Primary Crusher Modifications

e) Replace grizzly sections on all jaw crusher units (three off) with upgraded grizzly bars.

f) Relocate three mobile stacker conveyors to the new primary crusher area and upgrade conveyor drives to 40hP (all three units).

g) Purchase four (4) 20 tonne bucket capacity Front End Loaders (FEL), CAT 992 or equivalent to manage the primary crushed ore stockpiles and load primary crushed ore into the trains.

Electrical

a) Relocate the existing Crusher C MCC trailer to the new primary crusher pad. Modify the electrical systems to power and control three (3) relocated jaw crusher trailers, three (3) relocated and modified stacker conveyors and area lighting (defined below).

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b) Supply and install power cables for the MCC trailers to equipment including raceway and grounding cables.

c) Supply and Install area lighting (poles and flood lights) on the new primary crusher pad to suit crusher operation and train loading. Allowance 8 poles with 4 lights per pole.

- Flood lights will be mounted on wooden poles (30' class 2 red pine).
- Depending on location and available power sources, either 347V or 120V power will be used for lighting. Cables supplying power to the lights will be direct buried.
- Floodlight to be 400 W MH, 120/277/347 V tri-voltage, Super CWA Pulse Start ballast, standard yoke with wall/wood pole/pipe bracket, CSA standard, dark bronze finish, lamp included.

Instrumentation and Control

a) Modify control systems and HMI in existing relocated trailer to control the new/modified primary crusher systems.

9.4 Area 2000 – Iron Ore Process Plant and Onsite Infrastructure

Area 2000 consists of the following major sub-areas:

- Area 2300 – Process Plant
- Area 2800 – Utilities and Onsite Infrastructure
- Area 2900 – Process Ancillary Facilities

9.4.1 Area 2300 – Process Plant

The Bulk Materials Handling and Processing System at Milne Port is covered by the following WBS elements.

- 2300 Process Plant
  - 2330 Secondary Crushing and Screening
- 4000 – Port
  - 4120 Ore Unloading and Stockpile
  - 4210 Stockpiling
  - 4229 Reclaiming
  - 4620 Ore Dock No.2
  - 4710 Ship Loading Conveyor
  - 4720 Ship Loading

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- 4800 – Utilities and on site infrastructure.

The descriptions that follow are aligned to this WBS and are presented in WBS order.

The process plant defined in Area 2300 will be provided by contractor CM001 under a design build and commission basis. The requirements for CM001 are defined Appendix A13. The overall layout for the port including the processing facilities is shown in Appendix A15. The process flow diagram defining the functional requirements is shown in Appendices A51 and A52.

Bids for CM001 are being evaluated and all bidders have confirmed compliance with the required plant performance specification. Each bidder has different approaches to plant design; the following descriptions are functional in nature as they relate to CM001 and the battery limits for CM001 supply. For scope outside the battery limits of CM001, detailed facilities descriptions are provided.

9.4.1.1 Area 2330 – Secondary Crushing and Screening

The secondary crushing facilities provide functionality per:

a) Reclaim of primary crushed ore from the crusher feed stockpile by way of a gravity fed reclaim tunnel with mass controlled apron feeders to generate a stream of primary crushed ore for feed to the screen plant by way of conveyors.

b) Screening ore to generate, oversize (+32mm), lump (-32 + 6mm) and fines (-6mm) materials.

c) Crushing of oversize material to meet a top size of +32mm and recirculation of crusher product over the screens to create a closed loop screening circuit.

d) Discharge of lump to feed onto a lump transfer conveyor which discharges to Stockpile No2 Yard Conveyor (refer to WBS 4210).

e) Discharge of fines from the screening plant to feed a wheel mounted radial stacker for intermediate stacking of fines adjacent to the screening building.

Civil and Foundations

a) Pre cast ground beams will be provided to contractor CM001 on which to install the crusher and screening building. The scope of CM001 requires the CM001 contractor to provide mass or other style foundation to absorb dynamic loads and loads to be transferred to the ground beams from their equipment and structures.

b) Conveyors and other structures will be supported by pre-cast concrete and, or, fabricated steel footings provided by the CM001 contractor.

c) Earthwork for the crushing and screening area is defined in WBS 2810.

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Structural, Mechanical, Electrical and Instrumentation

The secondary crushing and screening facilities will be designed and supplied by the contractor awarded package CM001 refer to Appendix A13. The following provides an outline of intended discipline functionality to be provided by the CM001 contractor.

a) Provision of the crushing and screening process plant consistent with functional specifications on throughput, feed specification, product lump and fine ore specifications and plant throughput. The crushers and screen buildings are provided with N+0 redundancy for all process equipment.

b) Supply and installation of a primary crushed ore vault (reclaim tunnel) containing a mass controlled ore reclaim mechanism, a tunnel for man and maintenance vehicle access which houses the reclaim conveyor.

c) Supply and installation of a screen feed conveyor to discharge over screen house to generate oversize, lump and fine ore fractions.

d) Supply and installation of a steel framed, clad screen building to screen incoming primary crushed ore and recirculating secondary crushed product. The screen building will be fitted with local dust collection facilities and an overhead travelling crane to allow for screen maintenance. The screen building will receive primary crushed ore and secondary crusher recycle material, screen this material and produce an oversize stream, a lump product stream and fine ore stream. Lump ore will be conveyed away from the screen building on a Lump Product Transfer conveyor. Fine ore will be conveyed to a fine ore stockpile area adjacent the screen building. Oversize ore will be conveyed to the crusher building for secondary crushing. The screening building will be insulated but not heated.

e) Supply and installation of oversized recirculation conveyor to return oversized material to be crushed in a new secondary crusher building.

f) Supply and installation of a secondary crushing building to receive +32 mm material and crush to suit a -32mm size distribution. The crusher building will be steel framed and clad. The crusher building will be fitted with local dust collection facilities and an overhead travelling crane to allow for crusher maintenance. The crushers will be provided with bins and feeders to allow for constant mass feed under choke conditions to the crushers. Crushed material will fall directly to the screen feed conveyor.

g) The crusher building will be insulated but will not be heated.

h) Supply and installation of a fine ore stacking conveyor which will typically be a rubber tyred wheel mounted radial stacker.

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9.4.2 Area 2800 – Utilities and Onsite Infrastructure

Area 2800 consists of:

- Area 2810 – Site Development & Plant Roads
- Area 2840 – Power
- Area 2850 – Communications and IT Infrastructure

9.4.2.1 Area 2810 – Site Development and Plant Roads

Civil, Earthworks and Drainage (refer to Appendix A14)

a) Installation of two new lined sedimentation ponds; one servicing the crusher feed stockpile and one servicing the fines stockpile. Other areas including pads for conveyors and process buildings drain directly to existing water courses.

b) Prepare crusher feed stockpile area including run off containment and base for reclaim tunnel (excavation and fill as required for CM001 equipment layout).

c) Construct pads for the crusher building, screening building (one off), crusher services building, conveyor foundations and other associated equipment.

d) Construct interconnecting roads, nominally 10m wide granular surface.

e) Construct fines stockpile pad.

9.4.2.2 Area 2840 Power

Refer to WBS 4830

9.4.2.3 Area 2850 Communications and IT

Refer to WBS 4830

9.4.3 Area 2900 – Process Ancillary Facilities

9.4.3.1 Area 2910 – Process Buildings

Crusher services Building

a. A crusher services building will be provided by contractor CM001 on a design supply and install basis. The building will be of modular construction installed on timber cribbing or similar and will contain;

- Mud Room at main entry door
- Secondary external door with breezeway
- Lunchroom suitable for 12 people
- Washrooms

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- Two (2) offices
- Bulk Materials Handling and Processing operator control office (room similar to standard office with operator control screen(s) capable of monitoring and controlling the full system)
- Laboratory room, nominally 10m x 16m in size (empty room, internal fit-out and laboratory equipment by others)
- Data network
- Fire alarm system
- Heating System
- Fresh water (non-potable) plumbing system including water tank with fill nozzle accessible for refill by tanker truck and reticulation to washroom and laboratory facilities
- Sewage plumbing system including sewage tank with fittings to empty by mobile vacuum truck and plumbing from washroom and laboratory facilities

Crusher Workshop

A workshop will be provided as part of contract Cx003 to allow for enclosed maintenance of bulk materials handling equipment. The arrangement of the building is shown in Appendix A15. The scope of the building is defined as;

a) Crusher Workshop is generally an open plan building with concrete floor, overhead crane, and external tool crib, parts storage and HVAC modules.

b) Reinforced concrete building foundation and floor slab, maximizing the use of precast concrete, including:

- Design foundations and floor slabs.
- Supply all materials required to construct foundations and floor slab.
- From finished grade constructed by others, place structural fill as required to achieve levels for construction of foundations and floor slab.
- Place pre-cast concrete, install grout and as required form and pour cast-in-place concrete to complete construction in accordance with approved Contractor drawings.
- Backfill around foundations and at slab edges to achieve final finished grade.

c) Building structure and enclosure, including:

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- Design building structure, cladding / flashing, doors / openings including specified truck doors, stairs, platforms, walkways and awnings as required to provide safe access to man doors and safe access to electrical panels and other equipment.
- Supply all materials and equipment to construct building structure and enclosure including doors and associated controllers.
- Construct building structure and enclosure supported from Contractor installed foundations.
- Supply timber, steel, grating, roofing, associated fixtures and other materials and hardware required to construct safe access.
- Commission and bring into operation the building doors

d) Electrical service entrance and electrical services, including:

- Design service entrance including step-down transformer(s), distribution panels and fused disconnects; with provision to connect Employer specified 600v power supply cable.
- Design electrical services including power supplies to fixed workshop equipment, internal / external lighting, receptacles, emergency lighting, exit lights and cable routing and raceway.
- Design all earthing, grounding and bonding systems.
- Supply all electrical equipment and materials required to construct the electrical service entrance and electrical services including panels, cable, raceway, fittings, fixtures and receptacles.
- Construct the electrical service entrance and electrical services.
- Commission and bring into operation the electrical service entrance and electrical services.

e) Building heating and ventilation (HVAC) system, including:

- Design building heating and ventilation system including diesel fired heaters, make-up air units, diesel tank and diesel supply / distribution system; preinstalled in an external modular unit and pre-commissioned to the maximum extent possible.
- Design building exhaust fans and recirculation (ceiling) fans.
- Supply all equipment and materials required to construct the building heating and ventilation system including unit heaters, make-up air units, diesel tanks, diesel pumps, HVAC control panel, pump control panel, power and control cables, flue vents, ductwork, piping, valves and associated equipment, materials and hardware.

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- Construct the building heating and ventilation system including, where applicable, modification of existing building heating and ventilation system.
- Commission and bring into operation the building heating and ventilation system.

f) Overhead Crane, 25 tonne capacity, Class ISO M3 including:

- Design overhead crane including girder crane, crane rails, maintenance platform with ladder access, power supply, controls and support structures.
- Supply all equipment, power and control cables / rails, structures and other materials required to construct the overhead cranes.
- Construct overhead crane and associated structures, systems and equipment.
- Commission and bring into operation the overhead cranes including load testing.

g) Tool Crib and Parts Storage modules consisting of three (3) 40’ ISO shipping containers, including:

- Design modules with internal shelving for parts and tool storage and internal access from the workshop.
- Supply complete modules.
- Install modules on concrete block foundations.

h) Fire alarm system, including:

- Design addressable fire alarm and detection system.
- Supply all equipment, cabling, materials and documentation required to construct the system.
- Supply fibre optic patch cable and conduit for connection of the fire alarm control panel to the communication network cabinet.
- Install all equipment and cabling.
- Program and configure fire alarm control panel and devices, including communication link to the main fire alarm panel located in the Port Site Complex (PSC).
- Commission and bring the system into operation.
- Supply fire alarm system verification report.

i) Communications and IT systems, including:

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- Design, supply and install a wireless communication system for use in the workshop. The wireless network will interface directly with the client supplied fiber optic backbone. The client will supply fibre optic cable between buildings as part of the data and voice networks. There is a requirement for a VoIP handset in the workshop for voice communication.
- Supply wireless communication equipment (Routers and wireless access points) that shall conform to 802.11n, to enable the wireless network to operate at Link Speeds of: minimum 300Mbps and maximum of 600Mbps.
- Supply Category 6 Ethernet cable for connection of RJ45 outlet to the communication cabinet for VoIP handset.
- Power and test communication equipment and cabling.
- Supply inspection and test reports.

j) Area lighting

- Flood lights mounted on 30 foot poles will be provided in the area of the crusher services building and crusher workshop to supplement lighting on the outside of buildings and conveyors.

k) Handover completed building with all systems operating after successful commissioning.

9.5 Area 3000 – RAIL

Area 3000 scope includes the supply and installation over the 109.6 km mainline and approximately 5km of yard and siding track including rolling stock and support buildings. The full alignment of the rail system is shown in Appendices A16 to A18.

Area 3000 consists of the following major sub-areas:

- Area 3100 – Terminals/Yards
- Area 3200 – Mainline Ch 2.80 km to 90.00 km
- Area 3300 – Mainline Ch 90.00 km to CH 106.00 km
- Area 3400 – Sidings
- Area 3500 – Bridges
- Area 3600 – Locomotives and Rolling Stock
- Area 3700 – Services and Utilities
- Area 3900 – Rail Ancillary Facilities

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The final design of the rail system (superstructure) will be completed under a design build contract TR001. Contract specifications for the work to be done are contained in Appendix A48. In addition to specifying the requirements for track construction the specification details requirements for the provision of train control systems and wayside monitoring equipment.

Route Wide Considerations

The rail infrastructure will include the provision of track lubricators along the rail alignment to reduce rail and wheel wear as well as limiting friction in the rail wheel interface through curves. The TR001 contractor will provide the final design for these installations.

Ballast laydown areas will remain once the project is completed to support the rail line during it operational phase. These laydown areas will be used to store material and ballast during operations.

Roads need to be re-aligned at grade crossings where the road and rail do not cross within a range of 70º and 110º of each other. Therefore, road alignments are required at all grade crossing identified.

Rehabilitation site have been identified by the environmental team and as such these are seen as opportunities where the civil and earthworks contractors for packages CC002 and CC003 will potentially be spoiling excess unsuitable material.

Quarries identified and used during the construction project can be retained for future use or they can be closed.

9.5.1 Area 3100 – Terminals/Yards

Area 3100 consists of the following sub-sections:

9.5.1.1 Area 3110 – Mine Terminal

The Mine track facilities are represented in **Figure 9-4**.

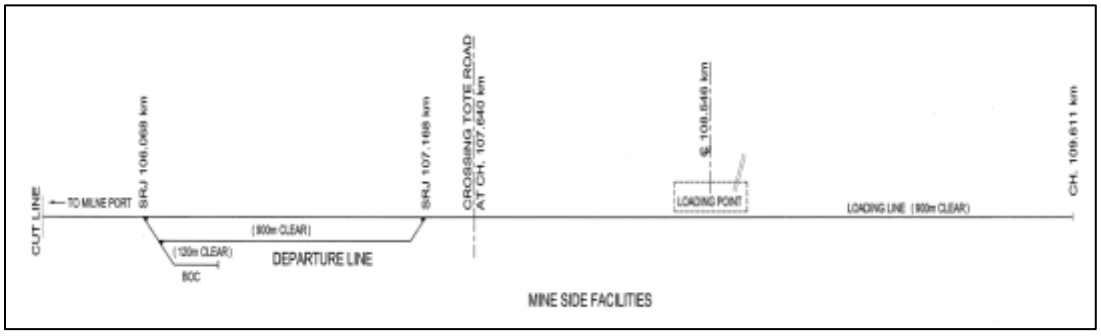

Figure 9-4: Mine Track Diagram

a) Loading staging line for empty train 900 m. (mainline chainage)

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b) Loading pull through line to stop block 900 m. (mainline chainage)

c) Departure Siding 900 m.

d) The extent of work included in this section is defined below

The tables that follow describe locations where construction water (**Table 9-3**), ballast laydown areas (**Table 9-4**), earthworks quarries (**Table 9-5**), earthworks spoil and rehabilitation areas (**Table 9-6**) have been located for this area of the project.

Table 9-3: Construction Water Source

Rail Chainage (km)	Construction Water Source
Mine	Construction water point

Table 9-4: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 14	107+840	10,515	Next to rail embankment

Table 9-5: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q42	109+000	North	1-3	62,500	Diorite/ Diabse	125,000

Table 9-6: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
Not applicable

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-7**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-7: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)

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900	8	117
1200	0	0
1400	2	26
1800	0	0

There is one stream between km 106+000 and km 109+600 that cannot be supplied with a culvert as the rail is in a cutting at the required location. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefor a cut-off drain will be provided to guide water to the next available drainage culvert.

One grade crossing exists at km 107+000. This will be a grade crossing with only regulatory road and rail signage provided. Approximately 900 m of road will be re-aligned to enable a grade crossing at this location.

9.5.2 Area 3200 – Mainline CH 2.80 km to CH 90.00 km

Area 3200 consists of the following sub-sections:

9.5.2.1 Area 3210 – CH 2.80 km to CH 10.00km

Refer to Appendices A22 through A23

The tables that follow describe locations where construction water (**Table 9-8**), ballast laydown areas (**Table 9-9**), earthworks quarries (**Table 9-10**), earthworks spoil and rehabilitation areas (**Table 9-11**) have been located for this area of the project.

Table 9-8: Construction Water Source

Rail Chainage (km)	Construction Water Source
None	Not applicable

Table 9-9: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 2	5+500	16,312	Access road from Laydown next to Tote road to rail embankment required - approximately 120m length

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Table 9-10: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ1a	4+500	East	0	300,000	Granitic Gneiss	600,000
PQ1b	5+200	East	0	135,000	Granitic Gneiss	270,000
PQ1c	6+200	East	0	120,000	Granitic Gneiss	240,000
Q4	7+200	East	0	7,500	Granitic Gneiss	7,500
Q5	7+500	East	0	7,400	Granitic Gneiss	7,400
Q6	7+800	East	0	6,350	Granitic Gneiss	6,350

Table 9-11: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
7+200
7+800
9+600

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-12**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-12: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	31	352
1200	4	66
1400	0	0
1800	0	0

There are 13 culverts between km 2.8 and km 10 that will be installed in areas where the rail alignment is in a cut, these culverts will be provided with an inlet and as this section is in a hard rock excavation the culverts will be provided with a daylight excavation through the hard rock.

One grade crossing will be provided at km 2+880. This will be a road under rail crossing, allowing vehicular access to the rail yard, the rail unloader and the rolling stock maintenance facilities. The design will be that of a corrugated steel plate arch bridge.

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Another grade crossing exists at km 9+700. This will be at a grade crossing with only regulatory road and rail signage provided. Approximately 800 m of road will be re-aligned to enable a grade crossing at this location.

9.5.2.2 Area 3220 – CH 10.00 km to CH 20.00 km

Refer to Appendices A24 through A25

The tables that follow describe locations where construction water (**Table 9-13**), ballast laydown areas (**Table 9-14**), earthworks quarries (**Table 9-15**), earthworks spoil and rehabilitation areas (**Table 9-16**) have been located for this area of the project.

Table 9-13: Construction Water Source

Rail Chainage (km)	Construction Water Source
15+000	Construction water point

Table 9-14: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 3	11+800	22,496	Access road from Laydown next to Tote road to rail embankment required - approximately 40m length

Table 9-15: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ1a	16+200	East	0	31,700	Gravel	118,000

Table 9-16: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
Not applicable

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-17** All culverts to be installed will be corrugated steel pipe culverts.

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Table 9-17: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	28	379.50
1200	8	103.00
1400	2	42.00
1800	0	0

One grade crossing exists at km 12+450. This will be a grade crossing with only regulatory road and rail signage provided. Approximately 300 m of road will be re-aligned to enable a grade crossing at this location.

9.5.2.3 Area 3230 – CH 20.00 km to CH 30.00 km

Refer to Appendices A26

The tables that follow describe locations where construction water (**Table 9-18**), ballast laydown areas (**Table 9-19**), earthworks quarries (**Table 9-20**), earthworks spoil and rehabilitation areas (**Table 9-21**) have been located for this area of the project.

Table 9-18: Construction Water Source

Rail Chainage (km)	Construction Water Source
None	Not applicable

Table 9-19: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 4	20+800	22,257	Next to rail embankment

Table 9-20: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ2	28+900	East	0.5-3	80,000	Granitic Gneiss	160,000

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Table 9-21: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
20+700
21+900
28+600
29+100
29+400

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-22**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-22: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	34	488
1200	2	35
1400	2	42
1800	0	0

There is one stream between km 20 and km 30 that cannot be supplied with a culvert as the rail is in a cutting at the required location. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, one cut-off drain will be provided to guide water to the next available drainage culvert. This cut-off drain will follow the shortest hydraulic path available.

A concrete jersey barrier will be provided between km 20+590 and km 20+670 to manage the road and rail interface where the road and rail alignment are in close proximity and specifically where the rail is in a cutting next to the road.

The road will be re-aligned between km 29+500 and km 29+600 where the road and the rail alignment clash.

9.5.2.4 *Area 3240 – CH 30.00 km to CH 40.00 km*

Refer to Appendices A27 to A29

The tables that follow describe locations where construction water (**Table 9-23**), ballast laydown areas (**Table 9-24**), earthworks quarries (**Table 9-25**), earthworks spoil and rehabilitation areas (**Table 9-26**) have been located for this area of the project.

Table 9-23: Construction Water Source

Rail Chainage	Construction Water Source

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(km)	
35+000	Construction water point

Table 9-24: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 5	30+950	12,000	Next to rail embankment
No. 6	39+250	10,387	Next to rail embankment

Table 9-25: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q16	31+700	East		54,400	Gravel	81,700
Q19	39+200	East		4,000	Gravel	4,000

Table 9-26: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
40+000

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-27**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-27: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	24	384
1200	5	100
1400	3	75
1800	0	0

A concrete jersey barrier will be provided between km 39+500 and km 39+680 to manage the road and rail interface where the road and rail alignment are in close proximity and specifically where the rail is in a cutting next to the road.

9.5.2.5 Area 3250 – CH 40.00 km to CH 50.00 km

Refer to Appendices A30

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The tables that follow describe locations where construction water (**Table 9-28**), ballast laydown areas (**Table 9-29**), earthworks quarries (**Table 9-30**), earthworks spoil and rehabilitation areas (**Table 9-31**) have been located for this area of the project.

Table 9-28: Construction Water Source

Rail Chainage (km)	Construction Water Source
43+500	Construction water point
48+000	Construction water point

Table 9-29: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No 7	44+140	22,415	Next to rail embankment - short haul road maybe required

Table 9-30: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ4a	41+600	East	0	90,000	DolomiticLimestone	180,000
PQ4b	42+500	East	0	90,000	DolomiticLimestone	180,000
PQ5a	45+700	East	0	120,000	Dolomitic Limestone	240,000
PQ5b	46+800	East	0	250,000	Dolomitic Limestone	500,000
Q23	48+600	East	0	4,000	Dolomitic Limestone	4,000

Table 9-31: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
40+000

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-32**. All culverts to be installed will be corrugated steel pipe culverts.

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Table 9-32: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	24	431
1200	9	189
1400	4	82
1800	0	0

There are three streams between km 40 and km 50 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, three cut-off drains will be provided to guide water to the next available drainage culvert. These cut-off drains will follow the shortest hydraulic path available.

A concrete jersey barrier will be provided between km 47+300 and km 47+450 to manage the road and rail interface where the road and rail alignment are in close proximity and specifically where the rail is in a cutting next to the road.

The road will be re-aligned between km 48+300 and km 50+000 where the road and the rail alignment clash. This road re-alignment avoids multiple grade crossings. This road re-alignment avoids multiple grade crossings.

9.5.2.6 Area 3260 – CH 50.00 km to CH 60.00 km

Refer to Appendices A31 to A33

The tables that follow describe locations where construction water (**Table 9-33**), ballast laydown areas (**Table 9-34**), earthworks quarries (**Table 9-35**), earthworks spoil and rehabilitation areas (**Table 9-36**) have been located for this area of the project.

Table 9-33: Construction Water Source

Rail Chainage (km)	Construction Water Source
51+000	Construction water point
55+100	Construction water point
60+000	Construction water point

Table 9-34: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No 8	53+300	11,000	Next to rail embankment

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No 9	57+500	37,593	Next to rail embankment at Midway Loop

Table 9-35: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q24	51+250	East	0	42,000	Dolomitic Limestone	42,000
PQ6a	56+200	East	0	180,000	Dolomitic Limestone	360,000
PQ6b	57+100	East	0	150,000	Dolomitic Limestone	300,000

Table 9-36: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
52+200
56+200

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-37**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-37: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	26	379
1200	7	166
1400	0	0
1800	0	0

There are two streams between km 50 and km 60 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, two cut-off drains will be provided to guide water to the next available drainage culvert. These cut-off drains will follow the shortest hydraulic path available.

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The road will be re-aligned between km 50+000 and km 52+000 where the road and the rail alignment clash. This road re-alignment avoids multiple grade crossings.

One grade crossing exists at km 55+585. This will be a grade crossing with only regulatory road and rail signage provided. Approximately 300 m of road will be re-aligned to enable a grade crossing at this location.

9.5.2.7 Area 3270 – CH 60.00 km to CH 70.00 km

Refer to Appendices A34 to A35

The tables that follow describe locations where construction water (**Table 9-38**), ballast laydown areas (**Table 9-39**), earthworks quarries (**Table 9-40**), earthworks spoil and rehabilitation areas (**Table 9-41**) have been located for this area of the project.

Table 9-38: Construction Water Source

Rail Chainage (km)	Construction Water Source
Not applicable	

Table 9-39: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
Not applicable			

Table 9-40: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q26	60+300	East	0	2,597,000	Dolomitic Limestone	5,190,000
Q27	63+350	East	0	90,000	Dolomitic Limestone	136,000
PQ9	66+000	West	0	90,000	Dolomitic Limestone	225,000

Table 9-41: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
63+000
63+300

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The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-42** All culverts to be installed will be corrugated steel pipe culverts.

Table 9-42: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	40	588
1200	2	48
1400	1	31
1800	1	51

There are eight streams between km 60 and km 70 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, eight cut-off drains will be provided to guide water to the next available drainage culvert. These cut-off drains will follow the shortest hydraulic path available.

9.5.2.8 Area 3280 – CH 70.00 km to CH 80.00 km

Refer to Appendices A36 to A37

The tables that follow describe locations where construction water (**Table 9-43**), ballast laydown areas (**Table 9-44**, earthworks quarries (**Table 9-45**), earthworks spoil and rehabilitation areas (**Table 9-46**) have been located for this area of the project.

Table 9-43: Construction Water Source

Rail Chainage (km)	Construction Water Source
Not applicable	

Table 9-44: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
Not applicable			

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Table 9-45: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ10a	73+100	North	0	90,000	Dolomitic Limestone	180,000
PQ10b	74+200	North	0	60,000	Dolomitic Limestone	120,000

Table 9-46: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
72+200

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-47**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-47: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	24	319
1200	6	97
1400	2	56
1800	4	61

9.5.2.9 Area 3290 – CH 80.00 km to CH 90.00 km

Refer to Appendices A38 to A 39

The tables that follow describe locations where construction water (**Table 9-48**), ballast laydown areas (**Table 9-49**), earthworks quarries (**Table 9-50**), earthworks spoil and rehabilitation areas (

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Table 9-51) have been located for this area of the project.

Table 9-48: Construction Water Source

Rail Chainage (km)	Construction Water Source
80+000	Construction water point
86+000	Construction water point

Table 9-49: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 10	84+360	22,615	Next to rail embankment
No. 11	87+660	22,444	Next to rail embankment

Table 9-50: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ12a	84+500	North	0	120,000	Dolomitic Limestone	240,000
PQ12b	84+500	North	0	60,000	Dolomitic Limestone	120,000
PQ13	85+700	North	0	90,000	Dolomitic Limestone	180,000

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Table 9-51: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
89+300
89+800

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-52**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-52: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	25	292
1200	5	81
1400	1	12
1800	4	65

There is one stream between km 80 and km 90 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, one cut-off drain will be provided to guide water to the next available drainage culvert.

Three grade crossings exist at km 84+520, km 85+800 and km 87+635 respectively. These will be at grade crossings with only regulatory road and rail signage provided. Approximately 250 m of road will be re-aligned at each grade crossing to enable a grade crossing at these locations.

9.5.3 Area 3300 – Mainline CH 90.00 km to CH 106.00 km

Area 3200 consists of the following sub-sections:

9.5.3.1 Area 3310 – CH 90.00 km to CH 100.00 km

Refer to Appendices A40 to A41

The tables that follow describe locations where construction water (**Table 9-53**), ballast laydown areas (**Table 9-54**), earthworks quarries (**Table 9-55**), earthworks spoil and rehabilitation areas (**Table 9-56**) have been located for this area of the project.

Table 9-53: Construction Water Source

Rail Chainage (km)	Construction Water Source
93+000	Construction water point
96+000	Construction water point

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Table 9-54: Ballast Laydown Areas

Stockpile Number	Rail Chainage	Approximate Ballast Quantity at Stockpile	Notes
No. 12	92+000	22,618	Next to rail embankment

Table 9-55: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q36	91+000	North	0	63,000	Dolomitic Limestone	94,500
PQ14a	96+700	North	0	40000	Dolomitic Limestone	80,000
PQ14b	96+000	North	0	15,000	Grandiorite	30,000

Table 9-56: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
93+000

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-57**. All culverts to be installed will be corrugated steel pipe culverts.

Table 9-57: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	38	546
1200	3	58
1400	1	24
1800	0	0

There are eight streams between km 90 and km 100 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefor eight cut-off drains will be provided to guide water to the next available drainage culvert. These cut-off drains will follow the shortest hydraulic path available.

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Two grade crossings exist at km 92+179 and km 96+730 respectively. These will be at grade crossings with only regulatory road and rail signage provided. Approximately 250 m and 450 m of road will be re-aligned at each grade crossing to enable a grade crossing at these locations.

9.5.3.2 Area 3320 – CH 100.00 km to CH 106.00 km

Refer to Appendices

The tables that follow describe locations where construction water (**Table 9-58**), ballast laydown areas (**Table 9-59**), earthworks quarries (**Table 9-60**), earthworks spoil and rehabilitation areas (**Table 9-61**) have been located for this area of the project.

Table 9-58: Construction Water Source

Rail Chainage (km)	Construction Water Source
102+000	Construction water point
105+000	Construction water point

Table 9-59: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 13	104+500	13,443	Next to rail embankment

Table 9-60: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
PQ15a	101+500	North	1-3	40,000	Diorite/ Diabse	80,000
PQ15b	102+300	North	1-3	22,500	Diorite/ Diabse	45,000

Table 9-61: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site Route (km)
Not applicable

The extent and type of culverts that will be installed in this area of the project is summarized in. All culverts to be installed will be corrugated steel pipe culverts.

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Table 9-62: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	12	134.20
1200	3	56.12
1400	2	36.60
1800	2	63.44

There is one stream between km 100 and km 106 that cannot be supplied with a culvert as the rail is in a cutting at the required locations. It is also not technically possible to daylight the culvert in the required location as the extent of daylighting required is too excessive. Therefore, a cut-off drain will be provided to guide water to the next available drainage culvert. The cut-off drain will follow the shortest hydraulic path available.

9.5.4 Area 3400 – Sidings

Area 3400 consists of the following sub-sections:

9.5.4.1 Area 3410 – Midway Siding

The midway siding includes a 900m clear passing loop as well as a 300m clear back track. The back track provides an area where track maintenance machines can be staged and where they can be placed temporarily while the mainline and passing loop is used to cross the main line trains.

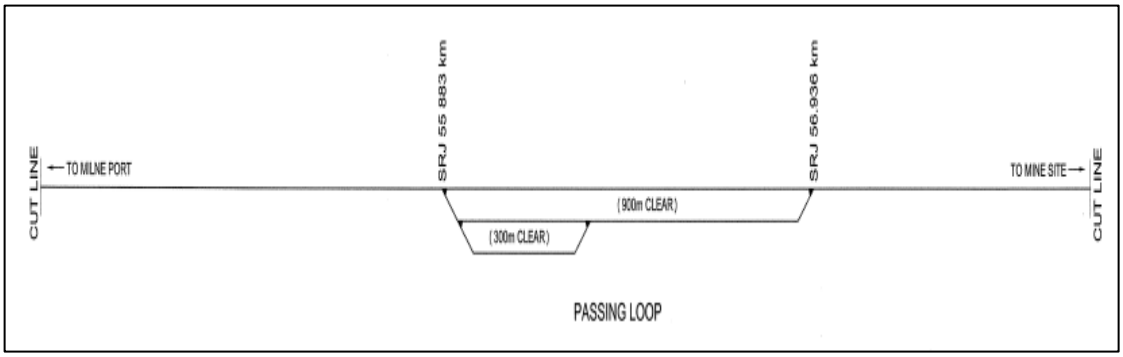

Figure 9-5: Midway Passing Loop and Backtrack

9.5.5 Area 3500 – Bridges

Four steel beam bridges will be built to allow the rail line to pass over waterways. The bridges will be steel decked and supported from piled abutments. Detailed design supply and installation of the piles and bridge structures will be undertaken by contractor CC003.

9.5.5.1 Area 3510 – Bridge 15.839 km

Refer to appendix A 44

4 span crossing 15.100 m per span, located at km 15.839.

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9.5.5.2 Area 3520 – Bridge 70.690 km

Refer to Appendix A45

2 span crossing 20.235 m per span, located at km 70.690.

9.5.5.3 Area 3530 – Bridge 86.355 km

Refer to Appendix A46

2 span crossing 20.235 m per span, located at km 86.355.

9.5.5.4 Area 3540 – Bridge 102.217 km

Refer to Appendix A47

Three span crossing with one centre span of 20.100 m and two outside spans of 20.235m per span, located at km 102.217.

9.5.6 Area 3600 – Locomotives and Rolling Stock

Area 3600 consists of the following sub-sections:

9.5.6.1 Area 3610 – Locomotives

Five diesel electric locomotives will be purchased and commissioned to provided power units for the ore trains. The locomotive requirements are contained in Appendix A49 and summarized as:

- Traction power – 3280 kW
- Track Gauge – 1435mm
- Vehicle Gauge – AAR Plate M
- Axle Mass – 33 tal maximum
- Suitable for operating in Arctic Conditions.

9.5.6.2 Area 3620 – Rolling Stock

Ore Wagons

152 gondola style ore cars will be supplied to Milne for Rail operations. The specification for the ore cars is contained in Appendix A 50. The ore cars will have the following attributes:

- Payload – 108 tonnes maximum
- Tare – 22 tonnes maximum
- Track Gauge – 1435mm
- Vehicle Gauge – AAR Plate M
- Axle Mass – 32.5 tal maximum

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- Couplers – 146 rail cars must have one rigid and one rotary coupler. 6 cars will have couplers at both ends.
- Suitable for operating in Arctic Conditions.

Other Rolling Stock

The rail operations and maintenance contractor under package ZR001 will include the following support equipment and rolling stock, flat cars, ballast cars, cold air blowers, snow clearing equipment, hi-rails steam generators for cleaning iced culverts and ice build-up, locomotive refueling truck, Skyjack Scissor Trolleys, Forklifts, Telehandlers, locomotive sanding unit, single car mobile brake testing equipment and any other dedicated track mounted (tampers, ballast regulators, rail grinding, ultrasonic rail testing etc.) and road-rail type vehicles.

Supply of all small equipment and support equipment required to maintain the locomotive, rail car and maintenance equipment fleet is to be supplied by the rail operations and maintenance contractor under package ZR001.

9.5.7 Area 3700 – Services and Utilities

Area 3700 consists of the following sub-sections:

9.5.7.1 Area 3710 – Communications and IT Infrastructure

Site Data Network

a) At each site, Milne Port and Mine site will be expanded, adding additional fiber optic branches interconnecting to the process areas.

b) All process control systems, process CCTVs, fire detection systems etc. will use the fiber/copper network (hardwire).

Satellite Communications

a) Existing satellite communications systems will be upgraded to improve bandwidth for data upload and download.

Railway and Intersite Communication

a) Fourteen (14) existing communications towers provide a VHF data link between Milne Port and Mary River. Seven (7) of the towers also serve as radio repeaters for the existing Tote road.

b) Communication requirements for the link between the sites will be reviewed and options to improve the bandwidth and system reliability assessed. A significant improvement could be achieved by running a dedicated fiber optic cable to replace the microwave link. The installation would require:

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- Arctic grade low temperature armoured fiber cable
- Specialized transceivers and pre-amplifiers/repeaters for (over 80 km distance). The pre-amplifiers/repeaters can be located in the existing communication sheds
- Fiber patch panels, core switches and peripherals.

This option would also render some of the existing communications towers obsolete, simplifying the overall system and reducing the number of remote generators.

In addition to the data link assessment, the existing radio repeater locations will be assessed to ensure reliable coverage of the new rail alignment.

Some modification of the system is expected and may include either relocating the existing tower(s), increasing the height of existing tower(s) or adding new tower(s). This assessment will also include review of opportunities to reduce the number of radio repeaters and thereby simplifying the overall system.

c) Under this section the train control and occupancy control as well as wayside monitoring equipment will be discussed from an overall project perspective. These are overarching disciplines across the entire rail line and it is best described in an overall approach instead of breaking these disciplines down into further facility details.

Train Control System

This rail line will not have line side signals nor track circuits. These types of tracks are often referred to as “dark territory”. Train movements in dark territory operations are controlled by rail traffic controllers and train occupancy control systems as outlined in the Canadian Rail Operating Rules (CROR). The CROR is overseen by Transport Canada and provides the parameters to operate all railways in Canada. The system consists of Rail Traffic Control and Occupancy Control Systems.

Train controls and control equipment will be provided by contractors performing the delivery of contract TR001 under a design, supply and install basis.

Rail Traffic Controllers (RTCs)

a) The rail control room will be stand-alone and dedicated for the rail control operation. The rail control room will be equipped with a rail traffic controller computer, VOIP phone and dispatch radios. The current design is based on an off-site control room supplied and operated by the ZR001 contractor responsible for the operating and maintenance of the rail infrastructure.

b) RTCs issue clearances (movement authorizations) by voice over the radio from a pre-fabricated train control room at the port. These clearances give permissions to train

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crews to use a section of the track between two named points (milepost sign or station). This is known as Occupancy Control System (OCS).

c) The RTC is responsible for the following:

- Control and route trains safely and expeditiously to maintain their schedule.
- Maintain and plan safe access track times for track maintenance work or inspections of sidings.
- Authorize train movement by way of train orders for reduced track speeds, planned train meets and train bypassing.
- Advise train crews of improper track conditions and notify of obstacles on the tracks, such as vehicles, trespassers, high water conditions, snow drifts and fires.
- Coordinate and plan with emergency response personnel, such as police and fire when required to deal with emergency situations, train derailments and accidents.

Occupancy Control System (OCS)

a) The Occupancy Control System is a procedure to operate trains at main track speeds without any signal protection. Each train movement and track work personnel must obtain clearance to occupy the main track. The RTC oversees the operation and issues clearances via radio to use the main track.

b) The clearance to use the main track remains in effect until fulfilled, superseded or cancelled. Provision to operate OCS is outlined in CROR 301 – 315. All track maintenance work requires the issuance of General Bulletin Orders to all train operators advising them of scheduled maintenance work.

c) A computer assisted system is typically used for train control by the RTC in the rail control room. This system is a highly effective, low-cost dispatching system which helps control train and on-track work equipment movements within un-signalled territory. Direct radio communications between the RTC and the train operator provides instantaneous control. Train clearances are graphically displayed to aid the RTC according to origin and destination, and color-coded according to type.

d) A global positioning system (GPS) may be outfitted on the trains for additional information for the RTS; however, OCS will remain as the main control of train

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movement on the track.

Figure 9-6: Computer Assisted Manual Block System

Wayside Monitoring Equipment

a) Faulty equipment detectors – This includes for faulty bearing detection (acoustic), and will be placed at a single position south of the Fulls Unloading line at Milne Port.

b) Weigh in motion system (incorporating skew loading and vehicle identification system) - north of the Mine front end loading platform, but before the mine departure siding southern switch at 107.168km

c) Dragging equipment detection – This equipment will detect any loose hanging pipes and equipment on the locomotives and cars and will be placed the port and mine areas in a location where the trains arriving and departing are operating at mainline speeds. S third installation will be near the midway siding and will be installed at a final location to be determined with the TR001 contractor.

d) Car identification tagging system – Each car to be equipped with a tag and a static tag reader will be located at the port entrance line in order to record train composition

e) Flat wheel detector – This measurement tool will detect flat wheels as a result of skidding and the placement of this equipment will also be on the Fulls Unloading line at Milne Port

f) Hot wheel detection system – locations to be determined by the contractor and approved by the Employer

g) Skew bogie detection/monitoring system – south of the port entrance switch on the mainline at 2.447km in order to cover bi-directional measurement.

h) The wayside monitoring equipment will communicate and provide real time reporting via the communication backbone infrastructure which will also forward information to the remote train control centre.

9.5.8 Area 3900 – Rail Ancillary Facilities

9.5.8.1 Area 3910 – Rail Buildings (refer to Appendix A71)

A rail workshop for servicing locomotives and wagons will be provided. An existing modular building will be relocated and attached to the workshop to provide offices and worker facilities for the rail operations group. (normally included in CX001 scope).

The workshop includes;

a) Reinforced concrete building foundation, floor slab and pits; complete with rail track for locomotives and wagons; maximizing the use of precast concrete, including:

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b) Design foundations, floor slabs, maintenance pits and rail track.

c) Supply all materials required to construct foundations, floor slab, pits and rail track.

d) Place fill and final grade base of excavation for pits, construct pits and backfill with aggregate provided by others.

e) From finished grade constructed by others, place structural fill as required to achieve levels for construction of foundations and floor slab.

f) Place pre-cast concrete, install grout and as required form and pour cast-in-place concrete to complete construction in accordance with approved Contractor drawings.

g) Backfill around foundations and at slab edges to achieve final finished grade.

h) Install rail track as shown on layout drawings.

i) Building structure and enclosure, including:

- Design building structure, cladding / flashing, doors / openings including specified truck doors, stairs, platforms, walkways and awnings as required to provide safe access to man doors and safe access to electrical panels and other equipment.
- Design equipment and utility modules connected to primary workshop building.
- Design opening in primary workshop building for modular lunchroom and washroom designed, supplied and installed by others.
- Supply all materials and equipment to construct building structure and enclosure including doors and associated controllers.
- Construct building structure and enclosure supported from Contractor installed foundations.
- Supply timber, steel, grating, roofing, associated fixtures and other materials and hardware required to construct safe access.
- Commission and bring into operation the building doors
- Electrical service entrance and electrical services, including:
- Design service entrance including step-down transformer(s), distribution panels and fused disconnects; with provision to connect Employer specified 600v power supply cable.
- Design electrical services including power supplies to fixed workshop equipment, internal / external lighting, receptacles, emergency lighting, exit lights and cable routing and raceway.

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- Design all earthing, grounding and bonding systems.
- Supply all electrical equipment and materials required to construct the electrical service entrance and electrical services including panels, cable, raceway, fittings, fixtures and receptacles.
- Construct the electrical service entrance and electrical services.
- Commission and bring into operation the electrical service entrance and electrical services.

j) Building heating and ventilation (HVAC) system, including:

- Design building heating and ventilation system including diesel fired heaters, make-up air units, diesel tank and diesel supply / distribution system; preinstalled in an external modular unit and pre-commissioned to the maximum extent possible.
- Design building exhaust fans and recirculation (ceiling) fans.
- Supply all equipment and materials required to construct the building heating and ventilation system including unit heaters, make-up air units, diesel tanks, diesel pumps, HVAC control panel, pump control panel, power and control cables, flue vents, ductwork, piping, valves and associated equipment, materials and hardware.
- Construct the building heating and ventilation system including, where applicable, modification of existing building heating and ventilation system.
- Commission and bring into operation the building heating and ventilation system.

k) Overhead Cranes, two (2) Class ISO M3 cranes: one 20 tonne and one 10 tonne, including:

- Design overhead cranes including girder crane, crane rails, maintenance platform, power supply, controls and support structures.
- Supply all equipment, power and control cables / rails, structures and other materials required to construct the overhead cranes.
- Construct overhead cranes and associated structures, systems and equipment.
- Commission and bring into operation the overhead cranes including load testing.

l) Workshop Equipment, including:

- Supply and install Air Compressor: Appropriate to drive air tools and charging the train brake system
- Supply and install Wheel Lathe: Floor mounted lathe for profiling of rail car wheels

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- Supply and install Portable Locomotive Wheel Lathe: Portable CNC Wheel Profile lathe to cut wheels without lifting body from bogies.
- Supply and install Hydraulic Bearing Press: Appropriate for pressing off/ on of wheel bearings from axle.

m) Utility piping system, including:

- Design utility piping distribution with hose reels for workshop compressed air system.
- Supply pipe, pipe fittings, pipe supports, hose reels and other materials to construct system.
- Construct piping system with hose reels.
- Pressure test and flush clean piping system ready for service.

n) Fire alarm system, including:

- Design addressable fire alarm and detection system.
- Supply all equipment, cabling, materials and documentation required to construct the system.
- Supply fibre optic patch cable and conduit for connection of the fire alarm control panel to the communication network cabinet.
- Install all equipment and cabling.
- Program and configure fire alarm control panel and devices, including communication link to the main fire alarm panel located in the Port Site Complex (PSC)
- Commission and bring the system into operation.
- Supply fire alarm system verification report.

o) Communications and IT systems, including:

- Design, supply and install a wireless communication system for use in the workshop. The wireless network will interface directly with the client supplied fiber optic backbone. The client will supply fibre optic cable between buildings as part of the data and voice networks. There is a requirement for a VoIP handset in the workshop for voice communication.

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- Supply wireless communication equipment (Routers and wireless access points) that shall conform to 802.11n, to enable the wireless network to operate at Link Speeds of: minimum 300Mbps and maximum of 600Mbps.
- Supply Category 6 Ethernet cable for connection of RJ45 outlet to the communication cabinet for VoIP handset.
- Power and test communication equipment and cabling.
- Supply inspection and test reports.

p) Handover completed building with all systems operating after successful commissioning.

The rail services building attached to the workshop will be;

a. Constructed by relocating the existing Port Construction Office, a 48ft x 60ft ,modular building installed on timber cribbing.

b. Include attached wash car relocated from the port construction complex.

c. Include design, supply and installation of a new arctic corridor module to interconnecting the buildings.

d. Include internal offices, lunchroom, kitchenette and rail operations control room.

e. Area lighting will be provided by contractor CX001 and include installation of flood lights near the workshop and associated rail track and switches.

9.6 Area 4000 – PORT

Area 4000 consists of the following major sub-areas:

- Area 4100 – Port Terminal
- Area 4200 – Ore Handling
- Area 4600 – Wharf and Marine Structures
- Area 4700 - Loadout
- Area 4800 - Utilities and Onsite Infrastructure
- Area 4900 – Port Ancillary Facilities

Appendices A51 and A52 are the Process Flow diagrams defining the functional requirements for the port process plant. Appendix A14 shows the proposed layout for the port area.

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9.6.1 Area 4100 – Port Terminal

The functional scope for this area remains unaltered from the Stage 2 Study Report. This area includes:

a) An ore unloading track runaround track after the dumper and a departure line.

b) Rail spurs to the workshop, for bad order and good order cars, and quarry/ballast access with turning wye.

c) A rotary car dumper.

d) Automated hydraulic car positioner for the car dumper.

e) Ore dump pocket and reclaim system beneath the car dumper.

f) Conveyor to create a crusher feed ore stockpile.

At the time of writing this report, two firm bids have been received for supply of plant for area 4100. Both bidders provide the functionality required to meet the functional requirements of the specification defined for contract CM001,and all bidders are proposing similar equipment to meet the needs of the CM001 specification. Detailed design for this plant has yet to be completed, however, the functional requirements of each element of the plant will remain unchanged as described in the following sections.

Area 4100 consists of the following sub-sections:

- Area 4110 – Ore Unloading Track
- Area 4120 – Ore Unloading and Stockpile

9.6.1.1 Area 4110 – Ore Unloading Track

The port terminal and yard layout is presented in **Figure 9-7**.

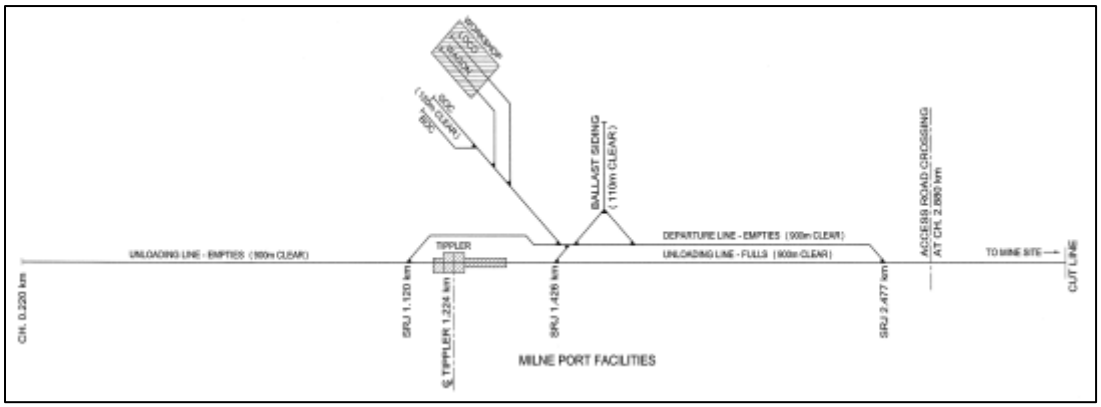

Figure 9-7: Port Site Track Diagram

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The scope of the port terminal rail unloading track works contains the following elements. Refer to Appendix A14, A19, A20 for details.

a) Unloading lines 2800 m (mainline chainage)

b) Departure Siding 900 m

c) Locomotive Run-around loop 347 m

d) Locomotive Workshop Spur 390 m

e) Ore Car Workshop Spur 215 m

f) Bad Order Car Spur 205 m

g) Good Order Car Spur 160 m

h) Ballast Spur 400 m

i) Triangle Link 375 m

j) Cross Over 120 m.

The tables that follow describe locations where construction water (**Table 9-63**), ballast laydown areas (**Table 9-64**), earthworks quarries (**Table 9-65**), earthworks spoil and rehabilitation areas (**Table 9-66**) have been located for this area of the project.

Table 9-63: Construction Water Source

Rail Chainage (km)	Construction Water Source
Port	Construction water point

Table 9-64: Ballast Laydown Areas

Stockpile Number	Rail Chainage (km)	Approximate Ballast Quantity at Stockpile (m^3)	Notes
No. 1	1+800	15,349	On triangle for ballast siding

Table 9-65: Earthworks Quarries

Quarry No.	Route km	Quarry location relative to Track alignment	Overburden (m)	Area (m^2)	Type of Material	Volume (m^3)
Q1	0+900	East	0	300,000	Granitic Gneiss	2,300,000

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Table 9-66: Earthworks Spoil and Rehabilitation Sites

Rehabilitation/Spoil Site (Route km)
Not applicable

The extent and type of culverts that will be installed in this area of the project is summarized in **Table 9-67** All culverts to be installed will be corrugated steel pipe culverts.

Table 9-67: Drainage Culverts

Culvert Size (Ømm)	Total number	Sum of Length (m)
900	7	120
1200	1	30
1400	0	0
1800	0	0

There will be six culverts between km 1 and km 2 that will be installed in areas where the rail alignment is in a cut. These culverts will be provided with an inlet and as this section is in a hard rock excavation, the culverts will be provided with a daylight excavation through the hard rock.

9.6.1.2 Area 4120 – Ore Unloading and Stockpile

This area defines the plant scope from the point where ore wagons enter the immediate area of the car dumper and ore discharges onto the Primary Crushed Ore Stockpile. Definition to the stockpile, reclaim system and downstream crushing and screening plant described in the section detailing project scope for WBS 2300.

a) A single, one car barrel rotary car dumper will be provided to unload ore cars. The dumper will have the capacity to unload ore cars at a rate of one car unloaded every 61 to 90 seconds (depending on vendor selected) when a train is present and registered in the indexing machine.

b) The car dumper will be enclosed within a building notionally 60m long, 16.5m wide and 10m high. The building will be open at each end to allow entry and egress of trains. Insulation will be provided for the sheet metal structure and cladding; no heating will be provided within the dumper building.

c) A hydraulic room will be provided to house hydraulic equipment to power the grippers and other ancillary dumper devices. The building will be approximately 4m long, 5 m wide and 3m high. The building will be both insulated and heated.

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d) A single electro hydraulic indexer device will index the loaded train through the dumper. The indexer shall be equipped with grippers to hold cars immediately and before the dumper stationary whilst dumping is in progress. Hydraulic equipment required for indexer operation will be located on the indexer carriage.

e) Beneath the dumper barrel a surge bin will be provided.

f) An apron feeder system will be located beneath the surge bin to provide a constant feed of ore to the rail unloading conveyor.

g) Dust control within the dumper building and vault shall be provided by way of contractor CM001.

h) To accommodate the rail unloader, bin feeder and tail end of the primary crushed ore stockpile feed belt, a concrete basement shall be constructed into an excavation beneath the rail line. The basement will be formed from pre-cast concrete segments, fabricated off site to minimize on site concrete construction work.

i) From the base of the dumper vault a corrugated prefabricated tunnel will be installed for the rail unloading conveyor, to provide personnel and equipment access into the rail unloading basement. After installation of the tunnel, the excavation for the tunnel will be backfilled.

j) Installation of the dumper basement and primary crushed ore tunnel will be undertaken by the contractor providing earthworks constructions services under contract CC002. Electro mechanical supply and installation of the primary crushed ore tunnel will be by contractor CM001.

k) The rail unloading conveyor will be installed to receive ore from the apron feeder and discharge the ore onto a single conical primary crusher feed stockpile with a total capacity of 25ktonnes and a live capacity of ~ 10 ktonnes. No dust suppression equipment will be provided at the conveyor discharge point. The head of the conveyor will be founded on piled foundations.

l) Contractor CM001 will provide a modularized E-Room to house HV, MV, LV switchgear, motor control centres, variable speed drives, small power and lighting distribution boards, process control equipment, communications equipment and fire suppression equipment. The E-room will provide po0wer for;

- Rotary car dumper, indexer and associated equipment
- Rail unloading apron feeder system and rail unloading conveyor
- Rail workshop and services building
- Rail signalling equipment at the port terminal.

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m) Area lighting will be provided by contractor CM001 mounted from structures provided by the CM001 Contractor.

Civil and Foundations (refer to Appendices A53 to A57)

Design of the dumper basement has considered preliminary design information as shown in Appendices A53 to A57). Bidders responding to contract CM001 note that their designs may offer the potential for a reduction in the depth of excavation required for the dumper installation. Reduction in the order of 5m may be realized, however, this would require relocation of the dumper to ensure its foundations remain founded on rock or development of a revise foundation concept. Such analyses and decisions need to be made in the execution phase after award of CM001. The CAPEX reflects the concepts shown herein.

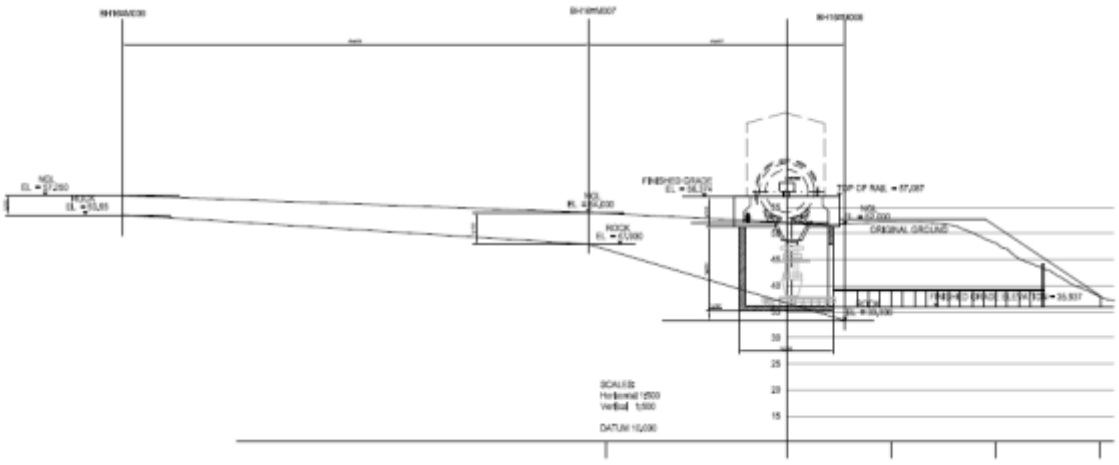

Figure 9-8: Car Dumper Foundation Concept

The scope of the project as represented by the capital cost estimate is contained in appendices A53 to A57 and summarized below.

a) Excavations to allow for installation of the dumper pocket and the tunnel excavation for the tail of the primary crushed ore stockpile conveyor.

b) Supply of pre-cast concrete beams to construct the retaining walls for the dumper pocket and tunnel entry.

c) Installation of pre-cast concrete to allow the contractor CM001 to install the dumper, reclaim bins, feeders and the primary stockpile reclaim belt.

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d) Supply and installation of prefabricated plate arch tunnel for the conveyor (budget held within CX001)

e) Backfill the outside of the dumper pocket and over the rail unloading tunnel.

f) Installation of a piled foundation on which to allow contractor CM001 to base the cantilevered section of the primary crushed ore stockpile which extends over the primary crushed ore stockpile to the conveyor discharge. Pile caps will be installed ready for foundation work by contractor CG001. Refer to Appendix A57 and A58 for location of piles and typical pile cap details. Detail design of piles will be undertaken by contractor CG001.

Structural, Mechanical, Electrical and Instrumentation

a) Supply and installation of a single car rotary dumper to empty ore from the ore wagons at a rate between 61 and 90 seconds per car.

b) Supply and installation of an automated rail car indexing system to increment the train through the dumper cell, one car at a time.

c) Supply and installation of car grippers to hold stationary the ore cars immediately before and after the dumper cell during dumping operations.

d) Supply and installation of power packs (hydraulic) to provide hydraulic energy for all rail unloader equipment.

e) Supply and installation of a hopper of sufficient capacity to maintain train unloading rates at 61 to 90 seconds, whilst ore is withdrawn at rates defined by the flow sheet developed by CM001 contractor.

f) Supply and installation of apron feeder system at the base of the ore bin to provide controlled mass withdrawal of ore to then discharge on to the primary crushed ore conveyor.

g) Provide dust control for the rail dumper building to provide a safe working environment for operations personnel.

h) Supply and installation of buildings to enclose the dumper cell and hydraulic building to provide protection from snow build up.

i) Supply and installation of a single conveyor belt to convey primary crushed ore to discharge onto the primary crusher feed stockpile.

j) Supply and installation of a tunnel to house the crusher feed stockpile co Supply and installation conveyor from the bottom of the dumper vault until the tunnel intersects with the natural surface contour. Typically, the tunnel will be a steel arch tunnel with concrete footings.

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k) Supply and installation of local equipment controls to provide for equipment operation and maintenance, and, the overarching control system to provide for integrated control and management for the complete ore system (dumper to shiploader) as a single system in a single control room.

9.6.2 Area 4200 – Ore Handling

Area 4200 consists of the following sub-sections:

- Area 4210 – Stockpiling
- Area 4220 – Reclaiming

9.6.2.1 Area 4210 – Stockpiling

In general the existing shiploader No.1 stockpile will be reconfigured and used for stockpiling fines only. Modifications required to the existing shiploader reclaim are included in WBS 4731 (considered part of shiploader No.1). In general, the reconfiguration includes:

a) The eastern half of the existing stockpile No.1 (6 kidney piles) will be decommissioned to make room for the construction of Stockpile No.2.

b) The south end of the existing reclaim conveyor will be re-aligned as shown in appendix A14, A79 and A80.

c) The south western quadrant (three kidney piles) will be re-aligned to suit the conveyor and the piles will be increased in size to provide the required stockpile capacity.

d) The north western quadrant (three kidney piles) will remain their existing location but will be increased in size to provide required stockpile capacity.

Stockpile No/1 stacking and reclaim will be carried out using existing equipment. Associated mobile equipment is included in WBS 4880.

A new lump ore stockpile, Stockpile No.2, will be developed and associated with the new ore dock and shiploader No.2. Stockpiling and reclaiming for Stockpile No.2 is described in sections describing WBS 4210 and 4220.

Stockpile No.1– Civil Work

a) A runoff containment berm and drain will be installed to run around the Western and Southern edges of the area required for placement of three new kidney stockpiles, which will be used for fine ore storage.
b) An extension to the existing stockpile pad will be built in the southwestern corner of the stockpile #1 area to provide space to re-align three kidney stockpiles. Refer to Appendix A57 for piling assumptions.
c) A 10m wide haul road will provide be provided to enclose the new kidney stockpiles and provide road access to the remaining (existing piles).

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d) A conveyor berm will be built to allow for reorientation of the Southern half of stockyard #1 reclaim conveyor. Sleepers recovered from the southern half of existing stockyard #1 reclaim conveyor end will be reclaimed and repositioned to provide foundations for the relocated southern extent of the stockyard #1 reclaim conveyor. Refer to Appendix A57 for piling inclusions.

e) New foundations will be built to provide for installation of;

- Head, tail, drive and belt tensioning device for the new re-orientated southern extent of the stockyard #1 reclaim conveyor system.
- A new tail, drive and belt tensioning device for the northern extent of the stockyard #1 reclaim conveyor system.
- Supply and installation of piled foundations on which contractor CM001 will install conveyor drive and tail assemblies. Pile caps will be installed ready for foundation work by contractor CM001.

Stockpile #2 Civil Earthworks and Drainage

a) Installation of a vehicle access road network to provide:

- Access along the Eastern extent of Stockpile #2 which is graded to drain from the mid-point to the north and south. The Eastern edge of the road will be installed with a berm to deflect run off presenting from the east of the stockpile.
- Access Road along the western edge of stockpile #2. The southern half the road shall be built from fill materials. The northern extent will be set at grade.
- Installation of two lined sedimentation ponds located at the south of the stockpile area.

b) Stacker/Reclaimer berm and rail drainage and road construction. Berm construction will provide for creation of a platform for installation or rails for the stacker/reclaimer system, foundations for the yard conveyor and an access road to the stacker and reclaimer. Bids received confirm the need to build a berm with a crest width of 16.4m and height above grade of 2.5m. Development of prepared surfaces for the base of the stockpile has not been considered in the scope of the project. Ore will be stacked directly onto unprepared ground surfaces at grade. The berm materials will be won from existing quarries at Milne.

c) Construction of piled foundations;

- Yard conveyor tail structure
- Yard conveyor drive house
- Yard conveyor to shiploader transfer tower and or shiploader surge bin.

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Stockpile No.2 - Structural, Mechanical, Electrical and Instrumentation

The structural, mechanical, electrical and instrumentation scope for the Stockpile #2 is to be provided by a single design build contractor under contract CM001 which includes provision of:

a) Stockpile conveyor and capacity to transport 16,000 tph of ore from the lump conveyor discharging the crushing and screening plant and then discharging lump ore to the bins and transfers on Dock 2 which then provides feed to shiploader No.2 (refer WBS 4730)

b) Installation of a rail mounted stacker and reclaimer units with a capacity reclaim ore with a peak rate of 16,000tph. The stacker reclaimer shall be equipped with a tripper car to lift ore from the ground conveyor level to a transfer chute feeding the stacker/reclaimer boom. The tripper car is fitted with devices to allow ore to be direct fed to the shiploader and bypass the stacker boom. The Stacker reclaimer has been configured to develop two lump stockpiles notionally 21 m in height with a base width of 84m; with a flat top configuration this stockpile provides for a total of 8Mtonne storage of which 6.68Mtonne is live and directly reclaimed, 0.52Mtonne of lump ore (50% in each stockpile) will be dozed into the area accessible by the reclaimer to create a single bench typically 14.5m wide and 5.25m high which can then be accessed as a discrete bench by the reclaimer. Dozing operations will occur in sections of the pile which have been cleared of ore by the reclaimer. Refer to Appendix A59 for stockpile profile.

c) Upon complete construction of the stockpile, after shipping of all the lump ore to meet the 12Mtpa shipping rate for lump and fines, 1.33Mtonne of lump ore will remain on the ground. In the event of an extended shipping season, the potential exists for this ore to be dozed into the active reclaim area and it can be loaded onto ships increasing the shipped volume for that season.

d) The boom length of the stacker reclaimer is notionally 60m. The machine has luff capability to allow reclaim of yyy tonne of lump ore from two stockpiles, one each side of the rail track. The stacker reclaimer has a slew capability to allow stacking on either side of the stacker reclaimer berm.

e) Provision of trailing cables for the stacker reclaimer including cable reel devices is included within the scope of supply of the CM001 contractor as is supply of HV, MV, LV, small power distribution, lighting panel, distribution rooms is included within the scope of the CM001 contractor.

f) The stacker/reclaimer will be able to stack ore in many modes:

- Cone
- Chevron

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- Strata
- Windrow
- Advanced Block.

Each train load has an ore load of 7632 tonnes (72 cars by 106 tonne per car) comprising 5876 tonne of lump after crushing and screening. Approximately 1,225 trains will be required to fill the expected 7.2 Mtonne of reclaimed ore. Detailed design of the stacking system (choice of stacking mode) is required in the next phase to ensure grade variation arising from mining plans is efficiently reduced to meet customer specifications during the stacking and reclaiming process. CM001 vendors have noted use of chevron stacking as the preferred stacking method. Consideration should be given in detailed design to the use of an advanced block style of stack build to minimize energy cost during the stacking operation.

g) Supply and installation of all rail systems including, ties, rails, clips, etc, required for operation of the stacker reclaimer is included within the scope of contract CM001. It is expected that the rail gauge will be 11- 12m and that the single stacker conveyor will be located within the gauge of the rails as will be a personnel and maintenance access road.

h) Supply and installation of local equipment controls to provide for equipment operation and maintenance, and, the overarching control system to provide for integrated control and management for the complete ore system (dumper to shiploader) as a single system in a single control room.

9.6.2.2 Area 4220 – Reclaiming

Stockpile No. 1 Reclaim

a) Existing equipment will continue to be used as per existing operations and operating practices.

Stockpile No. 2 Reclaim

a) Common equipment used for stockpiling is described in Areas 4210 above.

9.6.3 Area 4600 – Wharf and Marine Structures

Area 4600 consists of the following sub-sections:

- Area 4610 – Ore Dock No 1
- Area 4620 – Ore Dock No 2

9.6.3.1 Area 4610 – Ore Dock No.1

There is no project scope in this area.

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9.6.3.2 Area 4620 – Ore Dock No.2

A new ore dock, Ore Dock No.2 will be constructed. The dock will be capable of berthing Cape Size vessels with a capacity of up to 230,000dwt in addition to Panamax ore carriers with dimensional limits per Appendix A61.

The ore dock will serve two primary functional objectives which consist of the following:

- Provide a safe, efficient and secure deep-water berth for a range of design vessels including Panamax and Cape Size bulk ore carriers.
- Provide a means of support for the shiploaders, conveyors and associated mechanical equipment used for loading the vessel.

To achieve these objectives the ore dock will include symmetrical breasting and mooring points, a fender system and mooring hardware. The ore dock will efficiently accommodate the range of design vessels for the design and operating conditions.

This report is written to align with the capital cost estimate dated April 2017. Completion of negotiations for contact CM001 will enable firm selection of the ship loader configuration to be installed during construction. At the time of report writing options exist with the bids offered by CM001 to provide either:

- Two quadrant loaders with a capacity of 8000 tph each
- One dual linear loader with a capacity of 16,000 tph
- Two hybrid cantilevered radial shuttling shiploaders with a capacity of 8000 tph each.

The estimate (CAPEX) and the section that follows is based in installation of two quadrant shiploaders as defined in Appendices A60 to A63.

The Stage 3 Definitive Study process called for submission of bids for the design build of the No.2 Ore Dock. Two bidders have been preselected for further negotiations to conclude a contract. The bidders have proposed:

- Closed cell dock
- “Combi wall” construction techniques.
- Circular sheet pile dolphins

The bids received allowed for installation of two quadrant loaders to meet the functional needs of the project. The capital estimate was based upon the Circular sheet pile concept offered be EBC. The following provides a functional description of the dock facility to be provided within the scope of the CG001 contract. Further negotiation is required to finalise design details to provide a more definitive facility description. Notwithstanding, all bidders have complied with the functional requirements following.

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The Ore Dock shall provide support for all shiploading facilities and resist all applied loads (including berthing and mooring of Cape size vessels)

The Ore Dock shall have all necessary access and space required for the operation of the berth. All items necessary for the operation of the marine facilities and as required by the shiploader design shall be accommodated by the Ore Dock.

Fill materials for construction of the dock and access causeway will be won from quarries extant in the Milne port area.

Vertical Quay and Dock Area

a) The main berth face will consist of structure(s) that act as combined breasting and shiploader support platform. These structure(s) will accommodate fenders to absorb the energy of the berthing vessel, provide contact points for the moored vessel and mooring line points as required.

b) The main berth face will be equipped with a removable fender system which will provide an impact surface against which the vessel will make contact. The fender will absorb the impact energy so as to protect the vessel and the berth.

c) Mooring equipment will consist of bollards (or equivalent) spaced along the main berth face so as to facilitate the spring lines for the range of design vessels.

d) Removable ladder(s) will be provided on the main berth face as required, extending to three (3) rungs below the lowest low water level as a minimum.

e) The quay level of the facility shall be determined based on extreme water level analysis. The quay layout dimensions shall be adequate for the function specified in this specification, including associated construction, installation, operation and maintenance requirements. The adequacy of the quay level and layout shall be the responsibility of the Design Build Contractor (CG001 – Ore Dock).

Access Causeway

a) A causeway shall be constructed to support the conveyor system and provide access for pedestrians and service vehicles from the shore to the ore dock. Access for mechanical, conveyor and electrical systems will also be provided to the ore dock.

b) Double lane access to the ore dock will accommodate the following vehicles.

- All terrain loader for conveyor clean-up and snow removal.
- Pickup truck.
- Fire truck.

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- Maintenance Boom Truck.
- Revetment maintenance vehicle – accessible to repair armour stone on both sides of the causeway.
- Mobile crane for ongoing maintenance.
- Mobile Crane.
- Manitowoc 2250 with MAX-ER attachment (and additional counterweight, rated to 500t capacity).

Berthing and Mooring Infrastructure

a) The number and spacing of the berthing and mooring infrastructure shall be determined by a detailed berthing and mooring analysis for the range of vessels specified in this document. Mooring assemblies will be located so that mooring layouts meet standards outlined by the following:

- OCIMF, and/or
- BS6349.

b) The berthing and mooring infrastructure shall as a minimum include the following items:

- Fender assembly, complete with chains
- Mooring assembly (Bollards / Quick Release Hooks)
- Motorized capstans
- Walkway / stairway supports
- Handrails
- Adequate working and access space
- Edge protection to prevent abrasion by mooring lines
- Messenger rope reels

c) The layout of the location of berthing infrastructure shall take into consideration the hatch layouts of the various ships and ensure that the shiploading requirements can be met. The fender system shall be mounted in a way that no diver access is required to remove and replace the fender.

d) A minimum of 2.5m distance is required between the mooring assembly edge and any platform edge. Each mooring assembly shall be equipped with a mooring capstan. Handrail shall be fitted to ensure safe operations, without impeding mooring operations.

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Walkways and Quay Furniture

a) Clear pedestrian access to the walkway, stairways and ladders giving access to mooring infrastructure and the gangway shall be provided.

b) Walkways shall provide pedestrian access linking together all the berthing and mooring infrastructure to the quay area and shall also permit access for small-wheeled trolleys.

c) The walkways shall be designed for carrying the mooring lines from the vessels to the mooring assemblies and the grating level within the walkway shall not exceed a slope of 1 in 10 and there shall be no steps between walkway terminations and the connecting structures. The minimum clear width of walkways shall be 1.4m.

d) The structural form shall ensure that no obstructions are present on the seaward side of the walkway at a height greater than 1.2m above grating level to enable easy handing of lines. All members along the uppermost limit of the structure shall be rounded so as not to chafe or abrade lines being passed along. Ends of handrails shall be detailed so that mooring lines cannot catch on the handrail.

Access Tower / Gangway

a) Access Tower / Gangway are to be provided on the quay to allow boarding of personnel. The access tower / gangway design needs to take into consideration the range of design vessel sizes. The access towers / gangways and its components shall comply with national manned elevator codes, lifting appliance codes and shall meet all national working at heights requirements where applicable.

b) The location of the gangway shall be designed for safe access from the design vessels to the quay areas and should be located at a safe distance from any carrier mooring line or any equipment. The position shall be optimised from the "Spotting Line" with regard to the vessels to use the berthing facilities. The end steps from the gangway (i.e. on board the carrier) shall ensure safe step-down at all times on to the carrier's main deck.

c) If self-levelling steps are not to be used, the maximum safe gradient of the gangway is taken as 35 degrees, unless the local authorities use a smaller angle.

Shiploader

a) The main berth structure will also provide a foundation for dual quadrant shiploader and a feed conveyor system. It is assumed piling will be required to support shiploaders and shiploading equipment. Assumptions, pending final design by contractor CG001 are shown in Appendix A57.

b) Shiploaders have been specified with the following criteria:

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9.6.4 Area 4700 – Loadout

Area 4700 consists of the following sub-sections:

- Area 4710 – Ship loading – Conveyor
- Area 4730 – Ship loading

Design and construction of the Loadout falls within the remit of contract CM001 on a turnkey basis with the exception of the foundations which are designed and contracted by CG001. The Facilities description follows the functional format as has been used for other areas to be provided by contractor CM001. Bids received for contract CM001 confirm the functional scope may be delivered via a number of routes all of which fall within the contingent estimate amounts contained within the CAPEX estimate. Key functional criteria for the shiploader includes:

- One to two quadrant loaders.
- Design ship loading rate, each ship loader = 8,000 t/h, if two are provided.
- Design ship loading rate, two loaders operating simultaneously or of a single unit = 16,000 t/h.
- Ship loader geometry suitable for loading all hatches of a Cape Size ship, without warping (moving) the ship, using both quadrants.
- Ship loader geometry suitable for loading all Hatches of a Panamax ship, without warping (moving) the ship, using one of quadrants only (to allow some redundancy in the system particularly during late season ship loading).

9.6.4.1 Area 4710 Shiploading Conveyor

Civil and Foundations

a) Civil development of the dock structure to accommodate the dockside conveyors and any bins, diverter chutes, feeders and such will be undertaken during construction of the dock structure.

b) Piled foundations will be provided for the transfer tower connecting the No.2 stockpile yard conveyor to the dock conveyors. Pile caps will be provided to allow founding of structural foundations to be provides by contractor CM001.

c) Spread footing type footings will be used to support the conveyor trusses connecting the shiploaders.

Structural, Mechanical, Electrical and Instrumentation

a) Supply and installation of a transfer point to allow measured ore splitting from from No.2 yard Conveyor which then feeds shiploader 2A and 2B.

b) The specified functional requirements will be achieved by either:

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- A flow splitter and single transfer conveyor to control flow to both shiploaders.
- A hopper with feeder and transfer conveyors to provide surge capacity and to control flow to both shiploaders.

c) Supply and installation of all electromechanical equipment required to:

- Integrate the operations of the shiploaders with that of the reclaiming system
- Optimize the stop and start of No.2 Yard conveyor.
- Maximize the loading rate of the two shiploaders, during and after hatch changes.
- Supply and installation of local equipment controls to provide for equipment operation and maintenance, and, the overarching control system to provide for integrated control and management for the complete ore system (dumper to shiploader) as a single system in a single control room.

9.6.4.2 Area 4730 – Shiploading

Shiploader No.1 Reclaim Conveyor Modifications (Structural, Mechanical, Electrical and Instrumentation)

To facilitate development of the new Stockpile No 2 system the existing (Stockpile No 1) reclaim conveyor will be modified, including:

- Shorten existing conveyor by approximately 222m, this shortened conveyor will be referred to as Reclaim Conveyor 1A.
- Construct and new Reclaim Conveyor 1B with a length of 295m, at an angle to the existing, to replace the removed section of conveyor.

The new arrangement is shown in **Figure 9-9**. The design of the new conveyor is based on the existing reclaim conveyor.

Refer to Appendices A79 and A80 for detail of the plan and elevation.

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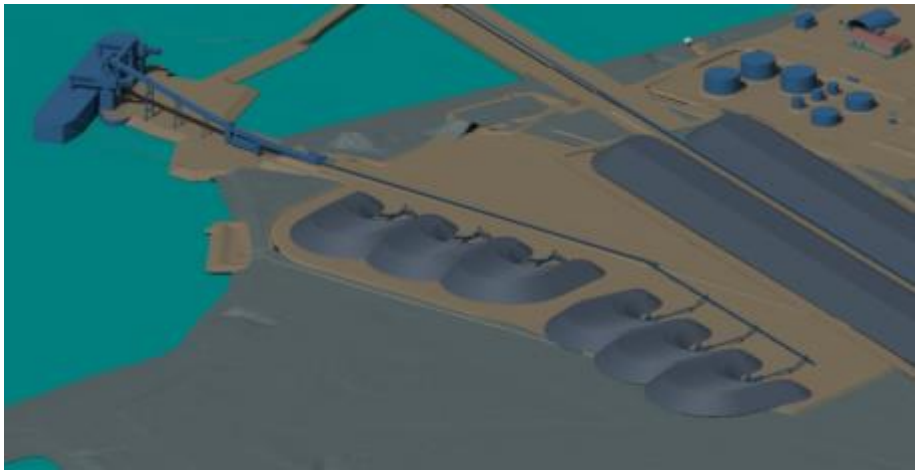

Figure 9-9: Fines Stockpile and Ship Loading Arrangement

The primary design criteria are summarized in **Table 9-68**.

Table 9-68: Fine Ore Handling Design Criteria Summary

Item	Element	Unit	Design Criteria
1	Product Size Specification - Fines	mm	+6.3 -0.10
2	Conveyor design capacity	tph	6 000
3	Conveyor normal operating capacity	tph	4 500
4	Ore SG		2.8
5	Conveyor Belt (same as existing)		ST2250
6	Idlers (same as existing)[1]		Carry - Series 35, 3 roll / Return - Series 25, 2 roll
7	Take-up		Gravity
8	Drive location		Head end (unclad)

New piled foundations will be constructed to support;

a) Relocated conveyor 1A tail pulley.

b) New conveyor 1B transfer tower and drive house including if required the take up tower.

c) New conveyor 1b tail pulley.

[1] Note: Modifications to the existing reclaim conveyor, including changing the idler arrangement, are currently being considered by Baffinland. Final design of Reclaim Conveyor 1B shall be matched to the as-built condition of the existing system at the time of modification.

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Piled foundations will be installed by contractor Cg001 and will include pile caps ready for installation of structural steel.

The scope of the work to modify the reclaim conveyor is summarised below:

a) Design, supply and installation of all modifications to the existing conveyor and the new conveyor.

b) Remove existing conveyor sections including concrete sleepers, these will be used for the new Reclaim Conveyor 1B.

c) Supply and install additional conveyor modules including sleepers, steel frames and idlers sets as required.

d) Remove tail pulley and frame, and relocate to the new position for shortening of Reclaim Conveyor 1A. This will be placed on piled foundation. Piling to be supplied by others.

e) Install new transfer tower on piled foundations. Pile foundation to be supplied by others.

f) Install new raised head-end and gantry module (24m long), relocated conveyor sections and new tail pulley to construct conveyor 1B. The tail pulley and structure will be placed on a piled foundation (pile foundation by others).

g) Supply and install new drive for Conveyor 1B including VSD and associated electrical switchgear and cables.

h) Supply & Install new 600 V MCC feeder cubicle for Reclaim Conveyor 1B in E-House 2342-BLD-001.

i) Supply and Install new 350kW Variable Speed Drive in E-House 2342-BLD-001.

j) Install and terminate 600V Cable between MCC and VSD.

k) Install and terminate 600V Cable between VSD and drive at Reclaim Conveyor 1B head-end.

l) Supply and install field control station at Reclaim Conveyor 1B drive, complete with control cable to MCC.

m) Supply and Install Electrical safety circuit between Local Control Station and conveyor safety instruments.

n) Supply and install instrumentation on Conveyor 1B and associated panels and cabling

o) Transfer chutes to transfer the ore from Conveyor 1B to Conveyor 1A.

p) Network and control system changes (PLC/HMI) to suit.

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q) Ensure that there will be enough I/O on the Existing Control System at the head end of the Stockyard Conveyor 1A to add new Conveyor Safety devices to the re-aligned conveyor

r) Add new Multicore cable to the conveyor cable racking (by others) between the Junction boxes at the head end of Conveyor 1B and the head end of Conveyor 1A. Pull new single pair cables for Safety devices onto the cable racking (By others) to the head-end of the Reclaim Conveyor 1B. Test all the safety devices and ensure that they are ready for the conveyor to be commissioned. Safety devices will typically be Belt Alignment switches, emergency stops, start-up alarm, belt tear device and speed switch.

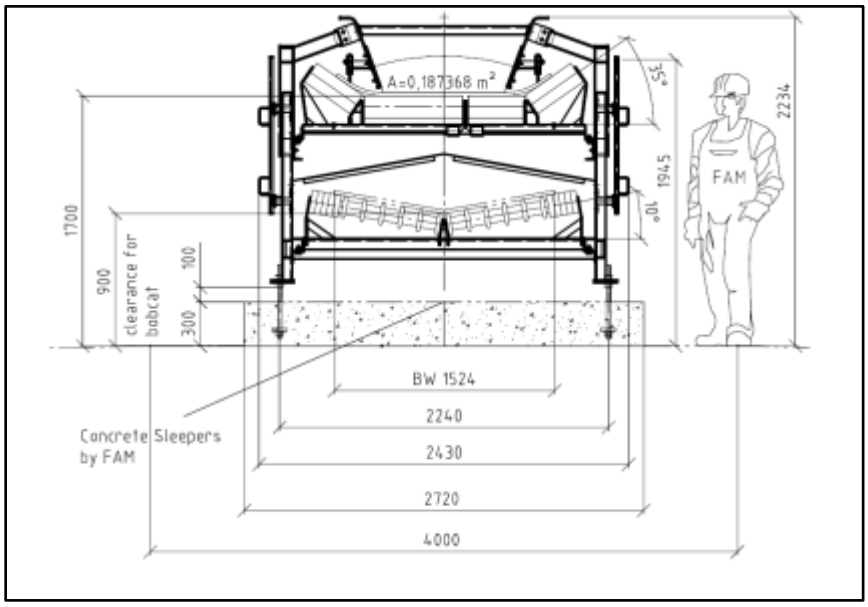

Figure 9-10: Cross Section of Existing Reclaim Conveyor

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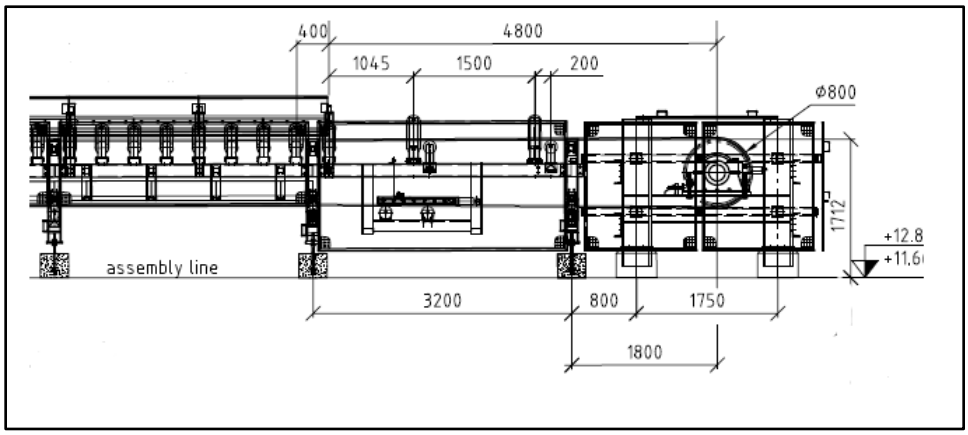

Figure 9-11: Elevation of Existing Reclaim Conveyor Showing Tail End

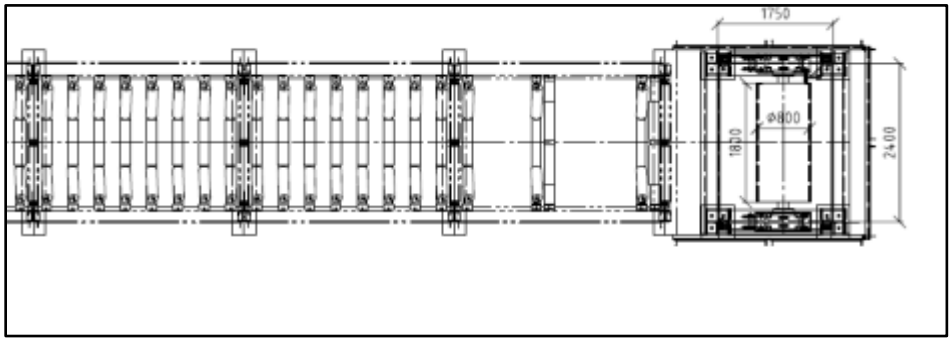

Figure 9-12: Plan view of Existing Reclaim Conveyor Showing Tail End

Civil and Foundations (refer to Appendix A57)

a) Foundations for the shiploaders will be piled and installed during construction of the dock.

b) Pile foundations will be installed to support the quadrant shiploader, quadrant rail.

Structural, Mechanical, Electrical and Instrumentation

a) Two quadrant style 8000 tph shiploaders will be provided. The shiploaders will be supplied as a part of contract CM001 and will be supplied with power supplies from E – rooms provided by contractor.

b) Supply and installation of local equipment controls to provide for equipment operation and maintenance, and, the overarching control system to provide for integrated control and management for the complete ore system (dumper to shiploader) as a single system in a single control room.

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9.6.5 Area 4800 – Utilities and On-site Infrastructure

Area 4800 consists of the following sub-sections:

- Area 4810 – Site Development (Mass earthwork, roads, grading, site drainage, sediment handling)
- Area 4830 – Power
- Area 4840 -Fuel Systems
- Area 4880 – Production Mobile Equipment
- Area 4890 – Production Services Equipment

Within area 4800 is work to reconfigure existing pipework related to treated effluent discharge.

Treated Effluent Disposal

a) The treated effluent discharge pipeline is to be extended to discharge at a new position, refer to Appendix A64 for detail of the pipeline route.

b) The length of new pipe required is 854 m. The pipeline is routed next to the new fuel system marine offload pipeline and is laid on a earth berm prepared by others. The pipeline needs to be secured from movement due to thermal cycling.

c) The modification of the pipeline to the new discharge location includes:

d) Remove end section of existing pipeline back to suitable field splice location (removed length of pipe will not be reused).

e) Supply and install pipeline (2” dia. HDPE DR11 with 50mm insulation, butt fused) to new effluent discharge point on earth berm provided by others. Pipeline to be guided and anchored using steel pegs driven into ground and crushed rock placed over pipe as required.

f) Terminate the existing heat trace cables where the pipe is removed.

g) Supply and install two new heat trace controllers (Thermon type as per existing) inside the existing welding shop service entrance E-room (Seacan). Connect 600V power supply including fused disconnect switches to provide power to the heat trace controllers. Controller installation shall include associated RTD’s and accessories.

h) Install heat trace cold lead power cables (600V TECK90) from controller to pipeline (at section where new pipe spliced to existing).

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i) Supply and install series constant watt heater cable along new pipeline, 2 circuits, Thermon TEK as per existing. Installation details to match existing Port Treated Effluent Pipeline including splice and termination details (external junction box).

j) Complete pipe insulation at pipe joints as per existing Port Treated Effluent Pipeline.

9.6.5.1 Area 4810 – Site Development (Mass earthwork, roads, grading, site drainage, sediment handling)

9.6.5.2 Area 4830 – Power (refer to Appendices A67 to 70)

The existing Port site power generation system will be expanded from 7x 1350 kW generators to 11x 1350 kW generators. The expansion requires installation of four (4) new generator modules and one (1) new switchgear e-house. In order to balance the electrical loads between the power generation e-houses, modifications to existing feeders are also requied. Work includes;

a) Supply and install hardwood timber and Styrofoam insulation to construct four (4) generator module foundation frames as shown on appendix A66.

b) Install four (4) off 1350 kW Power Generation Modules (free issue).

c) Install all PE002 vendor supplied generator module fixtures including, but not limited to:

- Air intake hood
- Exhaust stack
- Entry/exit stairs

d) Install one (1) power generation switchgear E-House and associated external access stairs.

e) Supply and install ground grid including ground rods, conductor and all interconnections. Backfill ground grid.

f) Supply and install cable tray connecting to each power generation module and new switchgear E-House, including multi-level cable rack along back of new generators (on existing power berm).

g) Supply and install bonding conductor to cable trays

h) Install interconnection power cables from power Generation Units into the Switchgear building – 5 kV, 600V and control cables. Seal all cable entry points.

i) Install interconnecting 5kV, 600V and control cables between existing E-House #2 and new E-House #3. Seal all cable entry points.

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j) Move Shiploader No1 E-house feeder cables (5 kV) from existing distribution board #1 feeder (F3, in E-House #1) to new distribution board feeder (F15, in E-House #3). Note: Existing cable will be shortened in length.

k) Move Fuel Farm E-house feeder cables (5 kV) from existing distribution board #2 feeder (F10, in E-House #2) to new distribution board feeder (F18, in E-House #3). Note: Existing cable will be shortened in length.

l) Replace existing 1200A breaker in E-House #2 with 2000A breaker (F11).

Power Distribution:

a) Install a new PSC E-House and feeders (Appendix A70 reference A9), including:

- Install power distribution E-house module (single module, installed on gravel pad)
- Supply and install vertical cable tray on E-House.
- Supply and install E-House grounding system including ground rods and copper conductor.
- Complete preparation of E-house in accordance with vendors' instructions, including removal of shipping items and connection of fire suppression system.
- Install and terminate 5kV power cable between new PSC E-house and existing Type 1 PSC E-House (E-House #1).
- Install and terminate 600V power cable between new PSC E-house and existing Type 1 PSC E-House (E-House #1).
- Install and terminate dual ground conductors between E-Houses

b) Supply and install road crossing conduit pipes (6" schedule 80 steel pipe trenched and backfilled) at the following locations:

- Fuel tank farm road, S-W corner
- Stockpile road, N-W corner of fuel tank farm
- New Yard Conveyor #1 berm / causeway to dock
- New crusher building area (details TBC)

c) Modify the existing Ship Loader E-House Feeders (Appendix A70 reference A4), including:

- Cut, re-route and splice (joint) existing 4160 V feeder cables (4 off) through culvert/sleeves under new Stockyard No. 2 Conveyor earthworks berm

d) Install a new Construction Camp Feeder (Appendix A70 reference A5), including

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- Install and terminate 5kV power cables between generation distribution E-House and Construction Camp E-house (E-House installed by TX002).
- Terminations will be onto switchgear.
- Splice cables where required – route length of 1320m with 500m reels supplied.
- Install dual ground conductors on power cable route between E-Houses.
- Supply and install grounding system accessories as required.

e) Install a feeder to the Crusher Building E-house (Appendix A70 reference A6), including:

- Install 5kV power cables between Power Generation E-House #3 and Crusher Building E-House (E-House installed by CM001). Terminate cables in Power Generation E-House #3 (other end termination by others)
- Install 5kV power cables between Construction Camp E-house and Crusher Building E-House (E-House installed by CM001). Cut power cables connecting to Construction Camp E-House and splice to new cables (to extend cable run to the Crusher Building E-House).
- Splice cables where required – route length of 1320m with 500m reels supplied
- Install dual ground conductors on power cable route between E-Houses
- Supply and install grounding system accessories as required.

f) Install 600V feeders for the Rail Services Area (Appendix A70 reference A7 & A8), including:

- Install 600 V cable between Rail Unloading E-house and Rail Workshop Building.
- Install 600V cables between Rail Unloading E-house and Rail System Signalling Equipment (switches, two locations)
- Terminate cables (three off) in Rail Unloading E-house (other end terminations by TX003 and TR001).

g) Install 5 feeders to the Stockpile No 2 Conveyor / Ship Loader E-House (Appendix A70 A10) including:

- Install 5kV power cables between Power Generation E-Houses and Stockyard No2 Conveyor / Ship Loader E-house(s) (E-house(s) installed by CM001).
- Terminate cables at Power Generation (other end termination by CM001).
- Splice cables where required – route length of 600m with 500m reels supplied.

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- Install dual ground conductors between E-Houses.
- Supply and install grounding system accessories as required.

9.6.5.3 Area 4840 – Fuel Systems

Work Scope includes installation of new tanks within the existing bunded fuel storage area at Milne with associated piping modifications; relocation of the marine manifold building with associated modification of the marine pipeline and installation of a power generation refueling facility. The scope includes design, supply and installation of;

Process/Mechanical

a) TK-003 – 15,000,000 Litre Tank – Artic Diesel

b) TK-010 – 750,000 Litre Tank – Jet A-1 Fuel

c) TK-011 – 3,000,000 Litre Tank – Artic Diesel

Structural

a) All pipe and equipment supports

b) Tank Roof

c) Tank Roof vent

d) Tank Stairs

e) Marine Manifold and Building Relocation including existing nine precast concrete foundation blocks

f) Fuel Receiving Building

Electrical

a) Tank lighting

b) Tank electrical grounding

c) Electrical and control cabling, cable tray, conduits, junction boxes and mounting hardware

d) Systems and Process Control

e) Level gauge with remote display

f) Remote tank level display

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Piping

a) Internal tank draw down piping

b) Internal water draw off piping

c) All tank nozzles, openings, gauge hatches, manways and water drain valves

d) Modify piping inside the dyke to suit three new tanks

e) Relocate marine manifold building with a modified and extended marine pipeline

f) Piping system for genset re-fueling

9.6.5.4 Area 4850 – Communication and IT infrastructure

Appendix A65 indicates the areas where work is to be carried out and the sections below refer to the key points indicated on the sketch.

Data Network

Appendix A65 indicates the areas where work is to be carried out and the sections below refer to the key points indicated on the sketch.

a) Modify existing fibre optic cable to shiploader No.1 - Reference A1

- Prepare the Existing Fibre Optic Cable to run under the Yard Conveyor. This Cable will be re-routed under the culvert. Cut the cable, pull cable back and re-route the cable under the Culvert. Allow 20 metres of new cable to make up wastage during cut and splice actions. This will require the supply of 2 x 24 core fibre splice domes. Connect one dome at each end of the 20 meter cable extension. Re-Splice the cable after the re-routing has been completed. Test cable to ensure that there is minimal DB losses.

a) Provide two Fibre optic interface points for CM001 data and control network.

- Provision must be made to allow for redundancy of the Port Site fibre optic cable network interface with the BMH systems from CM001.
- Pull 2 new 24 core Fibre Optic cable from the Generation house Reference A4 to Reference Point A5 and from A4 to Reference Point A5. Install new splice trays and Patch panels to accommodate these two new routes. Provide sufficient patch leads to complete fibre optic terminations. Test and commission.

9.6.5.5 Area 4870 – Process Control System

The process control system for the Milne Port will consist of;

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a) An integrated control system for the new Bulk Materials Handling and Processing equipment supplied by CM001, from the train loading system though to Shiploader No. 2. Area control cabling and a central control room will be provided by CM001.

b) Separate PLC systems for existing and modified plant as per existing (modified to suit upgraded plant where applicable).

9.6.5.6 Area 4880 – Production Mobile Equipment

a) Supply of one (1) front end loader with bucket capacity of approximately 12tonne (CAT 988 or equivalent) for loading fine ore at the screening building.

b) Other production equipment required for the 12Mtpa operation is existing.

9.6.5.7 Area 4890 – Services Mobile Equipment

a) Supply of two used passenger busses (1 x 24 seats, 1 x 48 seats)

b) Supply of one (1) telehandler (Cat 1255D or equivalent)

9.6.6 Area 4900 – Port Ancillary Facilities

Area 4900 consists of the following sub-sections:

- Area 4910 – Port Buildings
- Area 4920 – Port Accommodation Area

Further details as to individual components that make up Area 4910 – Port Buildings are as follows:

9.6.7 Area 4910 – Port Buildings

9.6.8 Area 4920 – Port Accommodation Area

The permanent camp (PSC) at the port will be expanded by the addition of 90 additional rooms and facilities relocated from the Mine at Mary River (refer to WBS 1830). Refer to Appendix A78 for a preliminary camp layout.

9.7 Area 6000 – Construction Facilities

This area includes:

- Area 6110 Temporary Buildings (Office, Warehouse, Change House, Canteen etc.)
- Area 6120 - Construction Plants
- Area 6130 - Temporary Utilities (Power, Fuel, Air, Water, Sewage etc.).
- Area 6140 - Temporary Transportation Facilities
- Area 6150 - Weather Protection

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- Area 6160 - General Purpose Scaffolding, Cribbing and Dunnage
- Area 6170 – Temporary Construction (Fences, Signage, Barricades etc.)
- Area 6180 – Roads, Bays, Parking Areas and Laydown Area.

9.7.1 Area 6110 Temporary Buildings (Office, Warehouse, Change House, Canteen, etc.)

a) A fully fitted out 800-man construction camp will be bought, dismantled, transported and re-erected at the Mine site. The camp is an existing camp located near Fermont Labrador. The camp will be shipped through the consolidation hub at Valley Field. The camp is complete and includes.

- Single occupancy rooms with ensuite bathrooms
- Food preparation, kitchen and meal area for the camp
- Camp Laundry facilities (personal and housekeeping)
- Exercise room
- Change rooms
- Water treatment plant (sewage)
- Fire protection system
- Power Generation for camp and camp facilities.
- Waste Management facilities
- TV and Internet connections.

The camp will be of a hard walled and modular construction.

The camp will be built on a new pad located south of the Tote Road and proposed rail alignment and north west of the office and crushing facilities at the Mary River mine site. The location is shown Appendix 15..

An additional incinerator facility similar to those currently on site will be purchased and installed for waste disposal.

b) A new with a capacity to house 380 people will be installed at Milne Port. The camp includes for:

- Soft walled single occupancy rooms and common ablution and bathroom facilities shared, one per wing. The remaining camp construction elements will be hard walled.
- All fit out for rooms and facilities provided.

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- Food preparation, kitchen and meal area for the camp
- Camp Laundry facilities (personal and housekeeping)
- Exercise room
- Change Rooms
- Water treatment plant (sewage)
- Fire protection system
- Power Generation for camp and camp facilities.
- Waste Management facilities
- TV and Internet connections.

c) Relocation, installation and re-commissioning of the Steensby Camp (located at Milne). The camp will provide approximately 50 beds.

d) Operation of the camps, including servicing of water supply, sewage treatment, collection of air lifted consumables (food), power supply and waste disposal will be contracted to the Milne camp provider.

e) Existing Mine Site Construction offices will be refurbished and furnished for use by the EPCM team and support staff. The office is expected to house up to 16 personnel.

f) The existing Pit office at Mary River capable of housing 16 people will be relocated to Milne port for use by the EPCM construction team and support staff. The scope of this work includes:

(Refer to drawing Appendix A72) for building layout), including:

- Disconnect and make safe electrical services
- Remove and pack all internal furniture, partitions etc. for transport to Port
- Remove internal and external trim and flashing connecting modules
- Install temporary bracing to all modules for transport, seal modules for transport to prevent excessive dust and water ingress.
- Transport modules to Port Site
- Remove existing damaged roofing from all modules and install new rubber membrane roof on all modules completely replacing existing roofing
- Remove temporary bracing and install modules on new timber cribbing

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- Install flashing, seal roof joints, install internal trim, install partitions and furniture and establish office to original design.

g) An existing series of trailers “Port Construction Complex” will be relocated to co-exist with the relocated Mary River Pit Office.

Refer to sketch Appendix A72 for layout of primary building, complete complex consists of:

- Trailer 1: Lunchroom module as shown in Appendix A74.
- Trailer 2: Aerodrome office module as shown in Appendix A75
- Trailer 3: Atco office module similar size to other modules, no reference drawing.
- Car Wash Module as shown in A76 with external sewage tank in site constructed timber enclosure
- E-Room: 20’ shipping container fitted with electrical equipment generally as per sketch Appendix A77.

The work to make functional for the Project includes;

- Disconnect and make safe electrical services
- Remove and scrap site constructed timber roof, floor and walls interconnecting existing trailers 1, 2 & 3 (as per sketch Appendix A73)
- Relocate trailers 1, 2 & 3 to a position adjacent to the Port Site Construction Office and install on timber cribbing and provide safe access at all external doors.
- Relocate washcar to adjacent to Port Site Construction Office
- Dismantle, relocate and re-construct washcar sewage tank with enclosure at new washcar location
- Relocate e-room and connect electrical services to relocated modules / trailers

9.7.2 Area 6120 - Construction Plants

All construction plant required for the project will be provided by contractors engaged directly in the supply of materials, labour and equipment to construct the scope of the Project. Such facilities will be bought to site and then demobilized at the completion of each contractor’s mandate. Provision exists within construction contracts for BIM to exercise the right to buy out any construction plant bought to site. No provision exists within the capital cost estimate for such purchases.

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9.7.3 Area 6130 - Temporary Utilities (Power, Fuel, Air, Water, Sewage, etc.)

- Power – all power for construction work will be provided by contractors with BIM providing fuel on site. Power for temporary EPCM and camp facilities are supplied by infrastructure works defined in WBS 4800.
- Fuel - fuel storage for construction is described in WBS 4840.
- Air - compressed air required by contractors for construction will be provided by the contractor.
- Sewage Treatment – sewage treatment plants are provided within the scope of contracts TX001 and TX002. Sewage collection, treatment and disposal will be undertaken by contractor CC002. Permanent sewage piping modifications are described in WBS 4800.

9.7.4 Area 6140 - Temporary Transportation Facilities

Temporary transportation comprises two elements:

- Sight Vehicles
- Construction of temporary docks, and roads to receive and allow transport of heavy modules using Self Propelled Module Transporters (SPMT)

Site Vehicles

a) 25 Pick-up trucks will be purchased for Owner's Team, EPCM use.

b) Personnel transportation of contractor personnel on site is the responsibility of the contractor.

Temporary Dock and SPMT Road

a) A new rock fill temporary dock will be built west of the existing stockpiles to allow tie up of special purpose barges to allow offload of heavy modules and equipment by contractor CM001. A temporary barge dock may be incorporated into the rock fill dock as required by the contractor (CM001) for their offload (to be provided by contractor).

A typical ramp arrangement provided by Thyssen Krup is shown in Figure 9-13.

Figure 9-13: Temporary Ramp and SPMT Offload Structure

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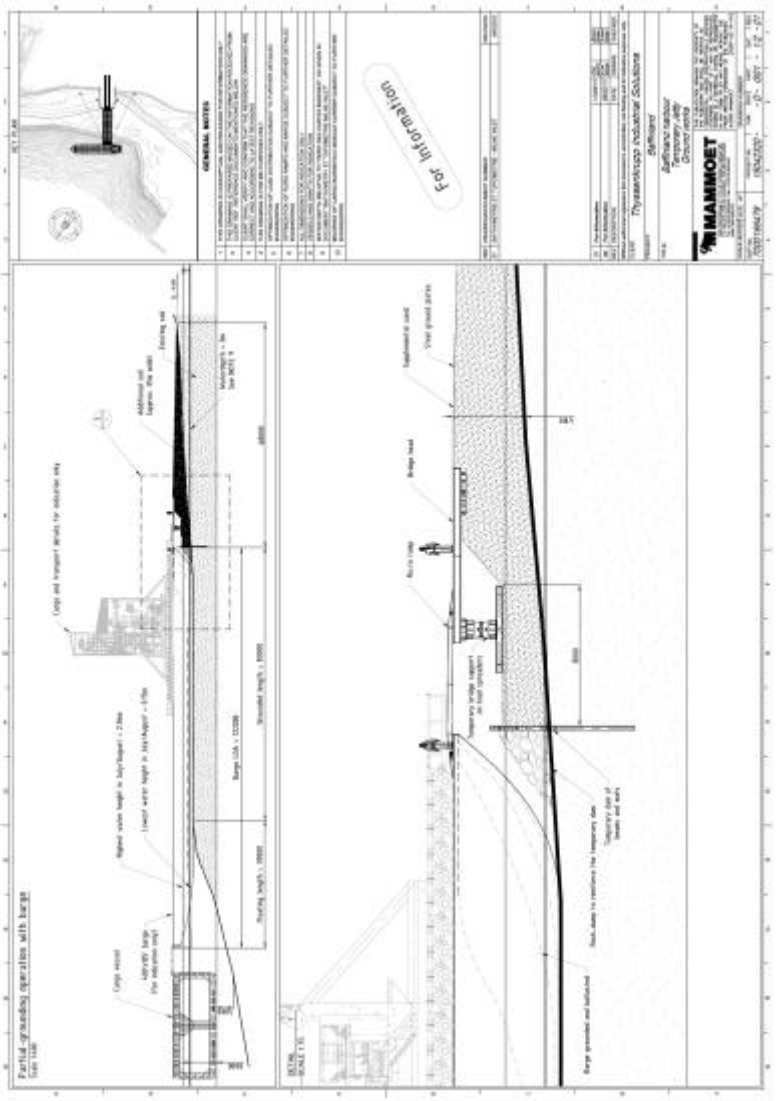

b) A rock fill road will be constructed with as crest width of 24m and graded to allow passage of SPMT machines between the temporary dock and the secondary crushing and screening area. The road is to allow for offload and transport of modules associated with:

- Car dumper module
- Crusher house module

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- Screen house module
- Stacker or Stacker reclaimer machines
- Miscellaneous other pre-assemblies and equipment transported directly to Milne by contractor CM001.

c) A separate road will be required to transport the dumper mechanical modules from the temporary construction dock to the rail alignment to allow the dumper module to be unloaded into the basement provided by CC002.

9.7.5 Area 6150 - Weather Protection

Provision of weather protection for all equipment and construction works rests with contractors mobilized to site.

9.7.6 Area 6160 - General Purpose Scaffolding, Cribbing and Dunnage

All scaffolding, cribbing and dunnage will be provided by contractors. No scope exists for supply of such materials as free issue to contractors.

9.7.7 Area 6170 – Temporary Construction (Fences, Signage, Barricades etc)

Supply and installation of temporary construction fences, barricades and signage is the responsibility of construction contractors mobilized to site.

9.7.8 Area 6180 – Roads, Bays, Parking Areas and Laydown Area

- **Roads, Bays, Parking Areas**

Laydown Area

Three laydown areas for contractor use will be developed.

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9.8 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-220-272-0005-0001	*Mine Site Block Plan Layout*	*0*	*30/3/2107*	*A - 1*
H353004-00000-220-272-0007-0001	Mine Site Construction Accommodation Earthworks Layout	0	13/13/2017	A - 2
H353004-00000-220-272-0014-0001	Mine Site 2017 Laydown Layout	0	13/12/2017	A - 3
H353004-CX001-244-248-0001 AP0F	Mine Effluent & Raw Water Sketch	N/A	N/A	A - 4
H353004-CX001-244-248-0001 AP0A	Mine Electrical Sketch	N/A	N/A	A - 5
H353004-CX001-244-248-0001 AP0C	Mine Fibre Optic Sketch	N/A	N/A	A - 6
H353004-10000-260-288-0001-0001	Power Distribution 4160V and 600V Distribution Single Line Diagram SHT 1 of 2	0	29/3/2017	A - 7
H353004-18000-220-272-0001-0001	Mine Site Mine Truck Workshop General Arrangement	0	14/2/2017	A - 8
H353004-41000-231-260-0002-0001	Mine Site Primary Crusher Feed Ramp Concrete Arrangement and Details	0	17/2/2017	A - 9
H353004-19000-231-260-0001-0001	Mine Site Primary Jaw Crusher Foundation Arrangement and Details	0	12/2/2017	A - 10
H353004-19000-231-260-0001-0003	Mine Site Primary Crusher Area Retaining Wall Details	0	17/2/2017	A - 11
H353004-00000-220-272-0008-0001	Mine Site Contractors Accommodation Layout	A	9/12/2016	A - 12
H354003-CM001-200-242-0001	*Specification – Scope of Works, Bulk Materials Handling and Processing*	*0*	*15/12/2016*	*A - 13*
H354003-00000-220-272-0001-0001	Port Site Block Plan Overall Layout	0	10/3/2017	A - 14

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H354004-29000-220-272-0001-0001	Milne Port Crusher Workshop General Arrangement	0	17/1/2017	A - 15
H353004-00000-224-272-0001-0001	Rail Site Plan and Longitudinal Section Ch 0.220km to Ch 37.000km	1	10/2/2017	A - 16
H353004-00000-224-272-0002-0001	Rail Site Plan and Longitudinal Section Ch 37.25 to Ch 74km	1	10/2/2017	A - 17
H353004-00000-224-272-0003-0001	Rail Site Plan and Longitudinal Section Ch 74.25 to Ch 109.611km	1	10/2/2017	A - 18
H353004-00000-224-262-0001-0001	Rail Site Diagrammatic Layout Milne Port to Mine Site	0	16/12/2016	A - 19
H353004-00000-224-272-0027-0001	Rail Site Line Plan and Longitudinal Section Ch 106.9km to 109.611km	0	10/2/2017	A - 20
H353004-00000-224-272-0004-0001	Rail Site Line Plan and Longitudinal Section Ch 0.160km to 4.800km	0	10/2/2017	A - 21
H353004-00000-224-272-0005-0001	Rail Site Line Plan and Longitudinal Section Ch 4.820km to 9.440km	0	10/2/2017	A - 22
H353004-00000-224-272-0006-0001	Rail Site Line Plan and Longitudinal Section Ch 9.46km to 14.080km	0	10/2/2017	A - 23
H353004-00000-224-272-0007-0001	Rail Site Line Plan and Longitudinal Section Ch 14.10km to 18.720km	0	10/2/2017	A - 24
H353004-00000-224-272-0008-0001	Rail Site Line Plan and Longitudinal Section Ch 18.74km to 23.360km	0	10/2/2017	A - 25

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H353004-00000-224-272-0009-0001	Rail Site Line Plan and Longitudinal Section Ch 23.380km to 28.000km	0	10/2/2017	A - 26
H353004-00000-224-272-0010-0001	Rail Site Line Plan and Longitudinal Section Ch 28.020km to 32.640km	0	10/2/2017	A - 27
H353004-00000-224-272-0011-0001	Rail Site Line Plan and Longitudinal Section Ch 32.660km to 37.280km	0	10/2/2017	A - 28
H353004-00000-224-272-0012-0001	Rail Site Line Plan and Longitudinal Section Ch 37.300km to 41.920km	0	10/2/2017	A - 29
H353004-00000-224-272-0013-0001	Rail Site Line Plan and Longitudinal Section Ch 41.940km to 46.560km	0	10/2/2017	A - 30
H353004-00000-224-272-0014-0001	Rail Site Line Plan and Longitudinal Section Ch 46.580km to 51.200km	0	10/2/2017	A - 31
H353004-00000-224-272-0015-0001	Rail Site Line Plan and Longitudinal Section Ch 51.220km to 55.840km	0	10/2/2017	A - 32
H353004-00000-224-272-0016-0001	Rail Site Line Plan and Longitudinal Section Ch 55.860km to 60.480km	0	10/2/2017	A - 33
H353004-00000-224-272-0017-0001	Rail Site Line Plan and Longitudinal Section Ch 60.500km to 65.120km	0	10/2/2017	A - 34
H353004-00000-224-272-0018-0001	Rail Site Line Plan and Longitudinal Section Ch 65.140km to 69.760km	0	10/2/2017	A - 35

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H353004-00000-224-272-0019-0001	Rail Site Line Plan and Longitudinal Section Ch 69.780km to 74.400km	0	10/2/2017	A - 36
H353004-00000-224-272-0020-0001	Rail Site Line Plan and Longitudinal Section Ch 74.420km to 79.040km	0	10/2/2017	A - 37
H353004-00000-224-272-0021-0001	Rail Site Line Plan and Longitudinal Section Ch 79.060km to 83.680km	0	10/2/2017	A - 38
H353004-00000-224-272-0022-0001	Rail Site Line Plan and Longitudinal Section Ch 83.700km to 88.320km	0	10/2/2017	A - 39
H353004-00000-224-272-0023-0001	Rail Site Line Plan and Longitudinal Section Ch 88.340km to 92.960km	0	10/2/2017	A - 40
H353004-00000-224-272-0024-0001	Rail Site Line Plan and Longitudinal Section Ch 92.980km to 97.600km	0	10/2/2017	A - 41
H353004-00000-224-272-0025-0001	Rail Site Line Plan and Longitudinal Section Ch 97.620km to 102.240km	0	10/2/2017	A - 42
H353004-00000-224-272-0026-0001	Rail Site Line Plan and Longitudinal Section Ch 102.240km to 106.880km	0	10/2/2017	A - 43
H353004-3330-230-270-0001-0001	Rail Site Bridge General Layout BR-15-1	0	14/12/2016	A - 44
H353004-3330-230-270-0002-0001	Rail Site Bridge General Layout BR-70-1	0	14/12/2016	A - 45
H353004-3330-230-270-0003-0001	Rail Site Bridge General Layout BR-86-1	0	14/12/2016	A - 46
H353004-3330-230-270-0004-0001	Rail Site Bridge General Layout BR-102-1	0	14/12/2016	A - 47

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H353004-TR001-224-248-0001	Specification – Scope of Works, Rail System	1	28/2/2017	A - 48
H353004-PR001-224-078-0001	Standard Specification, Locomotives	0	12/12/2016	A - 49
H353004-PR002-224-078-0001	Standard Specification, Railcars	0	12/12/2016	A - 50
H352034-2100-210-282-0001	Milne Port Ore Crushing and Screening Process Flow Diagram	I	14/10/2016	A - 51
H352034-2100-210-282-0002	Milne Port Ore Stockpiles and Shiploading Process Flow Diagram	I	14/10/2016	A - 52
H353004-00000-231-292-0001-0001	Port Site Rail Unloading System Concept Layout	0	15/12/2016	A - 53
H353004-00000-220-272-0018-0001	Port Site Rail Unloading System Section	B	14/12/2016	A - 54
H353004-00000-231-292-0003-0001	Port Site Rail Unloading Basement Concrete Arrangement	A	14/12/2016	A - 55
H353004-00000-231-292-0004-0001	Port Site Rail Unloading Basement Concrete Pre-Cast Beam Details	1	20/2/2017	A - 56
H353004-00000-220-272-0015-0001	Port Site Piling Location Overall Layout	0	14/12/2016	A - 57
H353004-00000-231-292-0002-0001	Port Site CM001 Contract Foundations Battery Limit Sketch	0	14/12/2016	A - 58
H352034-2100-240-290-0003	Baffinland Expansion 12 MTPA Mine Option Pre-Feasibility Study	B	15/09/2016	A - 59
H353004-00000-220-272-0010-0001	Port Site Ore Dock No. 2 Layout	0	14/12/2016	A - 60
H353004-00000-220-272-0019-0001	Port Site Ore Dock No. 2 Sections	0	14/12/2016	A - 61

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H353004-CG001-200-242-0033	Ore Dock Functional Specification	0	14/12/2016	A - 62
H353004-CG001-200-242-0030	Ore Dock Scope of Works	0	14/12/2016	A - 63
H353004-CX001-244-248-0001 AP0E	Port Effluent Pipe Sketch	N/A	N/A	A - 64
H353004-CX001-244-248-0001 AP0D	Port Fibre Optic Sketch	N/A	N/A	A - 65
E349000-PE001-50-042-0003	Baffinland Iron Mines Installation of Enclosures	0	24/6/2013	A - 66
H352034-2000-260-288-0001	Port Site Single Line Diagram, Sht. 1 of 2	E	24/10/2016	A - 67
H352034-2000-260-288-0002	Port Site Single Line Diagram, Sht. 2 of 2	E	24/10/2016	A - 68
H353004-40000-260-288-0001-0002	Port Site Power Distribution Overall Single Line Diagram	0	29/3/2017	A - 69
H353004-CX001-244-248-0001 AP0B	Port Electrical Sketch	N/A	N/A	A - 70
H353004-39000-220-272-0001-0001	Milne Port Rail Workshop General Arrangement	0	17/2/2017	A - 71
E349000-PX001-35-042-0018-001	Pit Office Complex Module 1 of 4, General Arrangement Plan of the Whole Building	3	20/3/2015	A - 72
H349000-2000-00-016-02	Port Site Construction Office	N/A	22/6/2014	A - 73
E349000-PX001-35-097-0001	12’x60’ Lunchroom, General Arrangement Plan	4	16/7/2013	A - 74
E349000-PX001-35-042-0010	12’x60’ Aerodrome Office, General Arrangement Plan	2	16/7/2013	A - 75
E349000-PX001-35-042-0014	12’x32’ Washcar, General Arrangement Plan	2	16/7/2013	A - 76
H349000-2000-70-016-0007	Ore Dock Office Service Entrance Distribution and Grounding	N/A	21/6/2014	A - 77
H353004-00000-240-292-0001	Milne Port, Port Site Complex (PSC) Expansion	C	21/12/2016	A - 78

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H353004-47000-240-272-0001-0001	Port Site Reclaim Conveyor Modification General Arrangement-Plan	0	29/3/2017	A - 79
H353004-47000-240-272-0002-0001	Port Site Reclaim Conveyor Modification General Arrangement-Plan and Elevation	0	29/3/2017	A - 80

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 10 – Business Systems

2017-05-01	0	Approved for Use	BIM	BIM	BIM	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**

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10. Executive Summary

BIM strives to implement and use the existing best in class business systems to ease and improve it operation.

10.1 Existing Business Systems

Currently BIM set up business systems and has been using these systems to operate, budget, maintain and forecast for the 4.2 Mtpa trucking operations.

10.2 Operations & Mining

10.2.1 Mine Planning

Currently the mine operation team uses “MineSight” software as the mine planning platform.

This is a software that allows mine planning team to use raw data from drillholes, blastholes and other sources to derive 2D & 3D models essential to mine design and planning.

The system allows for cut design and reserve calculations combined with scheduling, optimization, equipment planning, and haulage tools leading to a complete short-to-long-term planning schedules.

10.2.2 Operations Monitoring

PI system is used for operation monitoring with the assistance of other sub-systems example teletrac (fleet management system), Rival solution (road roughness), Factory Talk (OPC server for crushers), 920i Interchange (Rice Lake Scale Interface) feed into relevant information into the PI system which acts as data collector and visualization software.

Other systems used by operation for monitoring includes DeltaV distributed control system for generators, KepWare (OPC server for generator Scada).

See table 1 for current BIM systems and applications)

10.3 Finance and Accounting

The primary finance and accounting system is SAP. The SAP is a fully installed version including the project module.

10.3.1 Long Term Business Planning

Supporting collaborative decision-making across the business by integrating processes for sales, inventory, and operations with demand-driven business planning. By balancing demand with supply and maximizing product availability.

10.3.2 Financial Planning and Analysis

Functionality for financial planning and analysis in SAP software helps adjust plans and allocate resources to accommodate changes and align performance with strategy. The software provides the necessary means to define and cascade strategy, model cost drivers, improve financial forecasting, and report on and analyze massive amounts of transactional and operational data. With maximum cross-functional insight, managers can streamline

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budgeting processes, capture growth opportunities, short-circuit predicted variances against key performance indicators, and create a customized business flow to achieve the goals set. The end result is increased profitability and a closer match of tactics with organizational vision.

10.3.3 Accounting and Financial Close

Streamline the recording of accounting data for multiple companies, currencies, charts of accounts, reporting standards, and industry requirements with SAP software for accounting and financial close. Efficiently close books on time, and create financial statements at the entity and corporate levels for Financial Reporting Standards. Gain real-time financial insight based on a single source of truth of detailed information.

10.3.4 Treasury Management

SAP software enables cash, liquidity, and risk management as well as integrated financial reporting. Treasury managers can improve the management of every activity associated with cash, payments, liquidity, risk, and compliance. By simplifying working capital, risk management, and compliance, treasury managers can gain complete transparency into and control over interrelated activities and automate critical processes. They can also better understand the risks of those activities and how to mitigate them. Control over these complex demands enables treasury departments to ensure adequate liquidity to drive growth and innovation, while preventing exposure to the growing financial risks of the world market.

To increase Inuit content in the Project – support Sustainable Development department with training and community work ready programs, tours, recruitment campaigns and partnership with the Baffinland Community Liaison Officers in each community.

10.3.5 Governance, Risk and Compliance for Finance

Improve business performance and decrease the cost and effort of managing governance, risk, and compliance (GRC) processes with GRC solutions from SAP. Automate GRC processes using best practices and a scalable enterprise platform. By streamlining and automating processes, your organization can anticipate and manage risk events, reduce compliance violations, and extend GRC programs into value-adding business activities.

10.4 Procurement

10.4.1 Operational Purchasing

Solutions from SAP helps BIM to manage the procurement of direct material, indirect materials and services. By using functionality for self-service procurement, catalog management, plan-driven procurement, services procurement, and order collaboration, companies can effectively manage spending across the organization for all spend categories. Intuitive and familiar user interfaces for shopping cart and catalog streamlines the purchase of goods and services and improves user adoption. Furthermore, sourcing requirements from external sources, such as MRP, plant maintenance and project systems, can streamline source determination, increase operational efficiency, and improve compliance. Plan-driven procurement allows customers to bring more diverse spend under management for better

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contract compliance, increased cost savings, and better visibility for strategic sourcing - buyers can negotiate for and capture significant savings during sourcing and contract cycles. Once goods and services are acquired, integration with invoice management solutions further improves invoice processing and working capital management.

10.4.2 Supplier Management

Managing of external sourcing processes using cloud-based supplier management solutions from SAP that seamlessly integrate with your core business management application. Drive significant sourcing savings using a first-class supplier management platform and a global business network. Collaborate more efficiently with suppliers with our integrated, cloud-based solutions.

10.4.3 Invoice and Payables Management

Simplify processes for collecting and checking invoices, verifying them against preconfigured business rules, and handling exceptions with SAP solutions for invoice and payables management. Our software automates data extraction and streamlines invoice management, helping to eliminate data entry errors and duplicate invoices. You can record and manage accounts payable data, support standard payment methods, and adapt payment formats to country-specific rules and regulations.

10.4.4 Procurement Analytics

Improving BIM's position in the market and bottom line with procurement analytics solutions from SAP. With SAP software, you can:

- Obtain real-time insights into supplier spend, evaluations and scores, and contracts.
- Use embedded analytics in transactional processing.
- Monitor critical business situations through real-time key performance indicators.
- Spot gaps in suppliers' performance and act immediately to prevent the loss of business opportunities as well as drive customer loyalty.

10.5 Asset Operations and Maintenance

Many organizations struggle with excessive downtime, low return on assets, and wasted time and resources that drive up maintenance costs. Excessive downtime is often caused by ineffective maintenance procedures, inefficient information retrieval, unavailable parts, wrong spare parts in inventory, service delays, and maintenance service PO processing.

Overcoming these challenges requires having the right systems and processes in place. Asset operations and maintenance encompass a series of steps required to assure that an asset will retain, or be restored, to a state in which it can perform its designated function.

10.5.1 Asset Strategy and Performance

Analyze criticality of assets and optimize maintenance strategies. Improve reliability by using standard methodologies for lowering risks, maintenance cost, downtime, and energy consumption with asset strategy and performance solutions from SAP. Reduce bottlenecks

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and prevent recurrence of incidents. Hold consistent asset performance reviews, monitor asset performance, and optimize improvement plans across the asset lifecycle. Reduce outages and resolution time by updating asset strategy and performance from preventive to condition-based maintenance.

10.5.2 Maintenance Planning and Scheduling

Planning and scheduling of maintenance task planning, cost control, and budgeting. Maintenance organizations can use SAP software to plan work and find the right person who can use appropriate tools and resources to execute maintenance activities. Our software handles unplanned work requests and incomplete information, moving it to planned maintenance status. Maintenance organizations can measure planning by comparing planned hours versus booked hours on jobs. Maintenance staff gains a full view of asset status to mitigate breakdowns using our software, which integrates documentation for job execution and safety. The result? Companies can reduce maintenance costs, while synchronizing labor, material, equipment, and schedules.

10.5.3 Maintenance Execution

Optimal equipment reliability, repair reduction, and worker safety. Optimal asset maintenance involves proactive - preventive or condition-based - maintenance activities, which help minimize equipment breakdowns. SAP software supports maintenance planning, clear procedure development, visible resource availability, and access to relevant information. Staff can use our software to process integrated work clearances and work permits. On any device, remote workers can access, transfer, complete, and manage assigned work orders. Our software helps asset managers and staff increase equipment reliability and improve asset usage as well as safer maintenance processes.

10.6 Health and Safety

10.6.1 Environment, Health and Safety

Reduce environment, health, and safety risks to help ensure safety and business continuity. Organizations can mitigate environment, health, and safety risks by performing thorough risk assessments, measuring and reporting emissions, designing effective controls, and communicating safe work practices. Testing these controls, capturing incidents, and learning from events support intelligent change and continuous improvement.

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Applications/Software	Technology
1. SAP	1. Radio System
2. E-Mail (Exchange 2007)	2. Fuel Management System
3. PI system	3. Generator SCADA System
4. KPI system	4. Truck Weigh Scale System
5. SysAid	5. Lorex Camera System
6. FMS	6. point to point for network
7. Sharepoint	7. Wi-Fi system
8. VPN	8. Telecommunication
9. Firewall	9. Mitel Phone System
10. Software licensing (MS office, email, Firewall, SAP, etc..)	10. Network Infrastructure
11. Tape backups (Symantec backup exec)	11. Rruff system
12. Minitab	12. VIMS system
13. Antivirus (Symantec End Point)	13. IHL system
14. MS Office Suite	14. Microwave Communication
15. Rruf	15. Vincard
16. Jpro	16. BIM FTP
17. Intelex	17. SAP
18. VIMS	18. Active Directory
19. Solar Winds	19. Exchange
20. IHL	20. SQL
21. Kofax	21. Teletrac GPS
	22. PI system
	23. PLC Network
	24. Honeywell Camera System

Table 1

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 11 – Project Schedule

2017-05-01	0	Approved for Use	C.Anil/R.Fajardo	Biffi, Marie-Helene	Heiner, Sven	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
HATCH						

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Disclaimer

This report has been prepared by Hatch Ltd. ("Hatch") for the sole and exclusive benefit of Baffinland Iron Mines Corporation (the "Client") for the sole purpose of assisting the Client to identify potential options to increase production from the Mary River mine, and may not be provided to, used or relied upon by any other party for financing purposes without receipt of a copy of the attached waiver and release executed by such third party.

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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11. Project Schedule

The Basis of Schedule describes the parameters that were used to develop the schedule. It provides a common understanding for the planners to develop the schedule and the background for readers of the schedule to assist in its interpretation.

The project schedule has been aligned with the Work Breakdown Structure (WBS, refer to Section 12 of this report) and Project Execution Plan developed for the Expansion Project. The method used to develop the schedule integrates activities, relationships between activities, durations, calendars, and constraints. Primavera P6 Ver.8.2 has been used to prepare the Schedule.

The basis used for developing the project schedule is shown in Appendix A11-1

11.1 Project Background and Objective

11.1.1 General

Baffinland Iron Mines (BIM) has developed an open-pit iron ore mining operation at Mary River in northern Baffin Island, Nunavut Territory. Mining commenced in August 2014 and Baffinland shipped its first iron ore to European Markets in July 2015.

Product from the Mary River mine is high grade direct shipping iron ore, both lump (approximately 75% of product) and sinter fines (approximately 25% of product). Crushing and screening of the ore is carried out on site; no additional processing is required.

Ore produced from the mine is currently trucked approximately 100km to Baffinland's port facility at Milne Inlet. Mining, trucking and stockpiling of the ore occurs throughout the year. Ship loading and shipping of the product is only carried out during the 2-3 month open water season from late July to mid-October. Bulk resupply of fuel and consumables also occurs during the short open water season.

In 2015 Baffinland announced plans, and commenced activities to obtain permit approval, to expand production from the Mary River mine to 12Mtpa shipped through Milne Port.

The objective of the Expansion Project is to upgrade the existing facilities and equipment and the transport infrastructure from the Mine to the Port, to reduce unit operating costs and increase production to 12Mtpa.

11.2 Schedule Scope

11.2.1 Scope

The Execution Schedule has been developed for all engineering, procurement, logistics, construction, and commissioning aspects related to the Baffinland Expansion Project.

For detailed execution methodology refer to Project Execution Plan, H353004-00000-103-120-001.

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11.2.2 Exclusions

The schedule does not include any schedule risk mitigation measures or contingency, other than foreseeable risks such as productivity factors and seasonal restrictions such as weather conditions and sea freight availability.

11.3 Structure and Coding

The Execution Schedule has been developed based on the Work Breakdown Structure (WBS) and Execution Packages.

11.3.1 Structure

The schedule is structured to manage the whole lifecycle of the Project. Each major phase has been setup as a separate section within the overall schedule. These sections are:

- Milestones:
  - Primary.
  - Secondary.
- Permitting.
- Procurement:
  - Detailed Engineering.
  - Contracts.
  - Purchase Orders.
  - Bulk Materials Purchase.
  - Service Contracts.
- Logistics:
  - Sea Lift – Standard Freight.
- Construction:
  - Construction Contract Packages.
- Commissioning and Ramp Up:
  - Major Ore Handling Systems.

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11.4 Work Breakdown Structure (WBS)

The WBS is a logical division and sub-division of the work into a 4 level hierarchical manner. Within the WBS, the Project is divided into Areas, Facilities, and Sub-facilities or Systems.

Table 11-1: WBS at Level 1

WBS #	Description
1000	Mine
2000	Iron Ore Process Plant and Onsite Infrastructure
3000	Railway
4000	Port
5000	Other Offsite Infrastructure
6000	Construction Facilities and Support
7000	Implementation Contractor's Services
8000	Owner's Cost
9000	Contingency / Escalation / Risk

Please see Work Breakdown Structure (refer to Section 12 of this report) for full details of the WBS structure.

11.5 Level of Detail

The schedule has been developed to a Level 3 detail at packaged level. Some critical items have been broken down to further detail due to relationships and dependencies.

All critical and early procurement packages have been identified in the schedule and tied to corresponding engineering, fabrication, and construction activities.

All construction activities have been associated to an installation contract.

For reporting purposes, the schedule can be summarized either by WBS Tree or by using the defined Activity Codes in P6 library such as Construction Execution Package.

11.6 Calendars

Activity durations are based on the following calendars:

Calendar 1	5 day work week including statutory holidays – 8 hour day	Default for Engineering, Procurement, Vendor Engineering, fabrication, assembly and modularization.
Calendar 2	Construction 7 day work week (no breaks) – 12 hour day	Default for delivery, construction, and commissioning.

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11.7 Schedule Development Basis

11.7.1 General

The schedule is constrained by the key dates defined in the business case, which establishes:

- Railway Commissioned and Operating December 2019.
- Ship loaders No. 2 Available to Load Ore August 2020
- All dates in the schedule are early dates; early start and early finish.

11.7.2 Permitting

Permitting dates incorporated into the schedule are as follows:

Milestone	Date
Receive Project Certificate	30-Oct-2018
Revised Land Lease	31-Oct-2018
DFO Authorization – ore dock construction	01-Jan-2019
DFO Authorization – new water crossings	01-Jan-2019
Transport Canada & CTA rail construction approvals	28-Feb-2019

11.7.3 Engineering

The Engineering schedule has been developed to meet procurement requirements for technical specifications that lead directly into bid, award and fabrication lead times, which in turn, tie into sealift shipping windows to meet construction start dates.

- Standard duration for previously existing systems and construction services is 1 month (20 days) for specifications that require revision.
- Standard duration for new equipment specifications and systems is 2 months (40 days).
- Most of the Engineering is included under contractor scope of work.
- EPCM Engineering time frames are included in the schedule for each contract package
- EPCM Engineering completion target is end of 2017.
- Commence detailed engineering to support Early Procurement November 2016.

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11.7.4 Procurement and Fabrication

Procurement schedule has been developed with the following priorities

- To deliver materials, equipment and services to site to meet construction start dates.
- To obtain vendor information necessary for the completion of engineering design.
- Lead times are based on a combination of firm and budgetary quotes.
- Package award dates scheduled to meet shipping seasons to support construction .
- Following Recommendation to Award (RTA), BIM has 2 days for Commitment Approval and 1 day to sign Letter of Award.
- Assumes that Geotechnical information is available by end of April for Ore Dock bid package.
- The current fabrication, pre-assembly and delivery durations are based on a combination of vendor budget quotes, firm quotes and historical data.

The following tables list the critical scheduled contract and P.O. award dates:

Table 11-2: Contract Package Award and Mobilization Dates

Contract	Description	Award	Mobilize to Site
CC001	Early Earthworks	Feb-17 (A)	Mar-17 (A)
CC002	Earthworks North	5-May-17	2017 Sea Lift
CC003	Earthworks South	12-May-17	2017/18 Sea Lifts
CG001	Ore Dock–Stage 1 (Piling)	5-Jun-17	2017 Sea Lift
	Ore Dock–Stage 2 (Balance)	18-Aug-17	2018 Sea Lift
CM001	Ore Processing–Stage 1 (Engineering)	21-Apr-17 (A)	N/A
	Ore Processing–Stage 2 (Balance)	15-May-17	2018/19 Sea Lifts
CX001	Wrap Around MEIP	7-Jul-17	2017/18 Sea Lifts
TM001	Fuel Storage and Distribution	31-Mar-17 (A)	2017 Sea Lift
TR001	Rail System-Stage 1 (Tie Testing & Selection)	25-May-17	N/A
	Rail System-Stage 2 (Supply and Install)	31-Aug-17	2018 Sea Lift

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Contract	Description	Award	Mobilize to Site
TX001	Construction Camp	31-Mar-17 (A)	2017 Sea Lift
TX002	Permanent Accommodation Camps	13-Apr-17 (A)	2017 Sea Lift

Table 11-3: Supply Package Award, Lead Time and Delivery Dates

Package	Description	Award	Lead Time (*)	Sea Lift
PR001	Locomotives	26-May-17	66 weeks	2018
PR002	Ore Wagons	26-May-17	55 weeks	2018
PM100	Mobile Equipment – Mine Production	14-Jul-17	54 weeks	2018
PM007	Jaw Crusher Upgrades	22-Sep-17	32 weeks	2018
PE002	Power Generation	22-Dec-17	28 weeks	2018
PC001	Pre-Cast Concrete	14-Apr-17	22 weeks	2017
PM201	EPCM Vehicles	26-May-17	13 weeks	2017
BE001	Power Distribution Cable	28-Apr-17	12 weeks	2017/18
PM200	Mobile Equipment	12-Jan-18	12 weeks	2018
PE001	E-Houses	13-Apr-17	11 weeks	2017

11.7.5 Logistics

Material deliveries are all scheduled during the annual shipping windows meaning that some equipment and materials will need to be shipped as much as 9 months prior to when it is needed for installation.

Freight Delivery to Consolidation Hub June 1 to August 31.

Sealift Access to Milne Port August 1 to October 05. (Possible access window is July 25 to October 15, but for the purpose of the PFS level planning the window has been restricted.)

2017 Key Deliveries:

- Port and Mine Site Construction Camps and Sewage Treatment Plants.
- Fuel Storage Tanks:
  - 15 ML tank components.

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- Jet A tank (pre-assembled) and x 3 ML tank (2 pieces to site).

- Construction Buildings and Facilities.
- Pre-Cast Concrete.
- Contractor Equipment:
  - Construction Camp Installation Contractor.
  - Earthworks Contractors.
  - Piling Contractor.
  - Site Services Contractor.

2018 Key Deliveries:

- Specialty Freight (Heavy Lift Vessels).
  - Stacker.
  - Pre-assembled Rail Car Dumper.
  - Crushing Plant Module.
  - Screening Plant Modules.
  - Yard Conveyors, Transfer Towers, Drive Houses.
- Ore Dock Installation Contractor plus Equipment/Materials/Sheet Piling.
- Railway Panels.
- Power Generators.
- Bridges.
- Buildings.
- Pre-Cast Concrete.
- Mine Production Heavy Equipment.
- Rolling Stock.
- Contractor Equipment:
  - Materials Handling Installation Contractors.
  - Railway Installation Contractor.
  - Buildings Installation Contractor.
  - Wrap Around MEIP Contractor.

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2019 Key Deliveries:

- Specialty Freight (Heavy Lift Vessels):
  - Ship loader.
  - Reclaimer.

11.7.6 Construction

Construction schedule bases and assumptions are as follows:

- Construction schedule is based on 7 days/week, 12 hours/day calendar.
- Christmas shutdown for 2 weeks for non-critical activities.
- No allowance for weather days or other risks.
- All freight for first shipments to site must be delivered to the Canadian Consolidation Hub (CCH) by July 1 of each year.
- First shipment arrives on site August 1st of each year.
- Freight deliveries are dispersed throughout open water season with the final shipment arriving October 1 of each year.
- CM001 Package
  - Schedule generally based on details provided by ThyssenKrupp.
  - Lead time for rotary car dumper equipment delivery is 60 weeks per advice from Sandvik.
  - Assumed design revised to locate No.2 Yard Conveyor Drive House (and Surge Hopper, if possible) above high water mark to allow piling to be completed earlier.
- TX003 Package - Based on schedule provided by Bird Construction.
- PM007 Package
  - Schedule allows for additional time to repair/refurbish jaw crusher units in conjunction with relocation.
  - 4 weeks allocated in the schedule vs. 2 weeks specified by Masaba for basic relocation and modification without any repair/refurbishment.
- TR001 Package
  - Production Rates are based on 800 meters/day.
  - Schedule is NOT based on current bid received.
  - Ballast to be supplied and delivered to laydown areas in advance *(Ballast consumption by TR001 is three times faster than what CC002 can produce per day).*

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- Mobilise to site in 2018 sealift and ship all material and equipment to site.
- Commence welding of rail into 500m lengths to prepare for track laying starting 1 March 2019.
- Need to construct rail arrival and departure yard to a large extent except around dumper, so as to allow construction trains to operate.

- CC002 and CC003 Packages
  - Schedule is based on work through winter, although current bids received have all made adjustments to their working schedule. Any changes will be adjusted after final negotiation.
  - Work can only start after accommodation is available at the Port and the Mine.
  - Work can only start on the permitted areas.
  - Bridge construction is impacted by the revised DFO permit date. The 3 bridges that are impacted are now scheduled for construction in the winter months, between Jan 2019 and April 2019. The bridge at KM86 not impacted by the revised DFO date will commence November 2018.
  - Culvert construction is not subject to DFO Authorization.
  - Will require three teams to work simultaneously on the permit dependant work for this area to pull schedule back.
- TX001 Package
  - Based on revised schedule submitted by Horizon north including progressive handover of rooms.
  - Assumes all utilities related to sewer, water and power will commissioned within these timeframes.
  - Contractor will provide all the beds required for their workforce.
- TX002 Package
  - Based on key milestones given to contractors.
  - Core facilities + 500 beds available for occupancy by December 1st, 2017.
  - Remaining 300 beds turned over at a rate of 100 beds per month thereafter.
  - Assumes 60 beds can be given to the contractor for their construction workforce.
  - Assumes all utilities related to sewer, water and power will be commissioned within these timeframes.

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- On-Site construction labour requirements have been minimized by maximizing pre-assembly and pre-casting opportunities as much as possible at off-site module fabrication yards and suppliers.
- Early Earthworks contractor will utilize existing on site equipment and bed space.
- 15 ML, 3 ML and 750kl Jet. A fuel tank installation to occur during 2017 open water and be filled in same season – storage capacity needed for construction fuel.
- Port and Mine Site Construction camps will be first to site in 2017 sealift to allow for expedited installation as these are critical to mobilizing major earthworks contractors.
- Ship loader 2A will be off-loaded, installed and wet commissioned before the end of the 2019 shipping season.
- The following activities must completed in summer:
  - Reclaim berms earthworks construction (compaction).
  - Rail track welding (spring and fall).
- The following activities must be completed while the river and earthworks are still in a frozen estate with sub-zero temperature:
  - Rail Car Dumper Deep Excavation
  - Rail Car Dumper Backfill
  - Rail Alignment Deep Excavations
  - Bridge Installation (ice access)
  - Heavy and wide load movement to the mine site
- The following materials and equipment will be backhaul offsite:
  - All Contractor Equipment and Support Facilities used during construction.
  - All additional support structures used to stabilize pre-assembled modules during transportation.
  - All decommissioned and unused portions of the existing crusher spreads.
  - All decommissioned and unused Ore Haul Trucks (B-Trains).
  - All decommissioned and unused materials handling equipment (feeders, conveyors, etc.).
  - All temporary camp facilities including both currently existing camps and new camps brought to site for construction.

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Key production rates:

- Rail embankment earthworks – 6000 to 8,000 m^3 of placed material per 24 hour day (double shift operations).
- Infrastructure Earthworks – 3,000 to 3,500 m^3 of placed material per 24 hour day (double shift operations).
- Rail panel placement applicable to TR001 – average 775 meters per day.

11.7.7 Commissioning and Ramp Up

Commissioning follows construction completion, including pre-operational testing. The sequence of the commissioning activities are as follows:

- Crushing and Screening plants commissioned as independent system apart from rail unloading station and yard conveying and stacking system.
- Port yard conveying stacking system commissioned after crushing and screening, but independently of reclaiming and Ship loading aspects of the equipment.
- Rail Ore Unloading station to be commissioned with complete rail system.
- Rolling Stock to be pre-assembled and pre-commissioned to the fullest extent possible.
- Feed conveyor from ore unloading station to screening plant to be commissioned with ore unloading system after crushing and screening system.
- Ship loaders will be wet commissioned by October 2019.
- Mine Production equipment to be pre-assembled and pre-commissioned to the fullest extent possible while still allowing for equipment to be transported from Port Site to Mine Site.

11.8 Schedule Outcome

The level 1 summary schedule for the Project is shown in Table 11-1.

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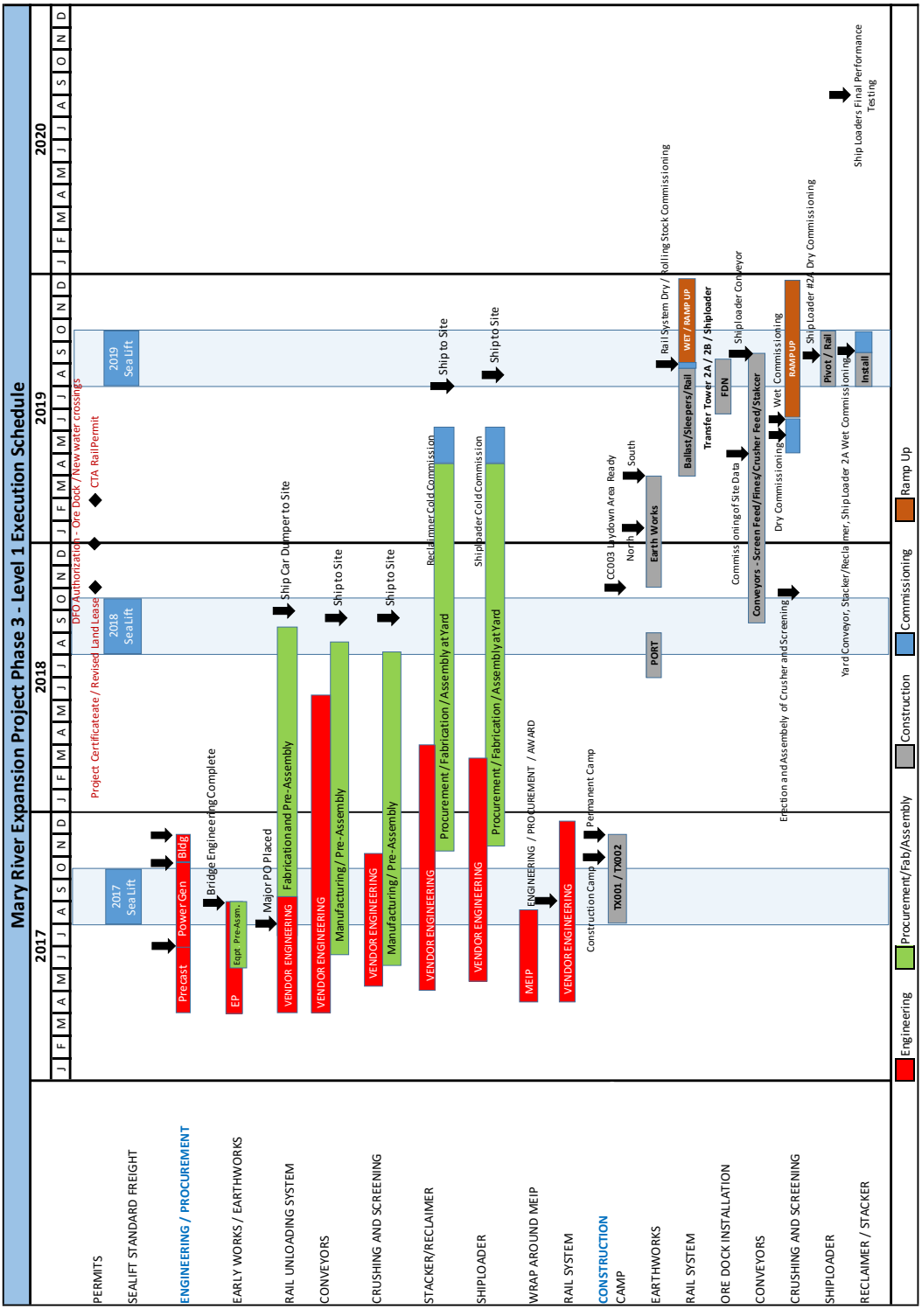

Figure 11-1: Level 1 Summary Schedule

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Level 1 to Level 3 project schedules may be found in Appendices A11-2 to A11-4.

11.8.1 Key Dates

The list of Milestones for the Expansion Project is as follows:

Milestones	
Primary Milestones	
First Ore Crushed, Screened, and Stacked	23-May-19
First Ore on Train	25-Aug-19
First Ore on Ship	27-Sep-19
12 MTPA Production Rate Achieved	30-Nov-19
Final Performance Test Complete	13-Sep-20
Secondary Milestones (Construction Completion)	
Crushing and Screening	8-May-19
Rail System	9-Aug-19
Yard Conveyor, Stacker/Reclaimer	13-Aug-19
Ore Dock	25-Jun-19
Ship loader 2A	12-Sep-19
Ship loader 2B	24-Oct-19
Mine Site Ore Handling	30-Nov-19
Permitting	
Receive Project Certificate	30-Oct-18*
Revised Land Lease	31-Oct-18*
DFO Authorization - ore dock construction	01-Jan-19*
DFO Authorization - New water crossings o/s exist permits	01-Jan-19*
Transport Canada and CTA Rail Construction Approvals	28-Feb-19*

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11.8.2 Critical Path

The critical path is defined as the sequence of activities that must be completed on schedule for the entire project to be completed on schedule. This is normally the longest duration path through the schedule. The Critical Path will change as the project evolves and activities are completed ahead or behind schedule.

The critical and near critical paths of this expansion project are mostly constrained by the open water delivery windows.

Level 1 to Level 3 critical path project schedules may be found in Appendices A11-5 to A11-7.

Below are the critical activities related to each windows:

- 2017
  - CC001 Completion of Early Earthworks to begin installation of camps in August to provide beds to start earthworks program.
  - TX001 Award and Completion of Construction Camps.
  - TX002 Award and Completion of Construction Camp
  - CC002 Contract Award & Mobilization to CCH
  - CC003 Contract Award & Mobilization to CCH
  - CM001 Contract Award, Vendor Engineering
  - CX001 Contract Award & Mobilization to CCH
  - TM001 Contract Award, Engineering, Fabrication & Delivery to CCH
  - TX001 Contract Award & Delivery to CCH
  - PC001 PO Award, Engineering, Manufacturing & Delivery to CCH
- 2018
  - CC003 Bridge Engineering, Fabrication and Delivery to CCH
  - CM001 Contract Award, Engineering, Manufacturing and Delivery of;
    - Car Dumper
    - Conveyors
    - Screening and Crushing Building
  - PE002 PO Award, Engineering, Manufacturing and Delivery to CCH
  - PM001 PO Award, Engineering, Manufacturing and Delivery to CCH
  - PR001 PO Award, Engineering, Manufacturing and Delivery to CCH

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- CC002 Rail Earthworks

- 2019
  - CC003 Bridge Construction
  - CG001 Causeway, Yard Conveyor, Ship Loader and Transfer Tower foundations
  - CM001 Installation of Conveyors
  - CM001 Delivery and installation of Reclaimer and Ship loader
  - PM007 Decommissioning, Relocate and Modify Jaw Crushers No. 2&3
  - TR001 Rail System
  - CX001 Installation of Rail Office Building and Power Generation and Distribution
- Commissioning of:
  - Crushing and Screening
  - Railway
  - Port Stockpile Stacker/Reclaimer
  - Ship Loader No. 2A

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11.8.3 Manpower Planning

An assessment of the manpower on site during construction has been made which is driven by information contained in submitted bid submissions and awarded contracts.

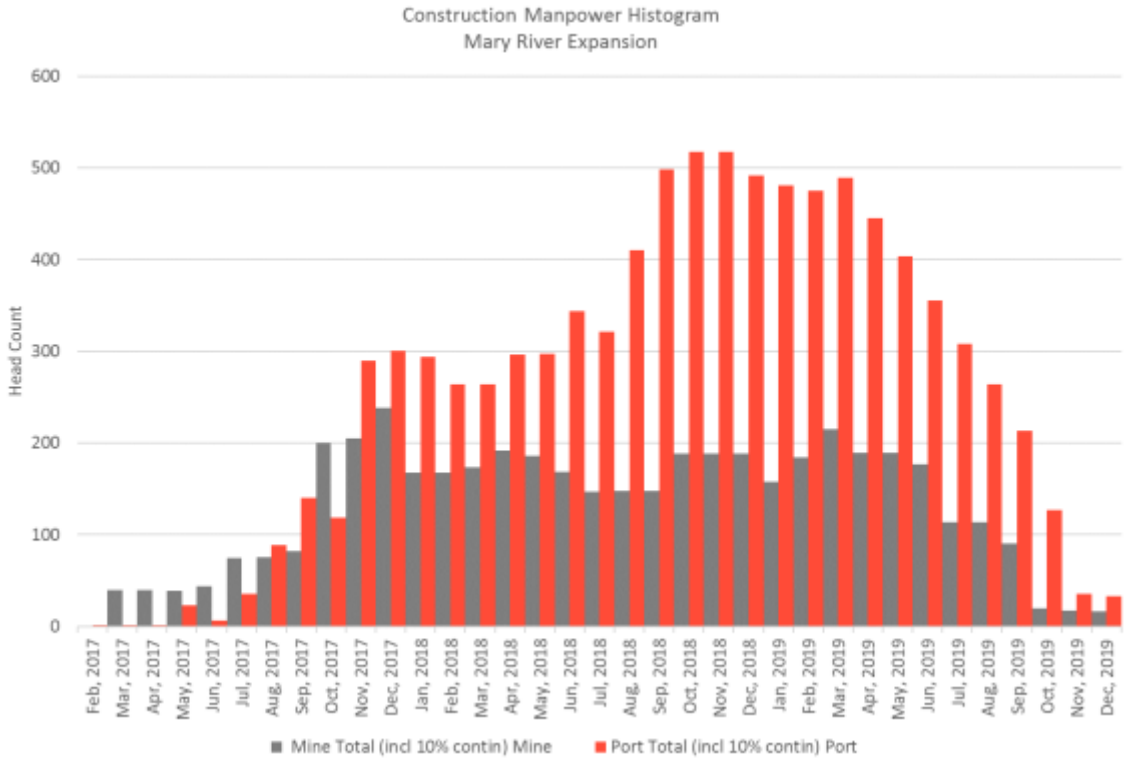

Figure 11-2: Construction Workforce Requirements (Appendix A11-9)

The figure shows workforce peaks aligning with the annual seal lift. To provide accommodation for this work force, camps will be established per:

- Mine – an 800 man camp will be built to house operations and construction workforces.
- Port – a 380 man camp will be constructed during the 2017 sea lift, supplemented by relocating 90 rooms (from the existing MSC camp) from Mine to Port.

When the proposed camp size is reconciled against expected construction work force size, insufficient port camp space is currently forecast. Excess camp capacity at the Mine (the 800 man camp has been purchased but not installed) suggests the shortfall in rooms forecast for 2018 at Milne may be accommodated by diverting 90 of the excess mine rooms for installation at Milne Port. Figures Figure 11-3 and Figure 11-4 have already been updated to reflect 90 rooms moving from Mine to Port.

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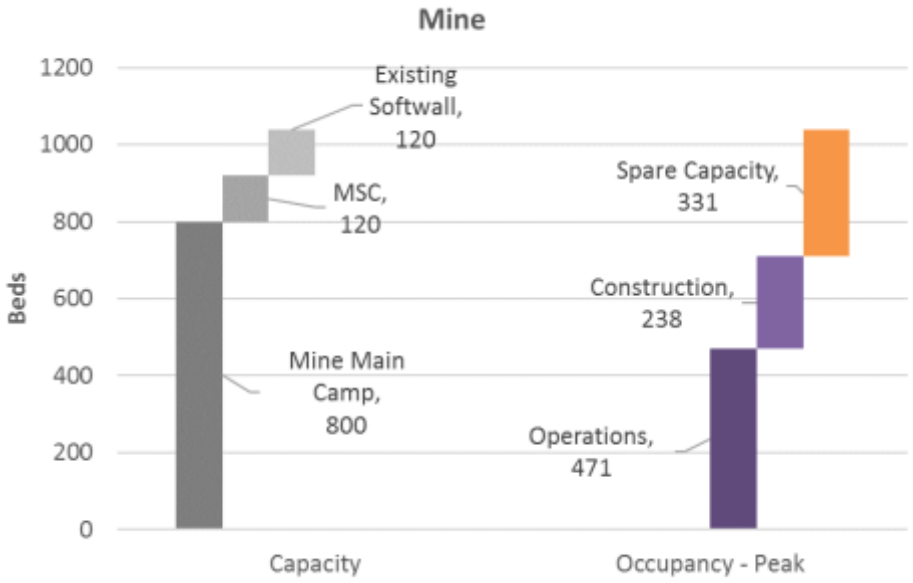

Figure 11-3: Mine Camp Capacity and Usage

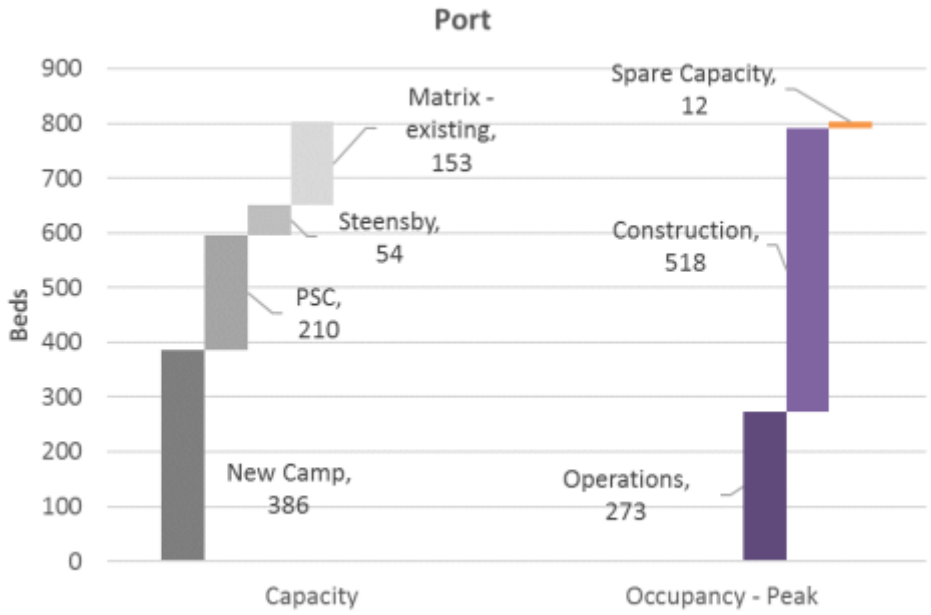

Figure 11-4: Port Camp Capacity and Usage

11.8.4 Execution Schedule Challenges and Concerns

- The following packages are critical to meet 2017 see lift dates;

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- CC002 Award and Mobilization to CCH in 2017
- CC003 Award and Mobilization to CCH in 2017
- CX001 Award and Mobilization to CCH in 2017
- TM001 Award, Vendor Engineering, Fab & Delivery to CCH in 2017
- TX001 Award, Supply and Delivery to CCH in 2017
- PC001 Award, Vendor Engineering, Manufacture and Delivery to CCH in 2017
- BE001 Award, Manufacture and Delivery to CCH in 2017
- PE001 Award, Manufacture and Delivery to CCH in 2017
- ZL001 Award, Sea Lift Standard Freight
- YH002 Award of EPCM services for execution

- Design and Manufacture of rail unloading basement precast concrete is critical/late for 2017 sea lift;
  - Interface and loads need to be confirmed for CM001
  - Engineering design completed
  - Precast concrete detailed and manufactured by vendor
  - And delivered to CCH – the earliest delivery is September 19, 2017
  - Bridge Construction is driven by revised DFO Authorization for new water crossing – 01 January 2019. This will require all four bridges to be constructed at the same time to ensure winter construction (four crews required)
- CTA Approval obtained 28 February 2019 which will allow track construction to commence. It leaves less than six months to complete the construction.
- Must commence with welding of rail into 500m lengths in summer/fall of 2018 with all equipment and material to site in 2018 sealift (will this be possible?).
- The followings are critical to achieve first ore on ship in 2019.
  - Causeway construction (starts date limited by ocean ice)
  - Piling for conveyors and ship loaders
  - Installation of conveyors and ship loader pivot
- Due to the above limitation, it may only be possible to start loading with one ship loader at the end of 2019 shipping season.

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11.9 Cash Flow Projections

Cash flows have been established to identify:

- Commitments
- Invoice Incurred cash flows
- Paid cash flows.

Detailed calculations are contained in Appendix A 11-8. A summary cash flow curve is presented in Figure 11-5.

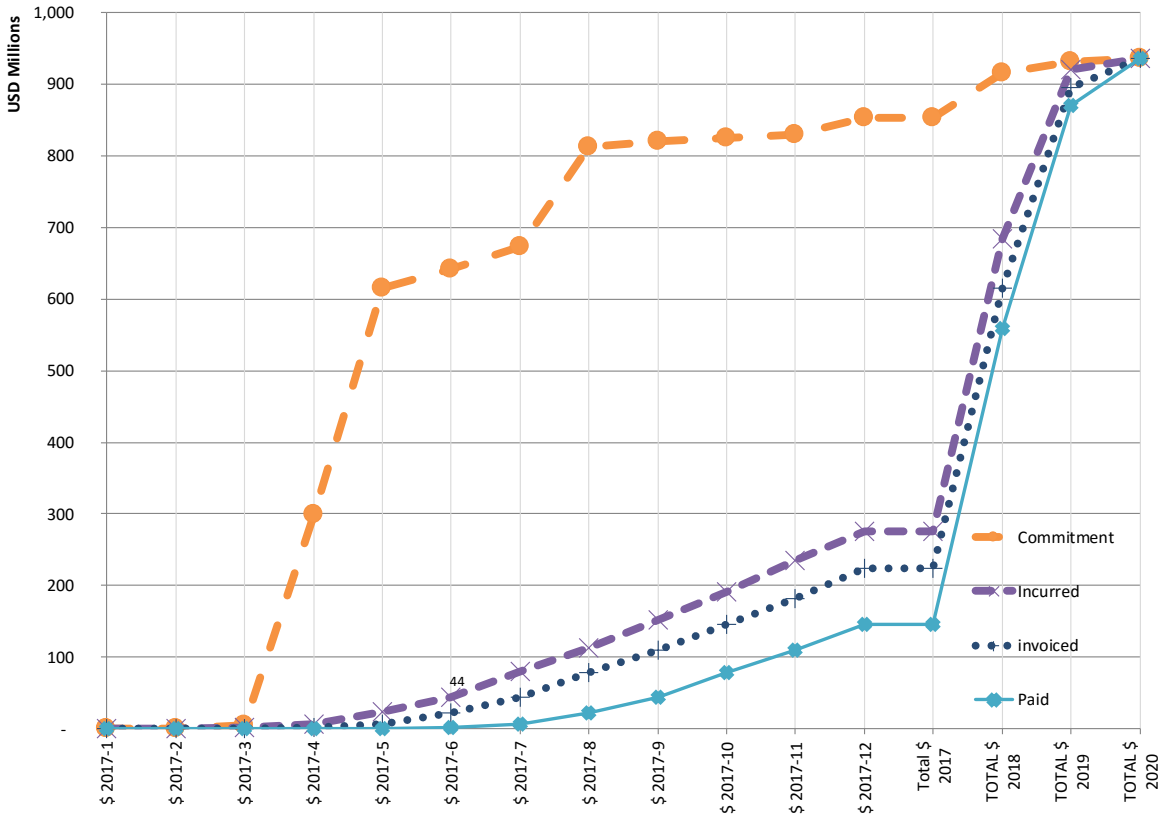

Figure 11-5: Project Capital Cash Flows

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11.10 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-610-610-0001	Basis of Schedule	A	2017-04-19	A11-1
H353004-00000-103-120-0002-AP0E2	P6 Level 1 Schedule	A	2017-04-18	A11-2
H353004-00000-103-120-0002-AP0E3	P6 Level 2 Schedule	A	2017-04-18	A11-3
H353004-00000-103-120-0002-AP0E4	P6 Level 3 Schedule	A	2017-04-18	A11-4
H353004-00000-103-120-0002-AP0E5	P6 Level 1 Critical Path	A	2017-04-18	A11-5
H353004-00000-103-120-0002-AP0E6	P6 Level 2 Critical Path	A	2017-04-18	A11-6
H353004-00000-103-120-0002-AP0E7	P6 Level 3 Critical Path	A	2017-04-18	A11-7
H353004-00000-620-076-0001	Detailed Cost Profiles		14/4/2017	A11-8
H353004-00000-610-076-0002	Construction Manpower – Calculation			A11-9

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 12 – Capital Costs

2017-05-01	0	Approved for Use	R. Villeneuve	A. Brathwaite	N. Mason	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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12. Executive Summary

This section outlines the estimate basis for the Definitive Study – Stage III capital cost estimate (CAPEX). This section is to be read in conjunction with the complete study report in preparation for onsite execution of additional facilities, rail, equipment and the transport infrastructure from the Mine to the Port.

A complete Basis of Estimate can be found in Appendix A12-1 of this document.

12.1 Capital Cost Estimate Summary Level 1

The total installed cost summary for the Definitive Study – Stage III is included in 12.1. The estimate meets the requirements of an AACE Class 3 capital cost estimate.

Table 12-1: Total Installed Cost (TIC) by WBS and Cost Type (USD Millions)

	Equipment	Material	Labour	Freight	Sub-Contract	Total	% of TIC
1000 - Mine	17.8	1.2	1.3	0.0	23.1	43.4	5%
2000 - Iron Ore Process Plant And Onsite Infrastructure	31.9	1.5	0.1	0.0	6.2	39.7	4%
3000 - Rail	30.9	0.0	0.3	0.3	251.3	282.8	30%
4000 - Port	79.1	13.7	65.7	0.1	95.2	253.8	27%
5000 - Other Off Site Infrastructure	0.0	0.0	0.0	0.0	0.0	0	0%
Direct	**159.7**	**16.4**	**67.4**	**0.4**	**375.8**	**619.7**	**66%**
6000 - Construction Facilities And Support	4.4	4.1	5.0	80.7	105.4	199.6	21%
7000 - Implementation Contractor's Services	0.2	0.0	3.5	0.0	43.8	47.5	5%
Indirect	**4.6**	**4.1**	**8.5**	**80.7**	**149.2**	**247.1**	**26%**
8000 - Owner's Cost	0.0				**29.6**	**29.6**	**3%**
9000 - Contingency / Escalation / Risk	0.0				**40.3**	**40.3**	**4%**
Total	**164.3**	**20.5**	**75.9**	**81.1**	**594.9**	**936.7**	**100%**

A copy of the detailed estimate can be found as Appendix A of the final Basis of Estimate, which is Appendix A12.1 of this Section.

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12.2 Capital Cost Estimate Summary by Package

The following table outlines the capital value of packages sorted by highest value.

Table 12-2: Total Installed Cost (TIC) by Package

Package	Feasibility Total
CM001 - Bulk Materials Handling & Processing	$ 228,295,587
CC002 - Earthworks North	$ 109,585,963
CC003 - Earthworks South	$ 109,566,643
TR001 - Rail System	$ 107,370,507
YH002 - EPCM Services Execution	$ 40,109,474
CG001 - Ore Dock	$ 37,724,550
ZF001 - Fuel Supply	$ 30,033,985
TX001 - Const. Accommodation Camp and Services	$ 29,773,064
ZL001 - Sea Lift Standard Freight	$ 26,698,650
PR001 - Locomotives	$ 18,600,417
PM100 - Mobile Equipment-Mine Production	$ 17,545,775
PR002 - Ore Wagons	$ 13,749,904
TX003 - Workshops	$ 12,723,348
TX002 - Permanent Accommodation Camp	$ 12,214,800
ZX004 - Air Services Passenger	$ 10,904,723
CX001 - Wrap Around MEIP	$ 10,786,271
ZX005 - Air Services Freight	$ 8,116,529
ZX009 - Air Services - Passenger from regional airports to Mirabel	$ 6,695,668
TM001 - Fuel Storage	$ 5,252,968
CC001 - Early Earthworks	$ 5,229,654
PE002 - Power Generation	$ 4,935,000
ZL004 - Consolidation Hub	$ 4,417,307
ZG001 - Site Survey	$ 3,734,148
ZX992 - Capital Spares	$ 3,564,376
YH003 - EPCM Office Supplies and Consumables	$ 2,514,833
PC001 - Pre-Cast Concrete	$ 2,216,004
BE001 - Power Cables	$ 1,714,883
ZX006 - Communications and Data Services	$ 1,331,391
YE999 - Third Part Vendor and Pre-Assembly Yard QA-QC	$ 1,152,000
PM201 - EPCM Trucks	$ 1,076,220
PM200 - Mobile Equipment-Other	$ 894,127
PM007 - Jaw Crusher Upgrade	$ 823,614
ZX011 - Transport of HME from Milne Port	$ 591,441

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YH001 - EPCM Services-Early Works	$	381,421
ZX010 - Early Works Camp Cost	$	341,346
PE001 - Power Distribution E-Houses	$	233,275

12.3 Estimate Parameters

- The capital estimate is compliant with both the Estimating Plan, as well as the Capital Cost Estimating Guidelines Document as provided by BIM. The estimate meets the requirements of an AACE Class 3 capital cost estimate.
- Estimate was assembled in Source Currency, and is reported in USD Dollars.
- Forex rates provided by BIM as outlined in Section 12.4.
- All dimensions and commodities were measured in metric units.
- An estimate base date of Q2 2017.
- All applicable taxes are included in the estimate, except for value added taxes.

12.3 Purpose

This section describes the estimating guidelines and basis used to compile the estimate and inputs into the Definitive Study Estimate for the Mary River Expansion Study – Stage III. The estimate has been compiled utilizing information from the project team, the client, suppliers, contractors, and sub consultants. The practices and procedures outlined in this document were used to create a consistent understanding of:

- Estimate Definitions and Structure.
- Estimate Assumptions.
- Methodology used to produce the estimate.
- The deliverables required to support the estimate.

12.4 Foreign Exchange

The estimate is based on foreign exchange rates as supplied by BIM is summarized in Table 12-3.

Table 12-3: Foreign Exchange Rates Applied to the Estimate

Currency Code	Origin	Conversion Rate	Inverse Rate
USD	United States Dollar	1	1
CAD	Canada Dollar	0.7355	1.36
EUR	European Euro	1.0867	0.92

The foreign currency exposure for the estimate are broken down as follows:

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Table 12-4: Foreign Currency Cost Exposure

Currency Code	Currency	Total (USD Millions)	% of TIC
USD	United States Dollar	144.21	15%
CAD	Canada Dollar	724.08	77%
EUR	European Euro	68.55	7%
TOTAL		**936.84**	**100%**

It is assumed that TR001 although estimated in USD will be awarded in CAD. As most of the costs will be in CAD it is assumed that contingency will be in CAD as well.

12.5 Basis of Capital Cost Estimate

12.5.1 Estimate Terminology

The capital cost estimate consists of four major cost groupings; Direct Costs, Indirect Costs, Contingency and Owner's costs. The overall estimate is based on FS level project definition. Each of these cost grouping are summarized in the sub-sections which follow.

12.5.2 Direct Costs

Direct costs include the cost of all equipment and materials, together with construction and installation costs for all permanent facilities. This includes:

- Supply, assembly and installation of equipment.
- Supply, fabrication and installation of bulk materials.
- Supplemental resources for equipment and bulk material installation, such as labour and, consumables.
- General construction plant and equipment.
- Construction distributable cost such as contractor Indirects.
- Further details are provided in Section 12.6 of this Section.

12.5.3 Indirect Costs

Indirect costs include items that are necessary for the completion of the project, but are not directly related to the direct construction costs. Further details are provided in Section 10.

12.5.4 Owner's Costs

The Owner's Cost estimate covers the period from approval to proceed with project execution, through to project handover to the operations group and close out. Further details are provided in Section 12.23.

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12.5.5 Contingency and Other Provisions

Contingency included in the capital cost estimate is an allowance for normal and expected items of work which have to be performed within the defined scope of work covered by the estimate, but which could not be explicitly foreseen or described at the time the estimate was prepared. Further details are provided in Section 21 of the report.

12.6 Direct Cost Basis

Direct costs are generally quantity based and include all of the permanent equipment, materials and labour associated with the physical construction of the permanent process facility.

This section describes the methodology for estimating the direct costs. The direct cost is summarized in Table 12-5 below.

Table 12-5: Direct Cost Summary by WBS Level 2

Description	WBS	USD Millions	% of Direct Cost	% of TIC
Mine	**1000**	**43**	**7%**	**5%**
Site Development	1500	4.5	1%	0%
Services & Utilities	1600	1.4	0%	0%
Mobile Equipment	1700	10.1	2%	1%
Mine Ancillary Facilities	1800	17.1	3%	2%
Mine Materials Handling	1900	10.3	2%	1%
Iron Ore Process Plant And Onsite Infrastructure	**2000**	**40**	**6%**	**4%**
Process Plant	2300	36.3	6%	4%
Utilities & Onsite Infrastructure	2800	0.7	0%	0%
Process Ancillary Facilities	2900	2.8	0%	0%
Rail	**3000**	**283**	**46%**	**30%**
Terminals / Yards	3100	35.7	6%	4%
Mainline CN 2.80 km to 90.00 km	3200	152.8	25%	16%
Mainline Ch 90.00 km to CH 106.00 km	3300	33.4	5%	4%
Sidings	3400	2.9	0%	0%
Bridges	3500	21.0	3%	2%
Locomotives & Rolling Stock	3600	29.7	5%	3%
Services & Utilities	3700	0.0	0%	0%
Rail Ancillary Facilities	3900	7.1	1%	1%
Port	**4000**	**254**	**41%**	**27%**
Port terminal	4100	80.6	13%	9%

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Description	WBS	USD Millions	% of Direct Cost	% of TIC
Ore Handling	4200	62.2	10%	7%
Wharf & Marine Structures	4600	34.2	6%	4%
Loadout	4700	44.3	7%	5%
Utilities & On-site Infrastructure	4800	32.6	5%	3%
Port Ancillary Facilities	4900	0.0	0%	0%
Total Direct Costs		**620**	**100%**	**66%**

12.7 Formal Procurement Bid Process

In supporting the intended level of accuracy for the feasibility study, the Procurement Team solicited bid pricing as per the Procurement Package Register (PPR), ensuring alignment in both technical compliance with the scope, as well as commercial compliance with the anticipated terms and conditions of the project.

The procurement team adjudicated and analyzed the bids for recommendations and inclusion into the capital estimate identifying the cost recommendation, including cost additions that may have aligned for scope adjustments, additional costs required associated with identified gaps and exclusions, including appropriate cost growth as applied.

The bid recommendation identified the preferred choice based on the preliminary evaluation completed, and were ready for further negotiation and award by BIM.

Detailed basis of assumptions for all bid packages received can be found in the final Basis of Estimate, which is Appendix 12.1 of this Section.

The following table outlines the packages that received market solicitation that were supported by market price solicitation, and the anticipated commercial model at execution.

Table 12-6: Package Estimated Values

Package	Type	Total Package Cost USD
BE001 - Power Cables	Lump Sum	$ 1,714,883
CC001 - Early Earthworks	T&M	$ 5,229,654
CC002 - Earthworks North	Fixed Unit Rate	$ 109,585,963
CC003 - Earthworks South	Fixed Unit Rate	$ 109,566,643
CG001 - Ore Dock	Fixed Unit Rate	$ 37,724,550
CM001 - Bulk Materials Handling & Processing	Lump Sum	$ 228,295,587
CX001 - Wrap Around MEIP	Other	$ 10,786,271
PC001 - Pre-Cast Concrete	Fixed Unit Rate	$ 2,216,004
PE001 - Power Distribution E-Houses	Lump Sum	$ 233,275
PE002 - Power Generation	Lump Sum	$ 4,935,000

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Package	Type	Total Package Cost USD
PM007 - Jaw Crusher Upgrade	Lump Sum	$ 823,614
PM100 - Mobile Equipment-Mine Production	Lump Sum	$ 17,545,775
PM200 – Mobile Equipment-Other	Other	$ 894,127
PM201 – EPCM Trucks	Other	$ 1,076,220
PR001 - Locomotives	Lump Sum	$ 18,600,417
PR002 - Ore Wagons	Lump Sum	$ 13,749,904
TM001 - Fuel Storage	Lump Sum	$ 5,252,968
TR001 - Rail System	Other	$ 107,370,507
TX001 – Const. Accommodation Camp and Services	Fixed Unit Rate	$ 29,773,064
TX002 - Permanent Accommodation Camp	Lump Sum	$ 12,214,800
TX003 - Workshops	Other	$ 12,723,348
YE999 - Third Part Vendor and Pre-Assembly Yard QA-QC	Other	$ 1,152,000
YH001 - EPCM Services-Early Works	Unit Rate	$ 381,421
YH002 – EPCM Services Execution	Unit Rate	$ 40,109,474
YH003 – EPCM Office Supplies and Consumables	T&M	$ 2,514,833
ZF001 - Fuel Supply	Fixed Unit Rate	$ 30,033,985
ZG001 - Site Survey	Fixed Unit Rate	$ 3,734,148
ZL001 - Sea Lift Standard Freight	Fixed Unit Rate	$ 26,698,650
ZL004 - Consolidation Hub	Fixed Unit Rate	$ 4,417,307
ZX004 - Air Services Passenger	Fixed Unit Rate	$ 10,904,723
ZX005 - Air Services Freight	Fixed Unit Rate	$ 8,116,529
ZX006 - Communications and Data Services	Fixed Unit Rate	$ 1,331,391
ZX009 - Air Services - Passenger from regional airports to Mirabel	Fixed Unit Rate	$ 6,695,668
ZX010 - Early Works Camp Cost	Fixed Unit Rate	$ 341,346
ZX011 - Transport of HME from Milne Port	Other	$ 591,441
ZX992 - Capital Spares	Other	$ 3,564,376
Total		**$ 870,899,866**

The following tables outlines the mix of cost types used to assemble the cost estimate.

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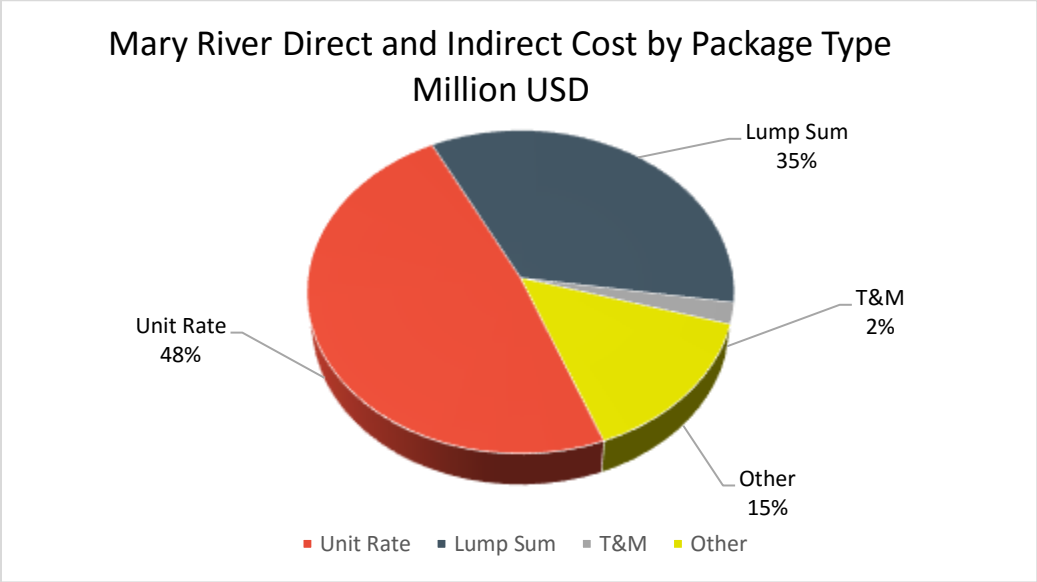
Table 12-7:Package Type Mix in CAPEX

Package Type	Direct and Indirect USD (M)	% of Direct
Fixed Unit Rate	$ 422	48%
Lump Sum	$ 303	35%
T&M	$ 19	2%
Other	$ 127	15%
Total	**$ 871**	**100%**

Figure 12-1: Pricing Mix for Estimate



12.8 Bottoms Up Estimating - Engineering Development

Contract CX001 captures the wrap around work required to integrate the major contracts comprising the Project. The brownfield nature of this package necessitated a bottoms up estimating methodology be applied to this package. The sections that follow outlines the process taken to develop the cost estimate for contract CX001.

The following outlines the strategy in capturing the Material Take Offs (MTOs) for package CX001 (MEIP) and any identified gaps between the remaining packages in ensuring a complete scope within the estimate.

All equipment pricing (mechanical, electrical, instrumentation and piping) was reviewed to ensure the following criteria were addressed, and taken into consideration where necessary:

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The following table outlines the Package Strategy that supported first principle estimating for CX001.

Table 12-8: Basis of Estimate

Commodity	Basis of MTOs
Civil	• Earthwork requirements were quantified based on G/A drawings. • Costs were estimated utilizing civil unit rates (CC002 & CC003) for equipment usage. Manual labour costs were estimated by evaluating required labour hours multiplied by labour rate and productivity.
Mechanical	• For minor equipment, prices were obtained from budget quotations, or from the current Hatch database and/or factored pricing based on historical data. • Installation costs for the identified equipment was captured from the Estimating Team's Standard Man-hour Manual or extracted from historical information.
Electrical	• HV/LV distribution was based on Single Line Diagrams and MTOs from plant layout and cable schedules. • Equipment list for all field devices. • Estimated costs for major electrical equipment were based on budget quotations derived from vendors using project specific specifications and data sheets, and/or factored pricing based on historical data from the Hatch database. • For minor equipment prices were obtained from budget quotations, or pricing based on historical data from the Hatch database, and adjusted as required for project and area-specific requirements. • Installation unit rates were estimated from first principles. • Major cabling and trays were identified as MTOs and costed from the recent electrical cost database from North America.
Instrumentation	• MTOs from Instrument list and based on P&ID's, layouts, specifications, data sheets and cable schedules. • Unit costs for instruments include all wrap around costs such as stands, cables, tubing etc., and were priced from recent in-house data from recent projects. • Automated valves costing supported from budgetary quotations or in-house historical data. • Allowances were inserted for secondary requirements by area. • Installation unit rates based on Hatch database, and adjusted to reflect project and area specific requirements.

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Commodity	Basis of MTOs
	• Factored costs where data and information may not be available.
Piping	• Lengths of pipe >6 inch diameter were taken off layout drawings. • MTOs for valve count and length of runs only. • Complexities of lines were identified. An allowance for each identified complexity will include for all fittings, bolt-ups, gaskets, etc. • Recently quoted budget unit prices for piping material and valves based on preliminary specifications. Installation unit rates were based on Estimating Team database adjusted to reflect project and area specific requirements.

12.9 Cost Growth, Design Growth and Waste Allowances

12.9.1 Cost Growth

A cost growth allowance when required, was an amount added the packages received to account for the level of accuracy of the budgetary quotes and/or bids received, or the expected increase in costs where uncertainties are identified through the review process.

The evaluation and application of cost growth was done on a case by case basis during the package review process.

Any Cost Growth applied to the bid packages are documented within the Basis of Estimate (ref. Appendix A12-1, Appendix A).

12.10 Design Growth

Experience tells us that there is a gap between what is known and identified during the estimating process and what is expected during the execution or construction phase.

Material take-off growth allowances are intended to capture the anticipated design growth from Feasibility Study to final design from the neat quantities developed by the engineering disciplines.

Any Design Growth applied to the bid packages are documented within the Basis of Estimate (ref Appendix A12-1, Appendix A).

12.11 Installation Costs

12.11.1 Labour Hours, Rates and Productivity

In recognizing that a significant amount of the capital cost values were captured through the firm bid market solicitation process, and that any ancillary work identified through the MTOs will be of minimal capital value, it was intended that the required labour rate assumptions identified for this work be estimated in consideration of historical rates, and adjusted for project specific requirements.

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The final labour rate assumptions are aligned with historical site labour rates, and escalated at 2% per annum.

The following table outlines the final labour rates assumed in the estimate for CX001:

Table 12-9: Labour Rates

Trade Code	Trade	All In Rate (4x2)
C	Concrete	$ 140.33
F	Architectural	$ 150.50
G	Marine Works	$ 134.76
L	Electrical	$ 165.25
M	Mechanical	$ 160.35
N	Platework & Tanks	$ 162.10
P	Pipework & Fittings	$ 160.90
S	Structural Steel	$ 160.84
W	Wire & Cable	$ 163.76
X	Site Services Crew	$ 128.31

Installation base man-hours were based on North American and in-house databases for similar projects. Labour man-hours were then adjusted by a productivity multiplier to take into account project specific requirements.

The base labour productivity factor took into account issues that affect labour hours regardless of the environment where the work is being completed. This productivity looked at the break walk times, tool box meetings, clean up, etc.

In alignment with historical information, the following outlines the labour productivity assumption associated with package CX001.

Table 12-10: Productivity Rates

Contractor Location	Productivity Factor (PF)
US Gulf Coast	1
Southern Ontario (labour pool)	1.3
Extended Shift Productivity Impact	1.3
Site Location Impact (10%-30%)	1.8 to 2.2
Selected Site Productivity	**1.8**

12.12 Contractor Indirect Costs

Contractor's indirect costs are execution costs which are related to the contractor's costs of executing the project on site, but which cannot easily be allocated to any particular part or are

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not part of the permanent works. For the purposes of these capital cost estimates, these costs are made of multiple resource types and are effectively direct costs, and will include the following:

- Contractor's mobilization and demobilization, including establishment and later removal and making good, of site offices, storage and other construction facilities, plant and equipment.
- Contractor's site supervision.
- QA/QC.
- Site Support Personnel.
- Contractor vehicles, cell phones.
- Contractor's financing costs, insurances and bonds.
- Contractor's profit and overheads.
- Site office operations.
- Contractor's manual indirect and non-productive labour, including time spent in inductions, training, toolbox meetings, clean-ups, bus drivers, crane and truck operators and storemen.
- Major scaffolding, safety equipment, fire watch, personal protection equipment.
- Special construction equipment and special temporary works.
- Trade permits, fees and testing.
- For the purpose of this estimate, contractor indirects for package CX001 were factored at 15 % of TIC.

12.13 Major and Heavy Lift Cranes

Major and heavy-lift cranes, are scope-specific and captured as part of the firm bid contract pricing related to said scope.

All general crane usage up to 90 tonne is allocated within the site service agreement packages (CC002/CC003), and will be provided on a "as-required" basis to all contractors.

12.14 Site Service Agreement

In recognizing common scope requirements that cross all anticipated Construction Contract Packages as identified, a site service scope and agreement package was captured and estimated separately in order to ensure all gaps and required scope are captured and costed accordingly. These costs were provided as part of the bids received for CC002/CC003

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12.15 Freight

For any freight requirements not covered as part of the bid packages, additional costs for freight were identified and estimated.

The following outlines the identified freight costs.

Table 12-11: Freight Costs

Freight Type	Freight Cost (USD Millions)
Contractor Freight	41.3
ZL001 - Sea Lift Standard Freight	26.7
ZL004 - Consolidation Hub	4.4
ZX005 - Air Services Freight	8.1
ZX011 - Transport of HME from Milne Port	0.6
Total	**81.1**

12.16 Indirect Costs

Indirect costs include items that are necessary for the completion of the project, but are not directly related to the direct construction costs.

These cost as detailed in the section below were generated by the project management and engineering team with input from estimating & construction.

The following table outlines the cost summary of Project Indirects

Table 12-12: Indirect Cost Summary by WBS

Description	WBS	USD Millions	% of Indirect Cost	% of TIC
Construction Facilities And Support	**6000**	**200**	**63%**	**21%**
Construction Facilities	6100	4.9	2%	1%
Construction Support	6200	36.6	12%	4%
Construction Equipment, Tools And Supplies	6300	31.1	10%	3%
Material Transportation to Site (if not included in the direct costs)	6400	80.8	25%	9%
Project Accommodation	6700	46.2	15%	5%
Implementation Contractor's Services	**7000**	**48**	**15%**	**5%**
EPCM - Labour & Expenses	7100	47.5	15%	5%
Owner's Cost	**8000**	**30**	**9%**	**3%**
Owner's Cost During Implementation Phase	8100	29.6	9%	3%
Contingency / Escalation / Risk	**9000**	**40**	**13%**	**4%**

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Contingency / Escalation / Risk	9100	40.29	13%	4%
Total Indirects, Owner's Cost, Contingency		**317**	**100%**	**34%**

12.17 Implementation Contractor (EPCM)

The cost for the implementation contractor were based on the Hatch bottoms-up services bid submitted mid-March 2017.

12.18 Temporary Construction Facilities and Services

Temporary offices, sheds, furniture; connection, reticulation and consumption of power, sewage and water; staff, communications, first aid, site security, catering, construction camp, site vehicles, parking and lay-down areas were identified and quantified according to the requirements of the construction and manning schedules.

The capital cost estimate include the calculated costs of establishment and later removal (as required) of the site compound, support facilities and services, and the operating costs of these facilities and utilities during the construction phase and the required commissioning period.

12.19 First Fills and Oils

First fills and oils typically include for the following:

- Oils, lubricants and fluids.
- Specific reagents (if required).

For the purpose of this estimate, requirements for first fills and oils are captured under the received bid packages.

12.20 Spares

Major requirements and costs associated with spares were captured as part of the bid solicitation. The Capital Spares value from the PFS was included in the FS as an allowance.

Operation spares are excluded from the estimate as they are assumed to be covered by site operations.

12.21 Third Party Services and Consulting

An allowance was inserted into the estimate for additional requirements of Third Party Services and Pre-assembly Yard QA/QC not covered under the received bid packages.

12.22 Vendor’s Representatives

Vendor representative requirements to supervise the installation of equipment or to conduct a checkout of the equipment prior to start-up and associated costs were captured as part of the bid solicitation for major equipment, or as part of the bid packages received.

12.23 Owner’s Costs

Estimate of Owner’s Cost were derived and provided by BIM, and issued to the Hatch team for insertion into the final estimate.

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12.24 Quarry Royalties

The quarry royalties costs are captured as part of Owner's Costs and were calculated using:

- Total earthworks borrow source quantities required for all project areas.
- Quarry royalties rate of CAD 2.50/m3 assuming a new rate is negotiated by Baffinland as per client direction received during the previous Option Study.

12.25 Operational Readiness

Costs for Operational Readiness were based on a first principle estimate evaluating the anticipated staffing, procedures, manuals, and training required to prepare the site for maintenance and operational strategies. These costs are captured under the project Owner's Costs.

For a detailed breakdown of assumptions, please refer to Section 23 of this report.

12.26 Quantitative Risk Analysis

12.26.1 Introduction

A Quantitative Risk Analysis (QRA) was completed to determine Capital and Schedule Risk Profiles for the project. The resulting levels of accuracy were influenced by the level of engineering completed to support the study, and by the inputs provided to the estimate.

The QRA assessed the level of cost performance variability in the project to establish an appropriate level of contingency to be applied/carried to the cost estimates at the stage of the project development that are congruent with the risk appetite provided as P75.

12.26.2 Results

The following table outlines the results of the ranging exercise and indicates that to achieve a 75% probability of underrun, a contingency level of 4.49% is required.

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Table 12-13: QRA Results

@ Risk Summary Page				**Notes:**	Iterations
Capital Risk					5,000
PROJECT:	**Mary River Mine Expansion**			**PREP**	**Camelia Bucur**
					4/26/2017 17:02
CLIENT:	**BIM**				
DESCRIPTION		**Estimate**	**Risk Mean**	**Contingency @ Mean $**	**Contingency @ Mean %**
Estimate Labour		$ 72,512,726	$ 71,126,699	$ (1,386,027)	-1.9%
Estimate Direct Non-Labour		$ 624,505,546	$ 620,187,949	$ (4,317,597)	-0.7%
Estimate Indirect		$ 199,528,570	$ 189,507,611	$ (10,020,959)	-5.0%
Total Risk Profile		**$ 896,546,842**	**$880,822,259**	**$ (15,724,583)**	**-1.75%**
		Risk Value	**Contingency $**	**Contingency %**	
	P30	$835,148,833	($61,398,009)	-6.85%	
	P40	$857,918,312	($38,628,530)	-4.31%	
	P50	$879,027,581	($17,519,261)	-1.95%	
	P60	$902,890,161	$6,343,319	0.71%	
	P70	$925,467,108	$28,920,266	3.23%	
	P75	$936,837,568	$40,290,726	4.49%	
		P10	**P90**		
Estimate Accuracy for 80% CI		**-11.6%**	**12.2%**		
		P5	**P95**		
Estimate Accuracy for 90% CI		**-14.3%**	**15.6%**		

12.26.3 Level of Accuracy

The level of accuracy of the estimate is reported below and is comparable to the ArcelorMittal Guidelines of +10%/-15%.

- +12.2%/
- -11.6%

12.27 Escalation

The base cost estimate is expressed in terms of value at a stated base date of Q2, 2017, with no escalation beyond that date.

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12.28 Estimate Reviews

12.28.1 Estimate Assembly Reviews

Once all internal and peer reviews were completed, a management review of the estimate was completed.

To ensure consistency of the information transfer and overall estimate assembly, the following checkpoints and estimate reviews were performed prior to the final issuance of the Capital Estimate.

Table 12-14: Estimate Reviews

Review	Responsibility	Checklist
Discipline Review	Discipline Leads	Completeness, Accuracy
Engineering Review	Engineering Manager	Battery limits, Duplications, Gaps
Interdisciplinary Review	Discipline Leads, Engineering Manager	Transfer of information, Battery limits, Duplications, Gaps
Management Team Review	Estimating Lead, Project Management Team	Completeness, Accuracy, Battery limits, Duplications, Gaps, Indirects
Hatch Peer Review	Project Management Team	Complete Estimate Review
Client Review	Project Management Team	Estimate Presentation and Review

12.29 Estimate Clarifications

The following costs are not included in the capital cost estimate, and are identified as exclusions:

- Value added taxes.
- 800 man camp shipping and costs in excess of $12.2M USD by Operations
- Cost of iron ore to fill the base of lump stock pile.
- Demolition of camps
- Further permit delays
- Development costs (sunk costs)
- Operating spares
- Forward escalation, forex variation
- Schedule delays and/or associated costs, such as those caused by:

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- Unexpected site conditions.
- Unidentified ground conditions.
- Labour disputes.
- Force majeure.
- Permit applications.
- Weather delays not included as part of the bid packages

- Development fees and approval costs.
- Cost of any disruption to normal operations.
- Foreign currency changes from project exchange rates.
- Forward Escalation.
- Environmental bonding costs.

12.30 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H3533004-00000-621-610-0003	Basis of Capital Estimate	0		A12-1

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 13 – Human Resources

2017-05-01	0	Approved for Use	BIM	BIM	BIM	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**

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13. Human Resources

13.1 Project Team Resourcing and Support

The purpose of this section is to outline the review criteria and detailed process to be completed to hire the correct person profile according to the project needs identified on the Project Staffing Plan, and/or approved Organizational Chart.

13.2 Human Resources Objectives

1. Compensation – plan to remain market competitive through industry benchmarking and a positive employee relations environment by effective management of compensation, benefits and incentive programs, as well as employee relations strategies.
2. To attract, hire and promote individuals which we expect will make the most contribution to its success and become its best leaders.
3. To select people who demonstrate required skills for positions and meet its expectations for leadership and company values.
4. To involve key stakeholders in the recruitment process to ensure appropriate selection decisions.
5. To apply consistent standards in its employment practices and to comply with employment standards and legislation.
6. To provide oversight and governance within Projects to HR standards, systems and processes.
7. To oversee recruitment of Project personnel.
8. To increase Inuit content in the Project – support Sustainable Development department with training and community work ready programs, tours, recruitment campaigns and partnership with the Baffinland Community Liaison Officers in each community.

13.3 Operations Resourcing and Recruitment Guidelines

1. The project organization chart and the work force planning study are generated by the Projects team and Human Resources.
2. Project Functional leads will provide brief information on job requirements for each position indicated in the organization design.
3. The Recruitment team will validate the Job Description and write a Job Requisition, which must include the following documents at a minimum:
    i) Position description.
    ii) Grade salary bands.

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iii) Expected starting salary.

iv) Hiring manager sign-off.

4. The Recruiter uploads the information obtained from the job description into the Recruitment Tool (ICIMS) routing it for approval.
5. The Recruiter meets the Hiring Manager to establish roles, expectations, recruitment strategy and timings.
6. Recruitment:

   i) For internal recruitment, job postings should be on Baffinland Website.

   ii) For external recruitment, recruiters will use Baffinland Website and depending on the characteristics and position level, will also use a different source and strategy.
7. If needed, depending on the recruitment strategy and the difficulty on identifying specific technical resource, the Recruiter could contact a Recruitment Vendor who will present a list of candidates.
8. The Recruiter must track Key Performance Indicators (i.e. Hiring process time spent, number of vacancies filled, cost for hiring, recruitment methodology, etc.).

13.4 Candidate Selection

1. All the information provided by external or internal job postings, including vendor lists, are reviewed and ranked according to the indicated criteria.
2. Selection process starts with the screening process, initial interview (i.e. phone), which is set to validate that the information provided is pertinent and fulfill the job requirements. The screening must include additional testing to ensure candidate is suitable to the position (i.e. recommended recruitment testing have to be set by job level in the Project).
3. The Recruiter will present a short list of candidates to the functional lead and/or requiring function to be interviewed by the pertinent functional team.
4. The functional team to interview must have interviewers at least one level up of the position required and the sign off on the decision made from the functional leader.
5. The Recruiter should meet with the Functional Leader and discuss the decision made, testing outcomes have to be discussed and a confidential report must be issue for the candidate or new employee personal file.
6. To the selected identified candidate, an Offer Letter will be sent.
7. Candidate will review and indicate decision, and if in agreement, the Offer letter will be signed confirming acceptance.

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8. If first candidate selected rejects offer, the next best candidates continue the process and an offer is extended to the second-best candidate.

9. Offer will be subject to successful medical evaluation.

13.5 Labour Cost Projections

Baffinland compensation will be determined based on salary bands by position and benchmarking review for the organization.

The labour costs below are average cost for OPEX estimate, inclusive of site uplifts and allowances.

All labour costs are by employee type ($,000 per employee).

Table 13-1: Labour Cost by Employee Type

Employee Type	Offsite	Milne	Mary River
Labour Contractor (@$95/hr)	208	208	208
Operator	0	118	118
Maintainer	0	141	141
Supervisor	109	145	145
Technical/Engineer	108	158	158
Superintendent/Manager	157	188	203
Executive	373	457	457

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 14 – Operating Costs

2017-05-01	0	Approved for Use	R. Cote	N. Mason	S. Heiner	BIM
Date	Rev.	Status	Prepared By	Checked By	Approved By	Approved By
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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14. Introduction

This report section summarizes the results and assumptions of the operating cost estimate for the expansion of Baffinland Iron Mine's Mary River mine from a 4.2 Mtpa road haul operation to 12 Mtpa rail haul operation.

The operating cost has been estimated to a level of appropriate for this stage of engineering. This stage II study is intended to produce a capital estimate roughly equivalent to an AACE Class 3 capital spending estimate of +/-15% with 10-15% contingency. This operating cost estimate aims to achieve a similar level of accuracy, and can be considered to have an Canadian Dollar accuracy of -5% to +15%. At the time this report was prepared, the updated Stage II mine plan was not yet complete, therefore the mine plan and associated mining costs are based on the previous Stage III mine plan.

All costs in this section are presented in US Dollars unless otherwise noted, however the majority of the inputs to operating cost estimate are priced in Canadian Dollars. These have been converted using an exchange rate of 0.7355 $US:$C, the live rate quoted on oanda.com around noon on April 26, 2017. All unit costs in this section are presented per wet metric tonne of finished ore unless otherwise noted.

The scope of this estimate includes the following activities:

- Mining, hauling and stockpile of ore and waste from the existing mine at Deposit 1 to the run-of-mine stockpile and waste dump respectively
- Primary crushing and stockpiling at Mary River
- Reclaiming, loading and rail transportation of ore from the Mary River crushed ore stockpiles to the Milne Port crusher feed stockpile
- Reclaiming, secondary crushing and screening at Milne Port
- Stockpiling, reclaiming and shiploading at Milne Port
- Fixed plant and mobile maintenance
- Site services managing provision of catering and charter flights, and the operation of the camp, power plants, and waste and water management facilities
- Functional support or general and administrative costs (G&A) on-site at Mary River and Milne, and off-site at the sealift marshalling area in Valleyfield, the airport and warehouse at Mirabel and the head office in Oakville including the following functional areas:
  - Health, safety, environment and community
  - Supply chain and logistics

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- Human resources
- Technical services (mining, exploration and information technology)
- Finance
- Marketing and sales

Operating costs are estimated based on the anticipated shift types, production schedule and volume for the rail operation. The includes the following considerations:

- 12 Mtpa of ore mining, rail haulage and shiploading
- Mine stripping ratio (waste:ore) of up to 2.4:1
- Rail operation by a third party contractor
- Year-round, 24 hour operation
- 12 hour shifts, 14 consecutive days for site positions following by 14 days off. Most positions consist of rotating day shift and night shift employees each with a cross shift.
- Shiploading from two berths only during open water (~July 25th to October 15th)

Exclusions

This estimate covers only cash, free-on-board (FOB) operating costs, and excludes the following:

- All marine costs such as tug boats, ore carriers, port fees and other shipping related services
- Non-cash items such as depreciation and amortization
- Value-added tax, territorial mining royalties, income tax, withholding tax (if applicable), and royalties associated with Baffinland's current or future Inuit Impact and Benefits Agreement
- Non-motive diesel fuel rebates
- Financing or equipment leasing
- Expansion, sustaining capital costs or working capital costs
- Operating, management or marketing fees

These costs, where applicable, are considered in financial analysis section of this report. Sustaining capital costs are reported at the end of this section.

14.1 Operating Cost Summary

Life of mine average operating costs are estimated to be $US 16.66/t. The largest components of the cost are labour and services. Services include many labour-heavy

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contracts, such a rail operations contract, and catering, housekeeping, and security contracts.

Costs are distributed differently than current cost reporting at Baffinland, and therefore are not directly comparable. Maintenance costs are allocated to each functional area rather than reported as a separate cost area, for example mobile maintenance for the mining fleet is included in mine costs. Overhead costs for flights, food and accommodations are also distributed to the different areas based each area's portion of total onsite headcount, as opposed to the current practice of reporting these costs under site services.

Figure 14-1: Average Life of Mine Operating Cost, $US/t

The stripping ratio in the mine is expected to be the only significant driver of cost variation year-over-year. Low in the first four years, the following eight years have relatively high waste volumes and a stripping ratio of 2.4:1.

The cost estimate starts at the beginning of 2019, while ore is still hauled to Milne by ore haul trucks on the tote road. Rail operation is not expected to start until the latter half of 2019. The estimate ends in the fourth quarter of 2041, with reserves almost exhausted and not enough remaining for another full year of operation. Shiploading operations are considered for 2042 to enable shipping of ore stockpiles in the prior year. G&A's Other cost group is negative as it includes an adjustment to bring total corporate costs (i.e. G&A excluding onsite, production related functions) to $C 12 million per year.

14.2 Labour

The labour estimate for the 12 Mt expansion was zero-based. Hatch developed an estimate of the number of positions required for each area with an indicative employee type for each position. By design, this estimate did not make any allowance for absenteeism, turnover,

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illness or anything else that could lead to less than full employment, however as is typical at any operation, contractors will be used to temporarily backfill operator or maintainer positions that are vacant. To capture the cost of this contract labour, it was assumed that 5% of all operator and maintainer positions are filled by contractors on average throughout each year at a higher cost than employees.

In the table below, 18 Mtpa is representative of 2021 and 2022, 41 Mtpa is representative of maximum waste year. Figures include key contractor positions such as explosives contractors (12), rail operators and maintainers (68), catering and housekeeping staff (80), security services (8), and medical staff (4). Peak numbers are shown which include 50 seasonal shiploading positions and 17 seasonal G&A positions. Refer to Appendix A22-4 for more detail.

Table 14-1: Peak Fulltime Equivalents (FTEs) at Different Mining Volumes

Volume/Location / Department	18 Mtpa Material Moved				41 Mtpa Material Moved			
	Mary River	Milne	Offsite	Total	Mary River	Milne	Offsite	Total
Mine	121	-	-	**121**	161	-	-	**161**
Mary River Process	52	-	-	**52**	52	-	-	**52**
Rail	-	68	-	**68**	-	68	-	**68**
Milne Process	-	89	-	**89**	-	89	-	**89**
Shiploading	-	54	-	**54**	-	54	-	**54**
Mary River Site Services	76	-	-	**76**	82	-	-	**82**
Milne Site Services	-	100	-	**100**	-	102	-	**102**
General & Administration	65	33	34	**132**	69	33	34	**136**
Total	**314**	**344**	**34**	**692**	**364**	**346**	**34**	**744**

The total annual labour cost for each employee type was provided by Baffinland and is summarized in the table below. Costs presented below include salary, benefits, pension, vacation and bonus. Northern allowance for Nunavut resident employees and a uplift for non-Nunavut resident, site based employees are also included.

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Table 14-2: Total Annual Labour Costs, $C (Source: Baffinland)

Location / Employee Type	Mary River	Milne	Offsite
Executive	457,000	457,000	373,000
Manager or Superintendent	203,000	188,000	157,000
Engineer or Technical	158,000	158,000	108,000
Supervisor	145,000	145,000	109,000
Maintainer	141,000	141,000	n/a
Operator	118,000	118,000	n/a

A rate of $C 95/hour for non-employee hourly contractors was also provided. This corresponds to $C 207,480 year.

14.3 Fuel

All diesel fuel is priced at Baffinland's current inventory price of $C 0.83 per litre. This price includes all applicable federal and territorial taxes and delivery to site. Operations diesel fuel consumption is expected to peak in 2019 at 55 million litres, a year in which the mine operates smaller equipment and ore is hauled for part of the year using ore haul tucks. Detailed equipment-by-equipment, month-by-month fuel consumption estimates can be found in appendix A14-1.

Diesel fuel consumption has been estimated using a combination of Baffinland's internal estimates, equipment supplier data and Hatch benchmarks.

At Baffinland's suggestion, and starting in 2024, power generation fuel consumption has been reduced through the addition of wind power generation. Wind power can be generated at a diesel equivalent of $C 0.78 per litre a direct savings of $C 0.05 per litre plus parts savings of another $C 0.10 per litre. Wind power is estimated to displace 20% of total power plant demand at both Mary River and Milne.

Similar to diesel, Jet A's price has been estimated at Baffinland's current rate of $C 0.64 per litre. Consumption has been estimated assuming use of a 737-200 aircraft for flights from Mirabel, and assuming 12,000 litres are consumed in each return flight to Mirabel airport, 1,750 litres are consumed on average in a return flight to a local community. Summer environmental and exploration campaigns are assumed to consume 200,000 litres each year. Peak consumption is around 3.4 million litres per year.

14.4 Consumables

As with diesel fuel, consumable costs have been estimated using a combination of Baffinland's internal estimates, equipment supplier data and Hatch benchmarks. 40% of consumable costs are incurred in the mine. Detailed equipment-by-equipment, month-by-month consumable cost estimates can be found in appendix A14-1. Costs for large mining equipment are based on estimates received from Toromont CAT found in appendix A14-2.

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Costs for smaller mobile equipment, generators and buildings are based on Baffinland's internal estimates. Costs for the bulk material handling systems are based industry benchmarks for similar equipment. Costs for the operating of the rail system come from third party rail operator quotes for the project and locomotive suppliers.

14.5 Services and Other

As labour, fuel and consumables form the majority of costs, this section summarizes all remaining costs. Of these, services are the most significant portion. Many costs in this section are based on current Baffinland contracts or estimates. In each area, miscellaneous costs of $C 3,200 per FTE are intended to cover training, travel, safety supplies and other small items.

14.6 Mine Operations

In the mine, the largest non-labour and consumable costs are the explosives supply contract and the laboratory services contract. Explosives costs in the table below exclude explosives fuel consumption, provided free of charge to the explosives supplier. Mining costs per tonne of material moved and excluding overheads allocated in Figure 14-1 are $US 2.00/t.

Table 14-3: Mine Operations Contract and Other Cost Summary for Typical 41 Mt Material Movement Year

Cost Item	Variable Cost, $C/t mat'l moved	Variable Cost, $C '000s	Fixed Cost, $C '000s	Total Cost, $C '000s
Explosives Supply	0.27	11,087	3,396	14,483
Laboratory Service	-	-	1,741	1,741
Consultants	-	-	400	400
Software	-	-	300	300
Misc.	-	-	515	515
Total	**0.27**	**11,087**	**6,352**	**17,439**

14.7 Process

Process operations do not include any key contracts, but include a provision for third party expertise when required. Total cost is estimated to peak at $C2.1 million per year.

14.8 Rail

At the time of writing this report, Baffinland was evaluating the feasibility of contracting with a third party to operate and maintain the rail system. Estimated contract costs are variable at $C 2.02 per tonne of ore plus. Costs of materials, fuel and freight are treated as pass-throughs and not considered in the rail service costs in this estimate. Source information for rail operating costs can be found in appendix A14-4.

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14.9 Shiploading

Shiploading operations do not include any key contracts, but include a provision for third party expertise when required. Seasonal operating and maintenance labour is included in labour costs. Total services and other costs for shiploading are estimated under $C 500,000.

14.10 Mary River and Milne Site Services

Site services manages and maintains the camps, power plants, and waste and water management facilities at both sites. They are also responsible for managing the return passenger charter flights to Mary River from the local communities (Pond Inlet, Hall Beach, Igloolik, Arctic Bay and Clyde River) and Mirabel airport in Quebec,

Passenger flights from Mirabel currently use a 102 seat Boeing 737-200 aircraft and land on a gravel airstrip at Mary River. Based on the following, with local community rates provided by Baffinland:

- Total site-based headcount for a typical year in which 41 Mt of material is moved is 355 at any one time plus 5% visitors, short term contractors or consultants, or others not included in labour estimates
- By 2023, 50% mine, 35% of camp, 5% or rail and 3% of port personnel travelling to site are from the communities
- 10% of seats are unused on a typical passenger flight
- Passenger flights have capacity for 102 and 11 passengers from Mirabel and the communities respectively

Up to four flights per week will be required from Mirabel. These will be supplemented by up to nine flights per week to the local communities.

In addition to passenger flights, freight flights from Mirabel bring air cargo to site. Each flight carries up to 12,000 kg. It is anticipated that one will be required each week on average.

Cost are estimated at $C 96,275, $C 93,775 and $C 3,370 for passenger flights from Mirabel, freight flights from Mirabel and the average community flight respectively.

Catering and housekeeping operations are based on third party estimates supplied to Baffinland to operate their camp of $C 57 per person housed per day. In addition to these services, $C 30 per person per day has been estimated for provision of food and catering and housekeeping supplies.

Information on these costs can be found in appendices A14-1 and A14-3.

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14.11 General and Administration

G&A covers the functional areas of Executive, Health, Safety, Environment & Community, Supply Chain & Logistics, Human Resources, Technical Services and Finance. Onsite G&A costs are estimated by Hatch.

Major annual cost items for onsite G&A include the following:

- Up to three sealifts per year at $C 1.75 million each plus $C 400,000 for warehousing, stevedoring and other related costs
- $C 3 million for Inuit owned land lease

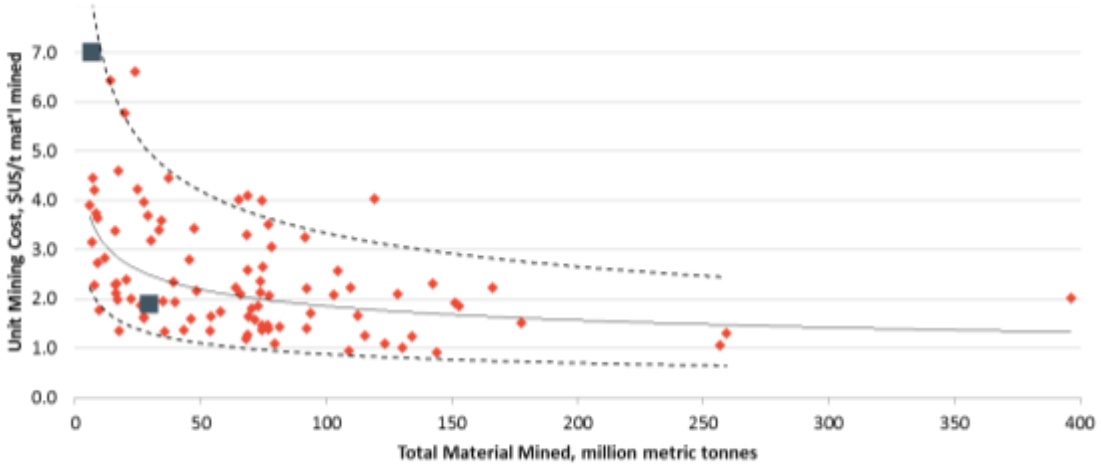
An estimate of $C 12 million per year for offsite corporate G&A costs has been provided by Baffinland. Information on the costs can be found in appendices A14-1 and A14-3.

14.12 Cost Benchmarking

Estimated operating costs for the mine and overall operation have been benchmarked against similar operations. Mine costs have been benchmarking excluding allocated site services costs as this is more representative of the other data points in the set.

Baffinland's current operation is about one standard deviation from the mean at current mining rates (top left square in chart below). A number of changes are anticipated to improve the mine's current cost position following the expansion (lower left square). The increase in mining volume will reduce the unit cost of any fixed in the mine. The expanded operation will also make use of more cost efficient equipment including larger haul trucks and drills, and shovels rather than front end loaders. The mine will also produce a higher proportion of waste which has a shorter haul distance than ore and therefore a lower unit cost to mine.

Figure 14-2: Cost Position Relative to Other Open Pit Mines, Source: Hatch



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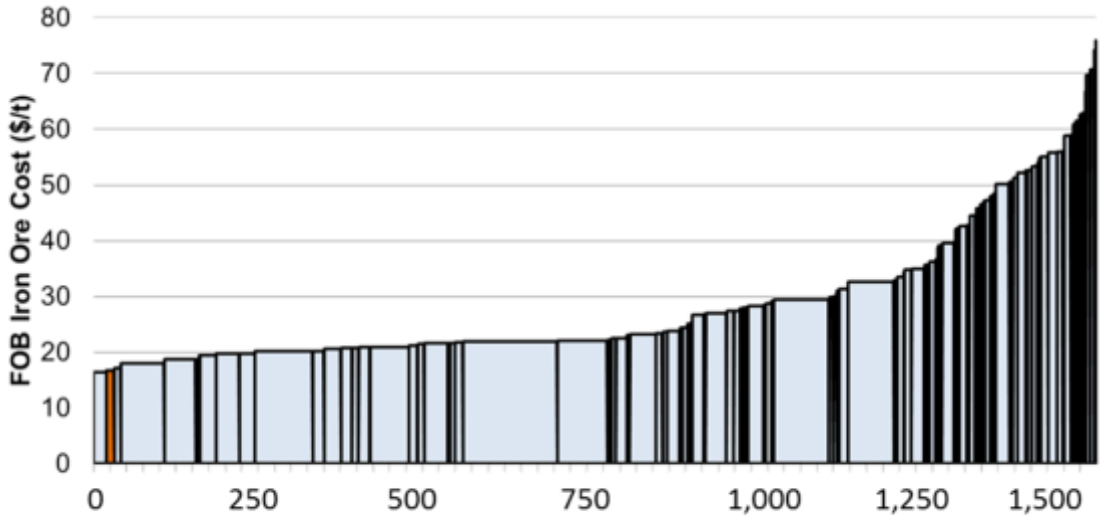
While the Mary River mine's location and weather present cost challenges, the relatively short distance from the mine to the port, lack of beneficiation required to produce a finished product and a maintained favourable exchange rate would all provide an advantage that could place the expanded operation on the lower end of the FOB cost curve.

Figure 14-3: Forecast FOB cost position, Data Source: SNL



14.13 Risks and Opportunities

The following risks and opportunities have been identified during the preparation and review of this operating cost estimate. These are project specific risks and opportunities in addition to standard operating costs risks and opportunities such as fuel price may increase or decrease.

Risks

- The labour quantity estimate used in the preparation of this estimate is lean by design, and contains a smaller functional support team than the existing operation, therefore there is a risk of a labour quantity increase.
- Costs are generally presented in US Dollars but priced in Canadian dollars, therefore changes in exchange rates between the two currencies could present a risk or opportunity.
- If community workforce participation rates are not achieved there is a risk a higher proportion of flights will be from Mirabel. Flights from Mirabel are higher cost than then average community flight.

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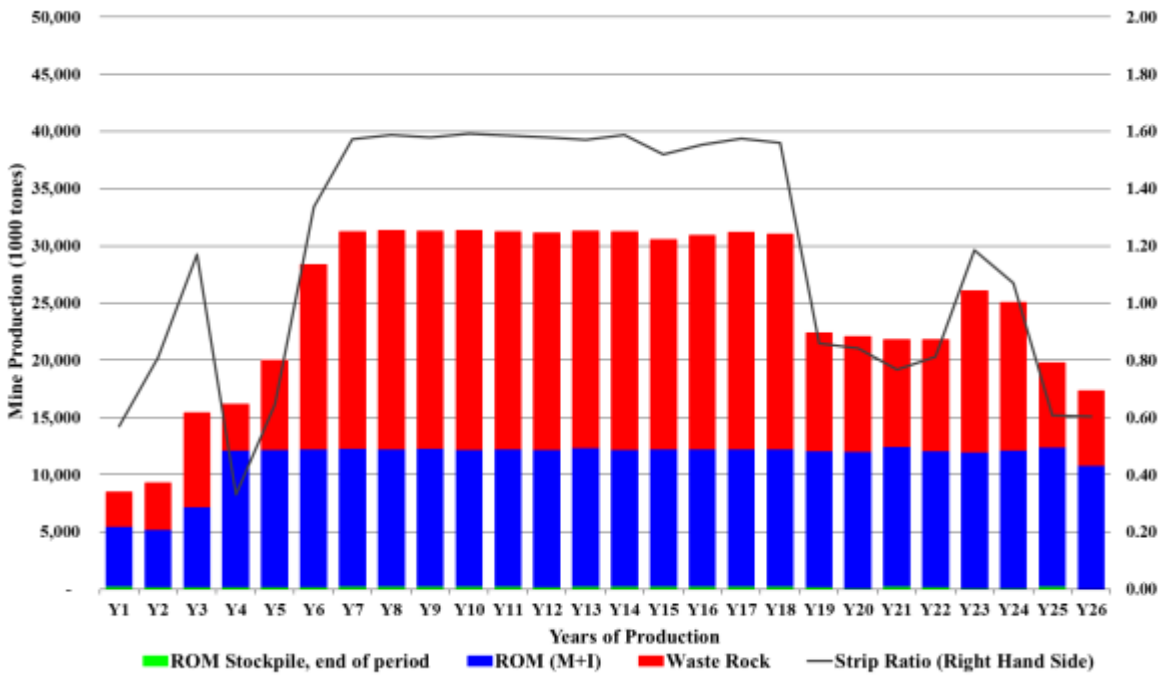
- Labour, material and fuel quantities are based on assumed equipment availability and productivity. Lower than estimated utilization and productivity of equipment risks increasing costs.
- Estimated corporate costs provided by Baffinland are significantly less than those estimated by Hatch and Baffinland's current corporate costs. There is a risk that these head office cost savings will not be achieved and G&A cost will be higher than forecast here.

Opportunities

- Paving the runway at Mary River would enable Baffinland to use more modern, larger, and more fuel efficient aircraft that are not currently available with the gravel kits required to land on the gravel airstrip at Mary River. A trade-off study could be conducted to evaluate the net present value of this opportunity.
- The cost of rail contract operation carried in this estimate is based on quotes received from potential operators, however this cost is above the cost of internal labour considered in the Stage II estimate. It is possible that total cost to operate the railway would be lower if it was operated by Baffinland rather than a third party.
- The final feasibility study mine plan provides a mine plan with a lower peak stripping ratio (1.6 down from 2.4). It is expected that this will reduce mining costs and may fleet size and therefore sustaining capital requirements as well.

Figure 14-4: Final feasibility study mine plan, Source: RPA



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14.14 Sustaining Capital

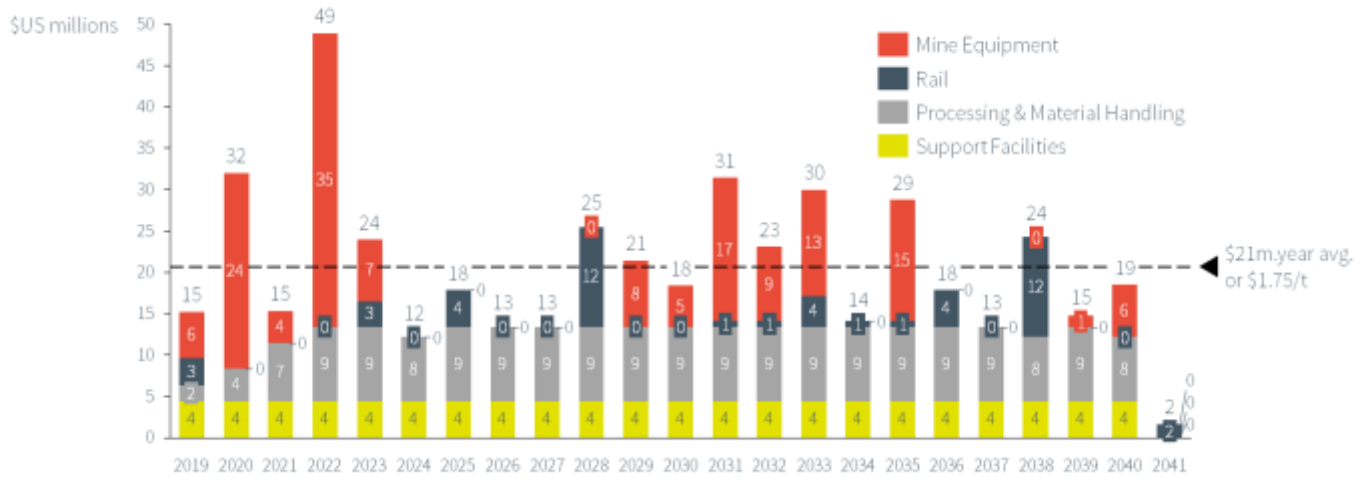
Sustaining capital has been estimated differently for separate areas of the operation.

Mine equipment replacement has been estimate based on expected operating hours in the Stage II mine plan and expected equipment life. Equipment costs include indirects such as freight, and the same contingency as the expansion capital estimate (4.49% for a 75% probability not to exceed). Mine equipment costs are much higher than would typically be expected at the beginning of mine life as more, larger mining equipment is purchased to meet the increased mine production capacity required as the mine reaches 41 million tonnes per year of ore and waste production.

Rail sustaining capital requirements have been estimated by contractors bidding to operate the rail on Baffinland's behalf. In addition to the requirements identified in these bids, an estimate has been made for the cost and frequency to replace mobile equipment used in train loading.

Processing and material handling, and support facility sustaining capital cost have been estimated using fixed annual estimates for key areas, with a ramp up included for newer equipment. In addition to these requirements, an estimate has been made for the cost and frequency to replace mobile equipment used in crusher loading and material handling in the port area. Detailed of this estimate can be found in appendix A14-1.

Figure 14-5: Annual Sustaining Capital Costs



In addition to the costs detailed above, in the financial model section of this report, the cost of producing 15 Mt of waste over the years 2023 to 2031 has been capitalized. This represents an estimate of waste produced in each of these years to reach ore produced in following years. Further mine planning is required to determine the actual amount of costs that can be capitalized.

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14.15 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
	Operating Cost Estimate			A14-1
	Mine Equipment Cost Data			A14-2
	Contract Cost Data			A14-3
	Rail Cost Data			A14-4

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 15 – Market Analysis

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2017-05-01	0	Approved for Use	BIM	BIM	BIM	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**

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15. Executive Summary

The current market for high grade iron ore is currently stronger relative to lower grade iron ore and it is forecast to continue as such into the medium term over the forecast period.

The quality of new material coming to the market from Australia continues to decline, as ore bodies deepen and age, offsetting the impact of announced supply increases from major iron ore miners. Additionally, it is assumed that a large proportion of the additional supply coming to market in the forecast period has been committed forward under long term contracts, and is already priced into the market.

Baffinland DSP and sinter fines are high quality products that are primarily targeted for sales to Atlantic basin customers. The first two shipping seasons have proven that the ores can be used productively in European blast furnaces and there is significant and sticky demand for the products.

Moreover, it has also shown that DSP does not perform as well as a complete pellet replacement and, to date, burden substitution has primarily been in place of lump ore. More product research and development is required if DSP is to be targeted further to capture a higher proportion of the pellet market.

Both DSP and SUSF have chemical and physical characteristics that are in strong demand in the current market. This is forecast to facilitate premium pricing for SUSF and enhanced VIU benefits in DSP pricing over the forecast period.

It is concluded that at 12Mtpa shipping the European market can absorb the full 12Mtpa, however, there will be associated price risk to capture this entire market share. Alternative marketing strategies are recommended that will, to an extent, mitigate the price risk, but will be highly dependent on freight into Asia being economical and Cape size ice-class vessels being sufficiently available.

15.1 Iron Ore Market Update

Global iron ore supply and demand in 2016 was approximately 2,000 million tonnes, of which 1,300 million tonnes was seaborne trade. The largest iron ore producing countries in the world continue to be Australia, Brazil and China. While Chinese production is largely captive to the local steel industry, Australian and Brazilian producers participate primarily in the global seaborne trade.

The four largest producers in the world (Vale, Rio Tinto, BHP Billiton and Fortescue) account for more than 80% of the seaborne trade and have been responsible for almost the entire new seaborne iron ore capacity that has come into the market in the past decade. Currently, there are a number of sizable supply additions coming into the market, however, those that are expected to enter have been also been fully anticipated for some years and will most likely replace lost production from those aging mines with declining quality. The below table shows iron ore supply projections in the period 2017-2019.

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Table 15-1: Iron Ore Supply Projections for Period 2017-2019

Shipments (Mwmt) - yearly	CY14	CY15	CY16	CY17	CY18	CY19
Vale (ex-Samarco)	314	335	336	365	399	410
BHP Billiton (Pilbara)	242	261	260	271	278	290
Rio Tinto (Pilbara)	288	319	328	335	350	357
Fortescue	153	167	171	170	170	170
Anglo	41	52	56	58	62	64
Roy Hill	0	0	23	46	55	55
Samarco	25	25	1	0	6	18
Total	**1063**	**1158**	**1174**	**1245**	**1320**	**1365**
Growth – YoY	148	95	16	71	75	44
Growth - YoY	16%	9%	1%	6%	6%	3%

Source: J.P. Morgan estimates, Company data.

The above supply forecast implies a broadly balanced market in the short to medium term. There are several key projects, other than the Mary River Project, which will provide new iron ore supply. It is forecast that 120mt of iron ore will be added to the market by the majors in the next 2-3 years. These additions include Vale's Carajás S11D, which is expected to add 80-90 million tonnes to 2019, Roy Hill in Australia, a recently developed mine, which is expected to have an annual capacity of 55 million tonnes and Rio's Silvergrass complex, which is expected to add 20 million tonnes of capacity per annum. Additionally, BHPB is undertaking logistics debottlenecking, which is expected to add 30 million tonnes per annum throughput capacity, and to be considered is a possible return to the pellet market by Samarco.

Estimated year-on-year supply growth at 3-6% is relatively modest in comparison to the period 2014-2015, and is not expected to outstrip the growth in demand. However, it should also be noted that the supply from these projects will be primarily targeted for the Chinese market and will be largely comprised of fines.[1] Of note also is that the capital expenditure decisions associated with these mine expansions were taken several years ago and would not have been taken without the security of long term supply agreements/commitments, therefore, it is likely that the bulk of the supply that will enter the market should be assumed to be "pre-sold", and its entrance to the seaborne market will have limited impact on price because the availability of this volume is already priced into the market.

Additionally, a natural attrition (phasing out) of current supply is also taking place; and it is forecast that Vale Southern System production will continue its current aggregate quality (Fe%) quantity decline (10% y-o-y) rate over the period, and the average Fe% grade of Australian ore will continue to decrease. The continued decline in Fe % of Australian and Brazilian ores, and quantity of Brazilian material will continue to dampen 3-6% aggregate tonnage growth which is predicted over the period.

[1] Company reports and filings

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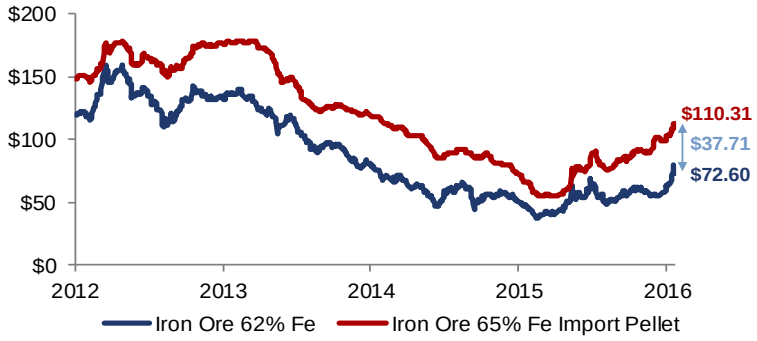
15.1.1 Iron Ore Fines vs. Pellets Over Time (US$ / dmt)



*Source: Bloomberg

Figure 15-1: Iron Ore 62% Fe CFR Tianjin Port China; 65% Fe China Import Pellet in US$ / Dry M

During the first half of 2016 the benchmark iron ore price experienced increased volatility, with most of this being driven from the corresponding volatility increases in the steel market, bullish demand sentiment due to improved steel margins in China, as well as, higher than expected crude steel production, despite announcements by Chinese officials regarding possible reductions in excess steelmaking capacity.

There is potentially a “perfect storm” for high grade iron ores brewing - Baffinland iron ore is high grade with low impurities.

From 2003-2008 the Chinese demand for ore was insatiable. The run up in demand consumed the “best” iron ore reserves of the Australian majors at a much faster rate than had been originally predicted. The reserves remaining today are lower in Fe and there has been a gradual but structural shift in Fe grade delivered to China. In conjunction with this, overall decline in Fe grade steel output has been increased, ultimately pushing aggregate demand for iron ore tonnes up. In the pricing of iron ore, Fe has traditionally been credited in a linear fashion. This was broadly representative of the value a steel maker could capture from the additional iron units with regard for alternative higher gangue material in the market. However, average grade decline, steel mill productivity pushes and increased environmental sensitivities now put a dis-incentive on the use of lower Fe iron ores. The phenomenon has permanently manifested itself in market pricing, and the Fe unit value curve has significantly steepened (see below chart).

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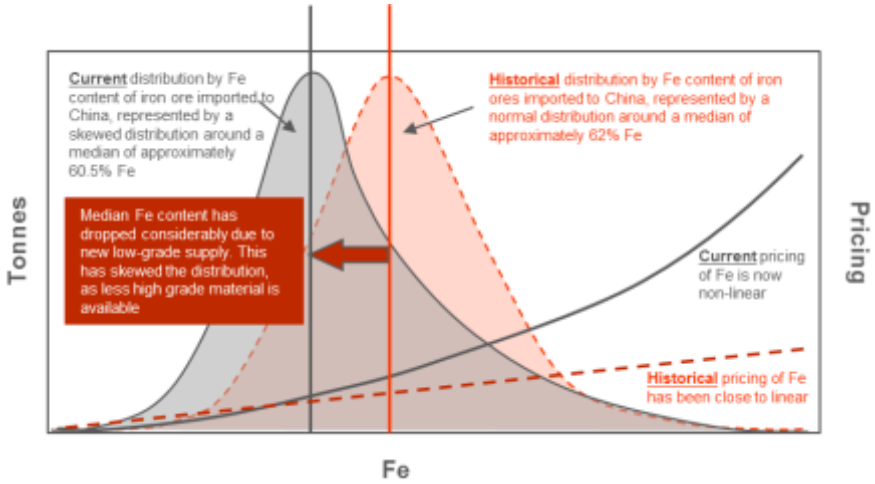

* Source: ArcelorMittal Technical Marketing

Figure 15-2: Fe Unit Value Curve

The “perfect storm” for high grade iron ore has hit the market in four phases. The first three phases of the storm are a function of shorter term market fundamentals; however, the fourth phase is indicative of a longer term structural change to the iron ore market.

Firstly, the second half of 2016 saw a rapid increase in metallurgical coal prices. This rise had a dramatic positive effect on the spread between the 65% and 62% indices. To reduce slag rate and capture the corresponding savings in fuel, steel mills sought to increase their percentage of higher grade material (lower gangue) charged to sinter plants and Blast Furnaces.

Secondly, a recovery in Chinese steel prices and profit margins steel exports, buoyed global steel production and re-fuelled the demand for iron ore. Strong demand side fundamentals continue to indicate that this trend will continue over the forecast period.

Thirdly, continued environmental pressure on Chinese steel mills heightens their appetite for high grade iron ore as steel production consolidation (closures) forces capacity utilisation improvements in the furnaces continuing to operate.

The fourth and final phase of the storm is a result of depletion of the global iron ore reserves.

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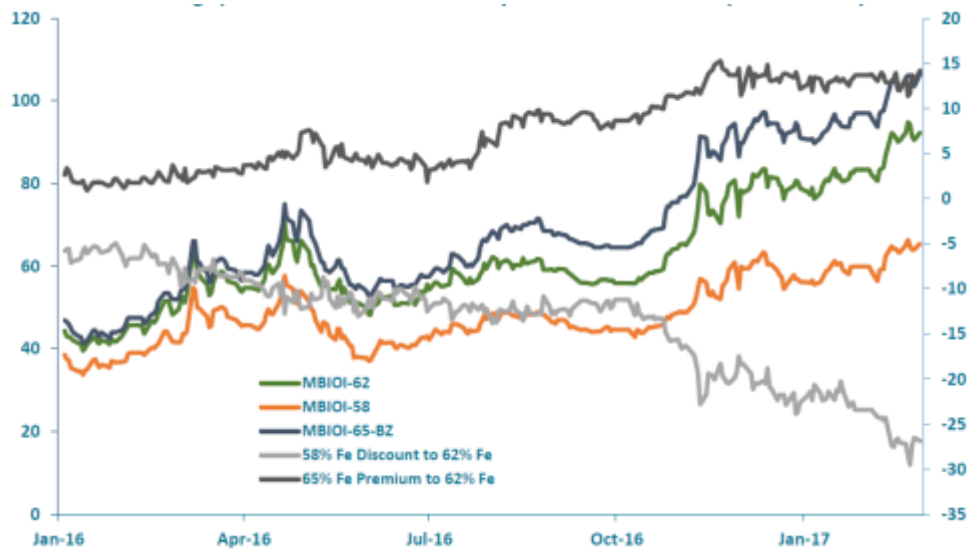

*Source: Metal Bulletin

Figure 15-3: Widening Spreads between Three Key Iron Ore Fine Indices

15.2 Crude Steel Market Update

Primarily all the iron ore produced in the world today is used to manufacture crude steel for use in construction, infrastructure development, automotive production and the manufacturing, industrial and energy industries. World steel production has historically grown in line with world GDP. The trend in steel production is forecast to continue growing, and by 2020, global steel production is forecast to be 5.1% higher than the 1.65 bn tonnes produced in 2016. Over the last decade, China has accounted for the greatest increase in crude steel demand and China currently represents ~50% of global steel production. Chinese steel production grew at 1.6% in 2016[2]; this added the equivalent demand for 30 mt of iron ore.

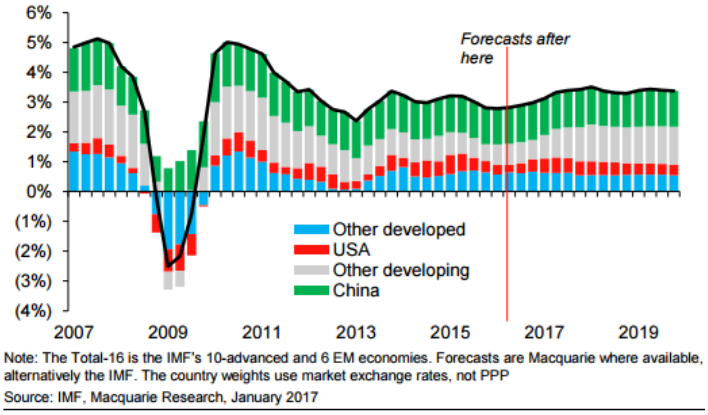

Figure 15-4: Global Real GDP Growth; Maquarie's Long Grindign Cycle Forecast

[2] World Steel Association - January 2017

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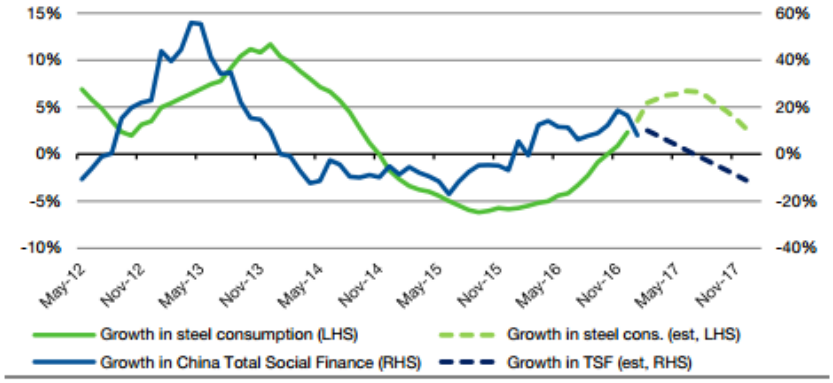

Source: Liberum, Bloomberg

Figure 15-5: Forecast Growth in China Steel Consumption vs. Total Social Finance (12m Trailing)

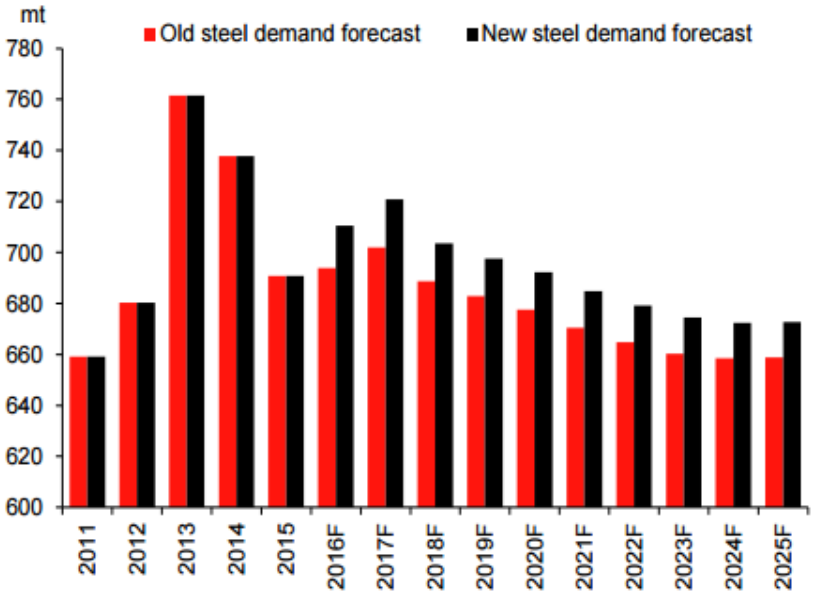

Figure 15-6: Old Steel vs. New Steel Demand Forecast

15.3 European Iron Ore Market

In Europe, the primary target market for Baffinland iron ore, the BOF, remains the dominant method of steelmaking and iron ore demand follows the steel market trends.

Europe requires 90 to 95 million tonnes of pig iron to feed its steel plants in periods of low demand and 110 to 120 million tonnes of pig iron during peak demand. This translates to iron ore demand of 145-150 to 175-190 million tonnes. This tonnage is a mixture of sinter feed, pellets and lump, which unlike Asia, Europe is limited in its flexibility (ability to switch between pellet or sinter production) in raw material inputs.

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Iron ore demand in Europe in 2015 was ~150 Mt, with 84.3 Mt in fines (56%), 53.3 Mt in pellets (35%) and 11.9 Mt in lump (8%). Germany is the largest single user (27%), followed by Turkey (10%), France (9%) and the UK (9%).

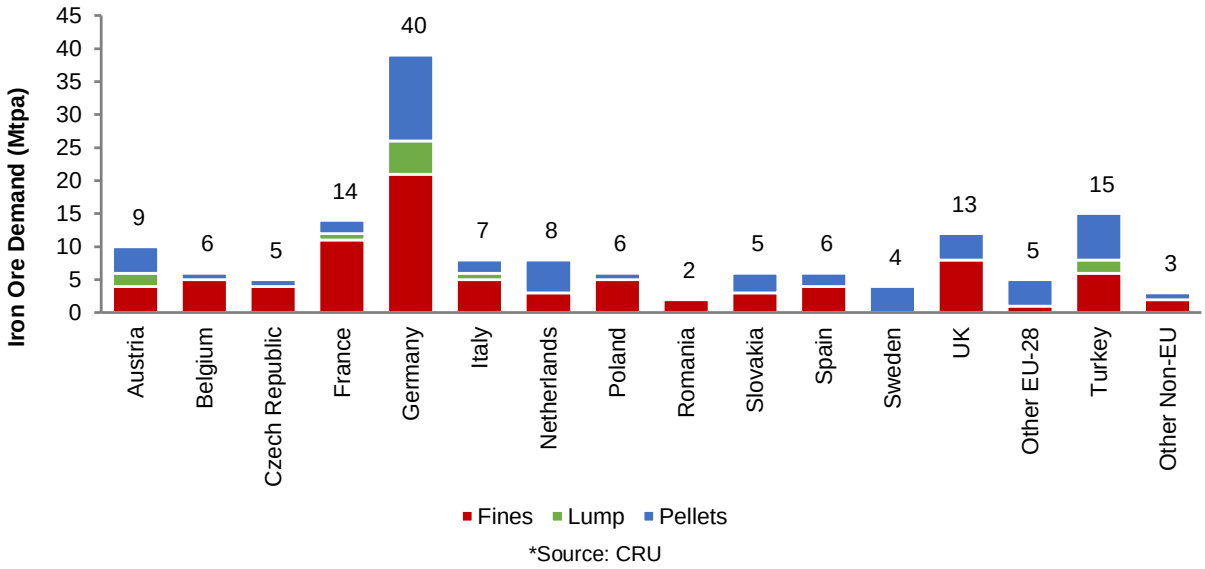

Figure 15-7: European Ore Demand

The iron ore market in Europe differs from the Asian markets due to capacity and environmental constraints, which ultimately limits the amount of fines consumed by steel mills and results in higher demand for direct charge (lump and pellets). The supply of high quality lump ore to Europe has declined in recent years, causing many European steel makers to increase use of more expensive pellets.

The European market is mature with high levels of productivity subsequently requiring high proportions of direct charge material such as lump, pellets and steel scrap at the BOF vessel. The continued decline of good quality of the lump and fines supplied to Europe has coincided with a European steel industry-wide drive to reduce latent steelmaking capacity. The combined effect of which has increased demand for expensive, high quality pellets, as the steel mills sought to improve/maintain productivity whilst reducing overall steelmaking capacity footprint.

Iron ore lump is supplied to Europe from only Brazil, Africa and Canada (Baffinland), while pellets are imported from Brazil, Sweden, Canada, Russia and Ukraine. It is currently not competitive to ship Australian lump or fines to Europe versus their import alternates.

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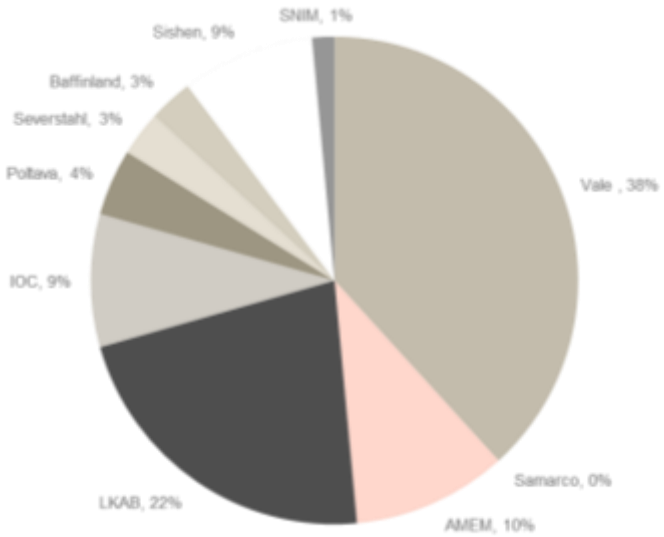

Figure 15-8: European Seaborne Lump and Pellet Supply

15.3.1 Pellet and Lump Supply Outlook for Europe

Pellet plants require large capital investments and have high variable operating cost components, resulting in lower economies of scale, thus the quantity forecast as new supply entering the market is low. The only realistic new (re)entrant to the pellet supply scene is the phased (re)start-up of Samarco's operations in Brazil. Following the tailings dam accident in November 2015, Samarco's pellet supply (15mt blast furnace pellet) has been absent from the market. A phased re-start of operations is planned for Q4 2017, but many regulatory hurdles must be cleared before this date becomes a reality.

Vale has latent pellet plant capacity, but availability of pellet feed in the areas of these plants continues to inhibit restarting. However, they have recently announced restarts of both the Sao Luis and Tubarao I and II plants.

The return of Australian lump ore to the European market is always a potential supply threat, however, the low Fe grade of these ores and, in particular, the high phosphorus content continues to restrict the quantities that European steel makers will use.

15.4 Sales of BIM Ore: Product, Price and Strategy

15.4.1 Value-in-Use (VIU)

Fundamental to marketing iron ores in Europe, is the concept of value-in-use (VIU). The use of all iron ores is a VIU driven decision by steel mills as they optimise overall cost of hot metal production. Hot metal VIU models present a direct comparison between a "known" material and "new" materials under a controlled set of conditions.

To assess the VIU of Baffinland DSP, a steel mill will take their steady-state/reference blast furnace (or sinter plant in the case of SUSF) operating conditions and model the impact of a

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product substitution(s) on the overall cost of hot metal. Accordingly, a steel mill without lump in the BF burden would remove some pellet, or a combination of sinter and pellet, then model the impact of Baffinland DSP on hot metal costs; likewise, a steel mill with lump in the burden would remove all the lump, or a combination of lump, sinter and pellet, and model the impact on hot metal costs.

The outputs of the VIU model allow the mills to make the optimal purchase decisions for each specific BF based on prevailing market prices associated with each input variable. The VIU model will indicate to the steel mill the price at which the purchase decision should change, and when it is optimal to switch inputs, *i.e. change the buying decision*.

In the case of lump ore, the VIU model outputs guide steel mills purchasing decisions to the optimal charge mix between lump and pellets (assuming sinter is always maximised). The dynamic equilibrium of lump and pellet price premiums versus operational benefits in the BOF constantly shifts and sways as the market seeks to clear.

15.4.2 DSP - Quality

Demonstrated in the charts below, DSP has significant quality advantages relative to much of the competition in Europe. The extremely high iron content and low presence of deleterious elements in DSP (and SUSF) means that the potential demand for the material in Europe should continue to be high. There are very few higher-grade direct charge ores available in the market; consequently it is expected that European steel mills should prioritise DSP.

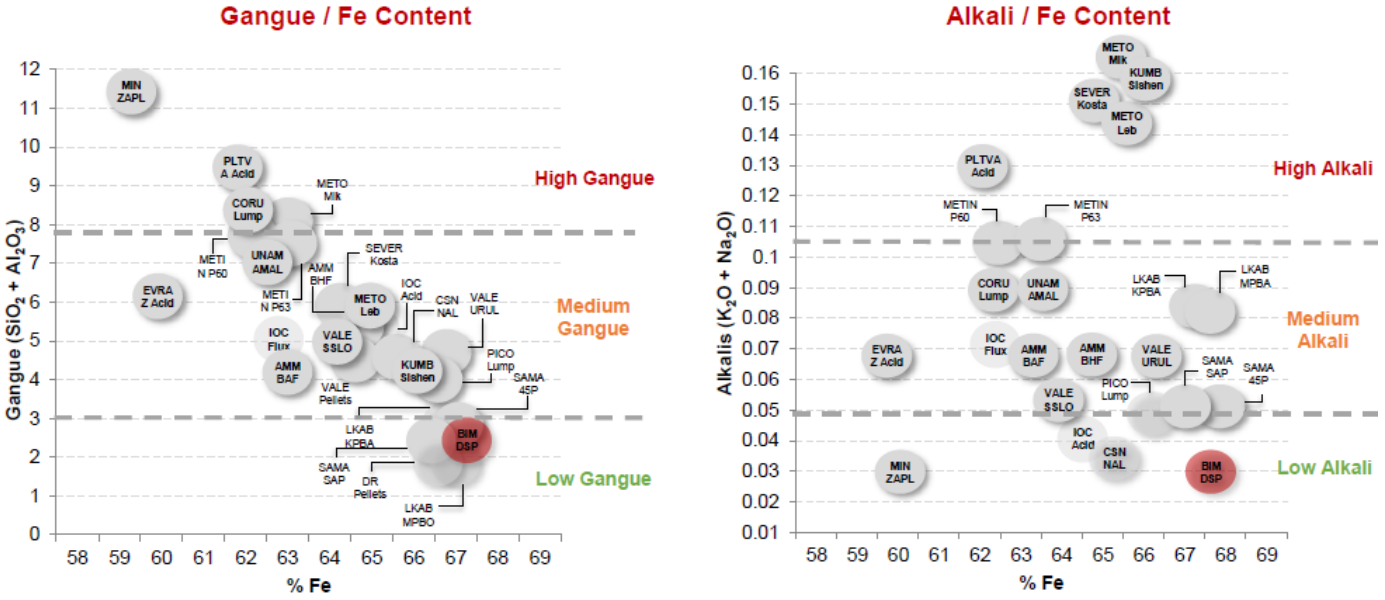

Figure 15-9: Significant Quality Advantages of DSP

15.4.2.1 DSP - Market Share and Product Placement

DSP currently occupies 3% of the total direct charge market in Europe. Following the planned expansion with DSP production at 9 mtpa, the market share would need to increase by a

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further 10% to 13% in total. There is significant opportunity to increase market share by 10% but the increase will only be captured by displacing competing products, which will ultimately compete with pellets and potentially create price pressure on lump and pellet premiums.

Through the Early Revenue Phase (ERP) of production, market entry and acceptance has occurred with DSP and SUSF now established within the BOF and sinter burdens of major European steel mills. Initial market entry costs have been digested into the pricing and it is assumed that there is sufficient and substantial demand for both DSP and SUSF.

Additionally, the geographical proximity of Baffinland to the European market clearly demonstrates that Europe should continue to be the primary target market. However, as highlighted above, the European iron ore market is not predicted to grow significantly, so market share must be captured through alternative product displacement/substitution.

15.4.2.2 Displacement of steel making raw materials in Europe is a function of VIU.

This VIU assessment/displacement balance at high rates of production and shipping should create an inflection point for sales to fall logically out into the region of Japanese, Korean and Taiwanese markets (JKT). The geographic proximity of JKT to Australia, coupled with differences in the steelmaking process and average lump ore rates in BOF's, mean that the JKT VIU equation for DSP will be different to Europe. JKT steelmakers use much higher rates of lump ore and, therefore, are expected to attribute a higher VIU credit to DSP because DSP displaces pellets in the first instance. In the case of European steelmakers (relatively low lump rates) ore the DSP displaces other lump in the first instance.

The inflection point for sales to JKT comes when the delta between Milne to NW Europe freight versus Milne to JKT freight rate is less than the difference in VIU credit attributed to the material. For this reason freight rate differentials must constantly be monitored.

It is expected that the freight rate differential will consistently outweigh the VIU differential, therefore the primary target market for DSP will be Europe (Primary Sales Case), however, a (Secondary Sales Case) is also considered in case the inflection point is reached. Note that if developed and opened, the Northern Passage to Asia could offset this freight delta between markets.

Due to low VIU credits in China, it is not forecast that material from Baffinland will be sold to China.

15.4.2.3 DSP - Use to Date

Sales in the ERP have proven DSP as a partial pellet and as a lump replacement in the BOF. Over 3.5mt of DSP has been used in European Blast Furnaces throughout 2015 and 2016 with the operational and technical feedback confirming that DSP replaces lump in the burden and partially replaces pellets.

The usage rates of DSP across customers has varied from 100-350 kg/thm. This is consistent with the industrial trials held in 2008 which indicated DSP could be used at ~350 kg/thm.

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Due to natural inherent variability of DSP, it is not considered that it could displace 100% of pellets in a blast furnace without presenting productivity losses, but, where users remained at the lower end of usage rates, it is thought that the unfamiliarity of BF operators using high lump ore rates could have been a contributory factor.

15.4.2.4 DSP - Pricing

DSP pricing methodology has been established in Europe. The price is linked to a percentage (%) of prevailing annual Blast Furnace pellet premiums. DSP is the first lump ore in the European iron ore market to achieve this direct link. Additionally, there is very little spot trade in pellets, therefore, the pricing is extremely illiquid and the price tenor seen in pellet supply agreements is usually 12 months.

The first two shipping seasons of DSP supply has seen the ore established with European steel makers burdens, and it is now possible to commence detailed technical evaluations of the products performance, not only to establish the behaviour of DSP in the burden, but also to begin to clarify whether there are complementary products already being used in European Blast Furnaces that marketing efforts should also be targeted at in order to enhance price realisation due to the specifics of that steel mill's VIU calculations.

15.4.3 SUSF - Quality

The overall high quality of SUSF puts the product in high demand. The entrance of S11D ore from Vale has meant a deterioration in quality of the fines being used by European mills. Although the Fe grade is higher than the Carajas product, alumina and phosphorus levels are elevated. The S11D coming to market in 2017 and 2018 will be approximately 0.10% P and this is expected to continue until at least 2020.

The low phosphorous and alumina in SUSF presents significant VIU benefits in the sinter plant and SUSF is expected to be a highly sought after product.

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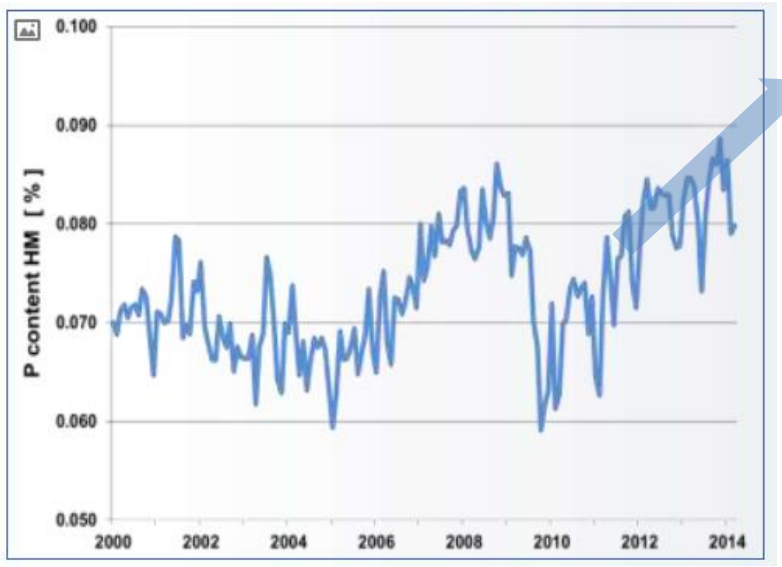

Figure 15-10

Source: Thyssen Krupp and ArcelorMittal estimates

The concept of adding an additional phosphorus premium into the pricing of SUSF has been established, and it is expected that this premium could increase in the coming years and could then be able to be extended to alumina levels. It can be seen from the chart below, SUSF has demonstrable high grade, low gangue quality which positions it extremely well relative to the competition.

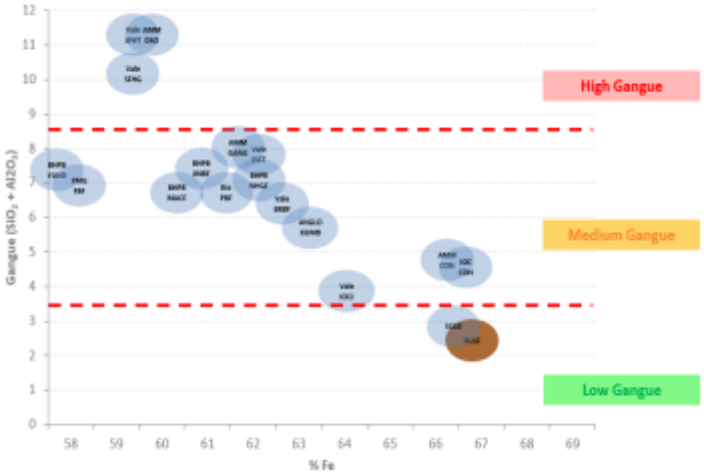

Figure 15-11

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15.4.3.1 SUSF - Market Share and Product Placement

SUSF currently represents 0.8% of the market for sinter fines in the EU. With SUSF production at 3 mtpa, this market share will increase to 3.5%. The high quality of the material means it should be possible to capture the additional market share without any impact on pricing relative to the competition.

15.4.3.2 SUSF - Use to Date

The limited quantities of SUSF used in European sinter plants mean that operational data is limited, however it is known that the coarseness and high quality of the material bring significant benefits to sinter chemistry and plant productivity.

SUSF also has the added benefit of being approximately 30% magnetite. This brings substantial environmental and cost credits to SUSF when input to a VIU model.

15.4.4 SUSF - Pricing

Over 1mt of SUSF has been consumed in Europe through 2015 & 2016. In these two years of sales it has been possible to capture a VIU premium in pricing. This premium is added and above the 65% Fe Index.

Due to the chemistry and mineralogy of SUSF it is predicted that the current premium should increase over the forecast period.

15.4.5 Production Profile and Sales Plan(s)

Phase 2 production will ramp up in stages from 2018.

Table 15-2: Phase 2 Production

	Year		2018				2019				2020				2021			
	Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Pre Feas Study	Mined Ore (as per mine plan)	Mt	1.3	1.3	1.3	1.3	1.3	1.8	2.4	2.5	2.5	2.5	2.8	3.0	3.0	3.0	3.0	3.0
	New Crushing & Screening Plant						CS											
	Road Transport	Mt	1.3	1.3	1.3	1.3	1.3	1.3	-	-	-	-	-	-	-	-	-	-
	Rail Transport	Mt	-	-	-	-	-	-	1.2	2.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Total Production	**Mt**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.2**	**2.4**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**
	Shipping Year Production	**Mtpa**	**5.0**				**5.0**				**11.4**				**12.0**			
	Calendar Year Production	**Mtpa**	**5.0**				**6.1**				**12.0**				**12.0**			

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SALES AND MARKETING					Year 2017	Year 2018	Year 2019	Year 2020	Year 2021
Total Output				*wmt*	5.00	5.00	11.40	12.00	12.00
SUSF Output			25%	*wmt*	1.25	1.25	2.85	3.00	3.00
DSP Output			75%	*wmt*	3.75	3.75	8.55	9.00	9.00
DSP	67.80 %	Customer	Region						
		AMS	Europe	*wmt*	1.900	1.900	4.000	4.000	4.000
		TATA	Europe	*wmt*	0.075	0.075	0.500	0.700	0.700
		Rogesa	Europe	*wmt*	0.500	0.500	1.000	1.000	1.000
		TKS	Europe	*wmt*	1.000	1.000	1.500	1.500	1.500
		Salzgitter	Europe	*wmt*	0.100	0.100	0.700	0.700	0.700
		Voestalpine	Europe	*wmt*	0.100	0.100	0.300	0.500	0.500
		SSAB	Europe	*wmt*	--	--	--	--	--
		British Steel	Europe	*wmt*	0.075	0.075	0.250	0.300	0.300
					3.75	3.75	8.55	9.00	9.00
					OK	OK	OK	OK	OK
		TOTAL DSP SALES	Europe	*wmt*	3.75	3.75	8.55	9.00	9.00
			JKT	*wmt*	--	--	--	--	--
			China	*wmt*	--	--	--	--	--
			Americas	*wmt*	--	--	--	--	--
			Middle East	*wmt*	--	--	--	--	--

Figure 15-12: DSP - Sales Plan 1 - (EU Primary Target)

SALES AND MARKETING					Year 2017	Year 2018	Year 2019	Year 2020	Year 2021
Total Output				*wmt*	5.00	5.00	11.40	12.00	12.00
SUSF Output			25%	*wmt*	1.25	1.25	2.85	3.00	3.00
DSP Output			75%	*wmt*	3.75	3.75	8.55	9.00	9.00
DSP	67.80 %	Customer	Region						
		AMS	Europe	*wmt*	1.900	1.900	4.000	4.000	4.000
		TATA	Europe	*wmt*	0.075	0.075	0.500	0.500	0.500
		Rogesa	Europe	*wmt*	0.400	0.400	0.750	0.750	0.750
		TKS	Europe	*wmt*	1.000	1.000	1.000	1.000	1.000
		Salzgitter	Europe	*wmt*	0.100	0.100	0.600	0.600	0.600
		Voestalpine	Europe	*wmt*	0.100	0.100	0.300	0.500	0.500
		SSAB	Europe	*wmt*	--	--	--	--	--
		British Steel	Europe	*wmt*	0.075	0.075	0.300	0.300	0.300
		Ilva	Europe	*wmt*	--	--	0.150	0.300	0.300
		Nippon	JKT	*wmt*	0.100	0.100	0.500	0.500	0.500
		JFE	JKT	*wmt*	--	--	0.150	0.150	0.150
		POSCO	JKT	*wmt*	--	--	0.300	0.400	0.400
					3.75	3.75	8.55	9.00	9.00
					OK	OK	OK	OK	OK
		TOTAL DSP SALES	Europe	*wmt*	3.65	3.65	7.60	7.95	7.95
			JKT	*wmt*	0.10	0.10	0.95	1.05	1.05
			China	*wmt*	--	--	--	--	--
			Americas	*wmt*	--	--	--	--	--
			Middle East	*wmt*	--	--	--	--	--

Figure 15-13: DSP - Sales Plan 2 - (Secondary and Tertiary Target Markets)

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SALES AND MARKETING					Year 2017	Year 2018	Year 2019	Year 2020	Year 2021
Total Output				*wmt*	5.00	5.00	11.40	12.00	12.00
SUSF Output			25%	*wmt*	1.25	1.25	2.85	3.00	3.00
SUSF	66.90 %	Customer	Region						
		AMS	Europe	*wmt*	0.600	0.600	1.400	1.500	1.500
		TATA	Europe	*wmt*	0.075	0.075	0.150	0.150	0.150
		Rogesa	Europe	*wmt*	0.200	0.200	0.300	0.300	0.300
		TKS	Europe	*wmt*	0.150	0.150	0.400	0.400	0.400
		Salzgitter	Europe	*wmt*	0.150	0.150	0.150	0.200	0.200
		Voestalpine	Europe	*wmt*	0.075	0.075	0.150	0.150	0.150
		SSAB	Europe	*wmt*	--	--	--	--	--
		British Steel	Europe	*wmt*	--	--	0.150	0.150	0.150
		Ilva	Europe	*wmt*	--	--	0.150	0.150	0.150
					1.25	1.25	2.85	3.00	3.00
		TOTAL SUSF	Europe	*wmt*	1.25	1.25	2.85	3.00	3.00
			JKT	*wmt*	--	--	--	--	--
			China	*wmt*	--	--	--	--	--
			Americas	*wmt*	--	--	--	--	--
			Middle East	*wmt*	--	--	--	--	--

Figure 15-14: SUSF - Sales Plan

15.4.6 Market Growth Opportunities (1) DR Segment

It is assumed that continued growth in the DRI production segment will also pull Atlantic BF pellet production into the DRI market. DR buyers pay a premium over the Blast Furnace Pellet premium for quality and to secure material versus the scrap alternate and, therefore, any tonne which a BF pellet producer can sell as DR pellet will move into the DR segment.

This market flow has two major benefits:

1. It creates further opportunity for DSP as in the BF pellet market.
2. The low gangue of DSP indicates it has potential for use in DR modules. The preferred technology capable of reducing DSP will be HYL as opposed to Midrex.

Some initial basket test results have proven that DSP has potential in this market, however, the performance is significantly lower that DR pellets and more work in close conjunction with a DRI producer will be required to prove the VIU of DSP.

15.4.7 Market Growth Opportunities (2) Great Lakes

The abundance of fine taconite ores in USA means US steel mills have traditionally run a burden practice of 100% pellets. There are some exceptions (AM Burns Harbor, USX Gary), but in general, BF burdens run a high percentage of pellets. Lump ore is not currently used in the BFs of the Great Lakes due to the quality, availability and disadvantageous logistics costs. Table 15-3 shows burden practice in selected North American blast furnaces:

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Table 15-3: Burden Practice in selected North American Blast Furnaces

Steel Mill	Blast Furnace ID	Fluxed Pellet consumption (kg/nthm)	Acid Pellet Consumption (kg/nthm)	Sinter Consumption (kg/nthm)	Lump ore consumption (kg/nthm)
AM Dofasco	2	799	677	0	0
AM Dofasco	3	614	895	0	0
AM Dofasco	4	780	699	0	0
USX Hamilton	E	0	1500	0	11
USX Lake Erie	1	773	630	0	3
AK Steel, Dearborn	C	47	1538	0	0

To maintain an alternative sales outlet to the EU, there is potential market DSP in the Great Lakes. At lower mine production levels (~5 mtpa) the extra logistics and handling costs involved in delivery is expected to be a disincentive, however, as mine output increases, establishing an efficient, trusted supply route into the Great Lakes is recommended.

The closest Great Lakes customers (geographically) and, therefore, the primary target customers, are shown below:

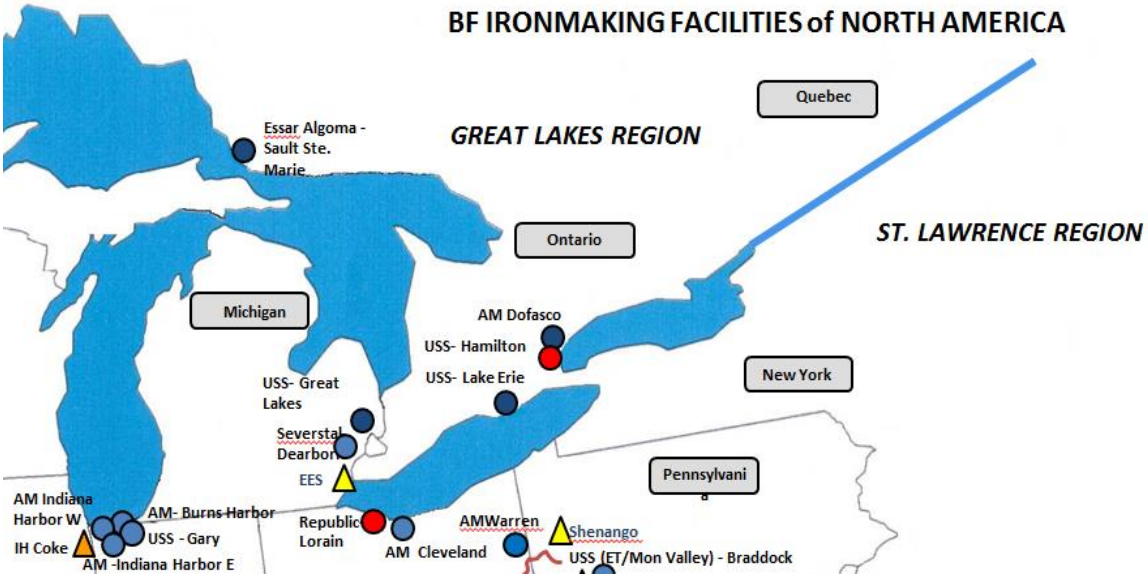

Figure 15-15: Primary Target Customers

The direct charge market in the Great Lakes are not expected to out-weigh the additional logistics cost involved in getting the material to the Lakes, but it is predicted that DSP could complement certain aspects of specific mill burdens.

15.4.8 Risks/Mitigations to 12mt Baffinland Sales

Capturing 13% market share in the European market will undoubtedly be accompanied by price risk as DSP seeks to displace other established ores, however, additional risks to pricing and marketing should also be considered:

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15.4.8.1 *Risk: Short Delivery Window*

Blast furnaces don't respond well to variation, and there is a risk that demand for the ore will be impeded in Europe due to the high tonnes being shipped and invoiced over a short, pre-defined period. It is the preference of European steel mills to maintain a constant charge rate consistently over 12 months of the year and to also ensure working capital is minimised.

Mitigation: Consignment stocking arrangement in Europe. Further study work is being done on this topic.

15.4.8.2 *Risk: Pricing Period (QP) Exposure*

All tonnes are delivered in 90 days. This exposed Baffinland material to market pricing in ¼ of a 12 month period.

Mitigation: Operational hedge can be taken through customer contracts to evenly spread pricing period over longer period.

15.4.8.3 *Risk: Competition*

There is a risk of becoming embroiled in a price war with incumbent iron ore lump and pellet suppliers in Europe.

Mitigation: Continue to differentiate DSP into its own niche/segment using VIU positioning to sustain premias.

15.4.8.4 *Risk: Macroeconomic Risk to European Steel Market*

If steel demand contracts then high grade iron ore demand will follow. This will negatively impact pricing and underlying demand for both DSP and SUSF.

Mitigation: Limited.

15.4.8.5 *Risk: Predatory Buyer Behaviour*

This phenomenon has not been experienced in the first two years of product shipment to Europe, however, the risk remains that if other material quality improves relative to the current DSP, Baffinland will face predatory price behaviour. Sales to the European market are preferred to avoid the freight handicap which currently exists on Asian sales, however, in case the market becomes grossly oversupplied and limited sales alternatives, there is a risk that only the "Asian" FOB equivalent price is achievable from European buyers.

Mitigation: Continue development of the DR market segment and an alternative market in North America.

15.4.8.6 *Risk: Shipping*

Due to the nature of the operating environment, the critical mass of volume required to be moved in the tight shipping window, all shipping is and will need to continue to be done on a carefully planned CFR basis and sufficient capacity will need to be captured to ensure all tons are shipped in any given season. There is also the risk of limited cape size ice-class fleet availability.

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Mitigation: Vessels need to be secured fixed under CoA and need to mitigate exposure to freight rates and bunkers through operational hedges and a variety of voyage contracts.

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 16 – Legal and Fiscal

2017-05-01	0	Approved for Use	BIM	BIM	BIM	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**

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16. Property Description and Location

The Project area is located in Nunavut on the northern half of Baffin Island on NTS Sheet 37 G/5 at Latitude 71°N and Longitude 79°W, approximately 160 km south of Mittimatalik (Pond Inlet), 270 km southeast of Nanisivik, 300 km north of Hall Beach, and 1,000 km northwest of Iqaluit, the capital of the Nunavut Territory. The Universal Transverse Mercator (UTM) location of Deposit No. 1 is 7915000N, 563000E (NAD 1983 Zone 17) (Figure 16-1).

16.1 Land Tenure

The territory of Nunavut was created on April 1, 1999 through the Nunavut Land Claim Agreement (NLCA). Nunavut is made up of three regions; Kitikmeot, Kivalliq and Qikiqtani (or Baffin). The Mary River Project lies in the Qikiqtani region. The 1.9 million square kilometres of land in Nunavut are classified as either Crown land, Inuit Owned Land (IOL) surface land, IOL surface/subsurface lands, or Commissioners land. Land ownership and regulatory processes are managed by the Government of Canada (GoC), Nunavut Tunngavik Incorporated (NTI), Regional Inuit Associations (RIAs), the Government of Nunavut (GN) and Institutions of Public Government (IPGs). Each has specific mandates and responsibilities, however, there is some overlap.

The mineral properties of Baffinland consist of three mining leases, three exploration areas leased from NTI, and a number of blocks of mineral claims (Figure 16-1). Detailed lists of the mining leases, mineral claims, and exploration areas are in Tables 30-1 to Table 30-3 of Appendix 1.

16.2 Mining Leases

The mining leases are numbered 2483, 2484, and 2485 and cover a total area of 1,593.4 ha. The leases are valid for a 21 year period and expire on August 27, 2034. BIM plans to renew the mining leases for an additional 21-year period.

The original leases were surveyed in 1971 by the Federal Land Surveyor and leases were issued in 1971, by the Northwest Territories Government, renewed in 1992, and are in good standing to August 27, 2034. The leases were legally transferred to BIM on March 4, 2005. Pursuant to the NLCA of 1993, a new survey of the lands and boundaries was required.

Survey markers of the lease boundaries comprised of steel pins and rock cairns were relocated by BIM personnel in the summer of 2007, using a Trimble GPS to confirm the previously defined latitude and longitude coordinates and the current coordinate system of UTM Zone 17 NAD (1983). The BIM surveyed UTM points indicate that Deposit Nos. 1 and 2 and the western extent of Deposit No. 3 are all well contained within the lease boundaries.

The mining leases predate the NLCA, but are surrounded by IOL (Figure 16-1), either designated as surface and subsurface rights (around mining leases 2484 and 2485) or surface only (around mining lease 2483). The mining leases are administered by GoC under

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the Canadian Mining Regulations. Access to land for which the Inuit have surface ownership is through the regional Qikiqtani Inuit Association located in Iqaluit.

16.3 Mineral Claims

BIM holds 406 mineral claims totalling 390,388.4 ha. In October 2008, Baffinland staked 18 mineral claims totalling 12,956 ha known as the McOuat block, which encircle the leases covering Deposit No. 4 and extend to the southeast to cover Deposit No. 5. In 2010, BIM staked four additional blocks of claims, the Glacier Lake Block consisting of 20 claims covering Deposit No. 6, the Turner River Block consisting of nine claims covering Deposit No. 7, the North Cockburn River Block consisting of eight claims covering Deposit No. 8, and the Rowley River Block consisting of four claims covering Deposit No. 8. Six more blocks of claims were staked in 2011. All mineral claims are reported by BIM to be in good standing as of the date of this Technical Report. The locations of the blocks of claims are shown in Figure 16-1.

16.4 Exploration Areas

In addition, BIM has the right to earn a 100% interest through an Exploration Agreement with the NTI on three exploration areas (Figure 16-1). Sub Area A totals 16,695 ha and surrounds mining leases 2484 and 2485. Sub Area B totals 1,425 ha and is located to the east of mining lease 2483. Sub Area C is located in the Eqe Bay area (Figure 16-1) and totals 30,506 ha.

BIM's mining leases are not subject to the Exploration Agreement and subsequent Joint Venture agreement, should BIM choose to continue with the Exploration Agreement and meet the expenditure and payment requirements.

16.5 Royalty Agreements and Encumbrances

BIM and Iron Ore Holdings are the exclusive owners of the mineral rights within the three mining leases that comprise the Mary River property which hosts the three main Mary River deposits (Nos. 1, 2 and 3). There are no royalties, back-in rights, payments, or other obligations pertaining to the Mary River property, other than taxation pertaining to any mining property being developed in Nunavut. For the purposes of economic analysis of the Project, assumptions have been made regarding potential royalties and payments that may eventually be agreed to in an Inuit Impacts and Benefits Agreement (IBA or IIBA) with First Nations.

16.6 Environmental Liabilities

Given that the Mary River site was explored in the 1960s, it is possible that some environmental liabilities exist in the form of petroleum contamination from general site activities, and from an original camp landfill. The potential environmental liability from these operations is thought to be minimal, based on an assessment of the area carried out in 2006. Surface clean-up of materials and equipment remaining from exploration in the 1960s has been undertaken by BIM since 2004, including removal of steel drums and equipment from the Project site.

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16.7 Existing Permits

A number of permits have been obtained to carry out the exploration activities. A list of permits provided to Wahl and Gharapetian (2011) by BIM include Water License (2BB-MR0710, NWB), Authorization S.35(2) of Fisheries Act (NU-06-0084, DFO), S.5(1) Navigable Waters Protection Act (8200-09-10415 8200-09-10425, 8200-09-10414, 8200-09-10424,Transport Canada, Inuit Land Use Lease and Aggregate Concession (Q10L3C010, QIA), Land Use Permit (N2007F0004, N2006C0036, INAC) and Quarry Permit (2010QP0088, INAC).

16.8 Jurisdiction

In February 2008, BIM announced the execution of a commercial lease of surface lands from the QIA, covering approximately 10,567 ha of surface lands on Baffin Island, Nunavut. The lease permits BIM to use the subject area for the purposes of the exploration of minerals, the undertaking of engineering, geotechnical, and environmental studies in support of the planning for a potential major mining development and to complete a bulk sampling program. The lease is valid from September 6, 2013 until December 31, 2043 and was renewed for an additional one year by the Company, subject to the terms and conditions of the lease.

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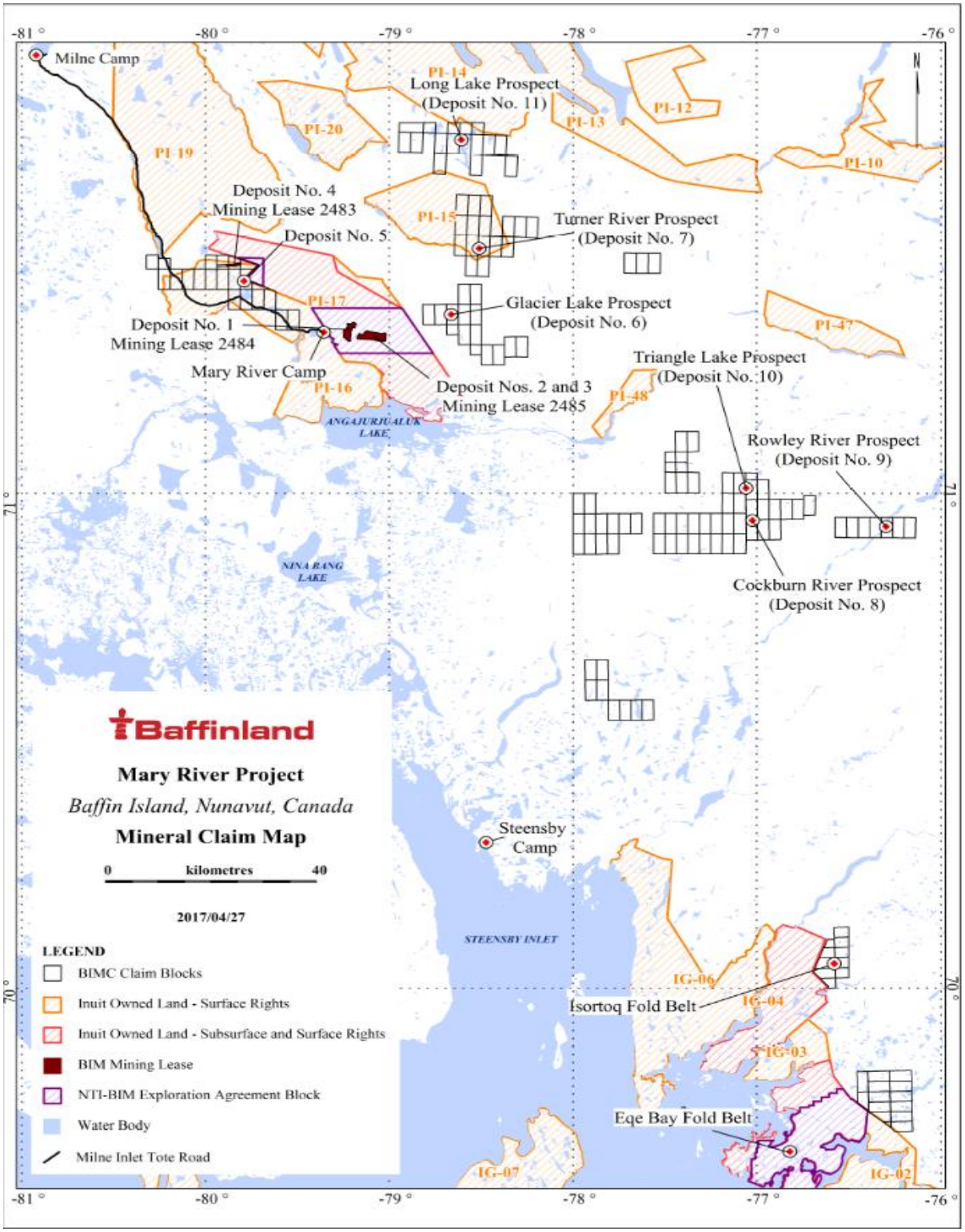

Figure 16-1: Location Map

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16.9 Reference Documents

Doc Number/Author	Description	Date	Appendix Number
George Wahl Associates	Mary River Deposit No 1 Resource and Mine Planning Report	October 2009	A16-1
RPA	Technical Report on the Mary River Project – Expansion Case, Baffin Island, Nunavut	December 2013	A16-2
Qikiqtani Inuit Association/Baffinland Iron Mines Corporation	Inuit Impact and Benefit Agreement	September 2013	A16-3

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 17 – Health Safety, Environment and Community

2017-05-01	0	Internal / Client Review	O. Gamache	T. Bruce	S. Heiner	
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			**Employer**

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Disclaimer

This report has been prepared by Hatch Ltd. ("Hatch") for the sole and exclusive benefit of Baffinland Iron Mines Corporation (the "Client") for the sole purpose of assisting the Client to identify potential options to increase production from the Mary River mine, and may not be provided to, used or relied upon by any other party for financing purposes without receipt of a copy of the attached waiver and release executed by such third party.

Any use of this report by the Client is subject to the terms and conditions provided in the ArcelorMittal General Service Agreement, dated November 14, 2014, including the limitations on liability set out therein. Without limiting the foregoing, Hatch explicitly disclaims all responsibility for losses, claims, expenses or damages, if any, suffered by a third party as a result of any reliance on this Report, including for any decisions made or actions made by such a third party and based on this Report ("Claims"), and such third party's use or review of the Report shall constitute its agreement to waive all such Claims and release Hatch in respect thereof.

This report is meant to be read as a whole, and sections should not be read or relied upon out of context. While it is believed that the information contained herein is reliable under the conditions and subject to the limitations set forth herein, this Report is based in part on information not within the control of Hatch and Hatch therefore cannot and does not guarantee the accuracy of such information based in whole or in part on information not within the control of Hatch. The comments in it reflect Hatch's professional judgment in light of the information available to it at the time of preparation.

This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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17. Health, Safety, Environment and Community

17.1 Introduction

The purpose of this section is to describe the approach the Mary River Stage 3 Expansion will implement to ensure Baffinland Iron Mines Corporation's (Baffinland) commitments to health, safety, environment, and community are actualized, and Baffinland's regulatory requirements and commitments are met by all contractors and sub-contractors that will be working at the site.

17.2 Health and Safety

The fundamental goal of the Health and Safety Program is Zero Harm.

Strategies to enhance the projects ability to achieve Zero Harm are outlined in the PEP Part B1 – Health and Safety Management. These strategies are summarized as follows:

1. **Health and Safety Alignment**, between all project stakeholders.
2. **Legal Compliance**, by all project entities with the authorities having jurisdiction in Nunavut.
3. **Effective Emergency Response Plan**, that is well communicated and known by the entire workforce deployed to site.
4. **Continual Audit Program**, by all staff and craft deployed to the project.
5. **Leadership and Commitment**, from all Owner, EPCM and Contractor management deployed to the project.
6. **Involvement, Communication and Motivation,** that provides clarity, transparency and inclusion to all stakeholders with respect to the Health and Safety drivers on the project.
7. **Performance, Tracking and Accountability**, that attains visibility into metrics, trends, quickly investigates incidents and items of concern, applies corrective actions and demonstrates to the workforce that Safety is First in every operation on the project.
8. **Learning and Competency**, training programs that are relevant to the work, evolve with the work, and are tracked and catalogued for the workforce.
9. **Occupational Health and Hygiene**, programs that are established ahead of the work, establish baselines, provide the necessary information to engineer solutions, develop programs, or requirements for additional PPE to allow operations to continue while protecting the worker.

The strategies above will form the foundation of the Mary River Expansion Health and Safety Program.

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17.3 Environmental Management Requirements

The capital cost estimate has been based upon project wide specifications (Standard Specifications) which were included in each contract package. Each contract includes Environmental Management Requirements (Attachment G), which is the Baffinland Environmental Protection Plan, and contains the following information:

- Purpose.
- Environmental Approvals.
- Responsibilities.
- Operational Environmental Standards (OESs).
- Documentation Logs and Forms.

Operational Environmental Standards (OESs) identify and address Project environmental issues and concerns and provide guidance and control measures (which may be field fit as required), to avoid potential negative impacts to the environment and/or minimize or mitigated these impacts to the greatest extent practicable. The OESs are not comprehensive and are intended to be used in conjunction with relevant documents such as Environmental Management Plans (EMPs), Standard Operating Procedures, Environmental Permits, Licenses, and Regulation, etc.

17.3.1 Environmental Management Plan

Contractors were required to submit the following documents with their bid submission in which their pricing was based upon:

- Contractor's Environmental Management Plan.
- Curriculum Vitae of the Environmental Officer.
- Undertaking to compliance with the Employer's Environmental Management Policy and/or list of deviations to the Employer's Environmental Management Policy.

Each contractor must submit a Contractor Environmental Management plan with their bid submission, which is reviewed by the Project for compliance with Baffinland's Environmental Protection Plan. If the bid evaluation process determines that there are any shortfalls in the Contractor's environmental management system, then a rectification action plan will be established with the bidder prior to contract award.

17.4 Local (Inuit) Content Requirements

Inuit content requirements are stipulated in all contract documents as the Standard Specification for Inuit Content Requirements. Contractors are required to adhere to the specification, which provides the following: relevant definitions related to Inuit content; responsibilities for the contractor and employer; hiring requirements for Inuit employees; the

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use of Inuktitut on site, and during the recruitment and employment process; training and education; the use of designated Baffin Inuit Firms and Designated Inuit Firms; the Contractors Inuit Content Plan; and record keeping.

17.4.1 Minimum Inuit Employment Goal (MIEG)

The Minimum Inuit Employment Goal (MIEG) for each contract is expressed as a percentage and is calculated as follows:

MIEG = (total number of training hours provided to Inuit + total number of hours worked by Inuit employees) / (total number of hours worked by Contractor on site)

For the purposes of each contract, Baffinland has established a MIEG that represents the percentage of Inuit employment that each contractor is expected to achieve. The MIEG may change over the course of the contract. For example, the average annual MIEG may be 10 percent in the first year but may increase to an average annual MIEG of 20 percent during the second year of the contract.

The contractor is required to consider these MIEG requirements when completing the Contractors Inuit Content Plan (CICP). The contractor is solely responsible for maximizing Inuit Content, including all subcontractors.

Contractors are required to acknowledge and accept the incentive and penalties associated with the MIEG established in the contract.

17.4.2 Contractors Inuit Content Plan (CICP)

The Contractor's Inuit Content Requirements establishes the minimum requirements as they relate to the Contractor's Inuit Content, which the contractor will be required to follow during all Project-related aspects of their work activities. The Contractors Inuit Content Requirement document identifies minimum requirements for the contractor to maximize Inuit employment and subcontracting opportunities.

Inuit content is evaluated based on the components included in this document and those described in the Contractors Inuit Content Requirements. In particular, Contractors shall submit a detailed Inuit Content Strategy (refer to section in table below) describing their Inuit employment, retention, and training strategies. In order to accurately assess the Contractor's commitment to Inuit Content, the Contractor shall provide the following information:

- Firm designation (where applicable): Designated Inuit Firm (DIF), Designated Baffin Inuit Firm (DBIF), head office located in the Baffin Region.
- Identification of roles and responsibilities to ensure Inuit Content is thoroughly planned and implemented: Project Manager, Human Resources Representative, Training Representative.
- Estimated percentage of work hours and proportion of wages according to the following categories:

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  - North Baffin Inuit communities of Pond Inlet, Igloolik, Clyde River, Hall Beach, Arctic Bay.
  - Other Baffin communities.
  - Other Nunavut Land Claim beneficiaries.
  - Employees from other Canadian provinces or territories.
  - Foreign employees.
- Workforce Plan, including estimated number of Inuit and non-Inuit employees at all levels of employment, from entry-level to senior management.
- Inuit Education and Training: training to Inuit in all areas of the contract. All areas of the contract will be considered for training opportunities. The Contractor will develop their own education and training policies subject to the Company's review and approval. The Contractor will identify and list training opportunities and programs to be available to Inuit staff for a defined list of job classifications.
- Subcontracts: best efforts used to maximize subcontracting opportunities for qualified Inuit Firms. The contractor is required to identify and list potential subcontracting opportunities, anticipated workforce breakdown, and the value of the contracts.
- Purchases from Inuit Firms: best efforts used to maximizing goods purchases from for qualified Inuit Firms. The contractor will identify and list the potential suppliers and associated goods.
- Detailed description of employment, retention, and training strategies to maximize Inuit content throughout the execution of the contract.
- Reporting: monthly and periodic submission of an Inuit Content Reporting Form, on key performance indicators.

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 18 – Sustainable Development

2017-05-01	0	Approved for Use	BIM	BIM	BIM	BIM
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18. Sustainable Development

18.1 Introduction

The purpose of this Section is to describe the approach the Mary River Expansion Project (The Project) will implement to ensure Baffinland Iron Mines Corporation's (Baffinland) commitment to sustainable development is actualized and Baffinland's regulatory requirements and commitments are met.

As The Project represents an expansion to an existing operation, the intention of this section is to summarize the current operational control and regulatory approval mechanisms obtained by the Mary River Project for its existing operation and identify the changes required to them to account for the anticipated changes to the biophysical and socioeconomic environment resulting from the Stage 3 Project.

The Project scope of work includes shipping 12 Mtpa of Direct Ship Ore (DSO) from Milne Inlet, using up to Cape size ore carriers ships utilizing a shipping window of July 01 to November 15 annually. Ore would be transported from the Mine Site to Milne Port via the development of a north railway that follows the existing Tote Road to the extent feasible.

18.2 Sustainable Development Policy

The Baffinland Sustainable Development Policy endorses the principle of sustainable development, recognizing that sustainable development includes commitments to health, safety, and the environment through a balanced approach to economic, technical, and social issues. This policy sets forth Baffinland's ongoing commitment to health, safety, and the environment. The Baffinland Sustainable Development Policy was approved by Baffinland's CEO, Brian Penney, in March 2016.

Baffinland Sustainable Development Policy is as follows:

> *Baffinland Iron Mines Corporation (Baffinland), we are committed to conducting all aspects of our business in accordance with the principles of sustainable development & corporate responsibility and always with the needs of future generations in mind. Baffinland conducts its business in accordance with the Universal Declaration of Human Rights and ArcelorMittal's Human Rights Policy which applies to all employees and affiliates globally.*
>
> *Everything we do is underpinned by our responsibility to protect the environment, to operate safely and fiscally responsibly and with utmost respect for the cultural values and legal rights of Inuit. We expect each and every employee, contractor, and visitor to demonstrate courageous leadership in personally committing to this policy through their actions. The Sustainable Development and Human Rights Policy is communicated to the public, all employees and contractors and it will be reviewed and revised as necessary on a regular basis. These four pillars form the foundation of our corporate responsibility strategy:*

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1. Health and Safety

2. Environment

3. Upholding Human Rights of Stakeholders

4. Transparent Governance

1.0 HEALTH AND SAFETY

- *We strive to achieve the safest workplace for our employees and contractors; free from occupational injury and illness, where everyone goes home safe everyday of their working life. Why? Because our people are our greatest asset. Nothing is as important as their health and safety. Our motto is "Safety First, Always".*
- *We report, manage and learn from injuries, illnesses and high potential incidents to foster a workplace culture focused on safety and the prevention of incidents.*
- *We foster and maintain a positive culture of shared responsibility based on participation, behaviour, awareness and promoting active courageous leadership. We allow our employees and contractors the right to stop any work if and when they see something that is not safe.*

2.0 ENVIRONMENT

- *Baffinland employs a balance of the best scientific and traditional Inuit knowledge to safeguard the environment.*
- *Baffinland applies the principles of pollution prevention, waste reduction and continuous improvement to minimize ecosystem impacts, and facilitate biodiversity conservation.*
- *We continuously seek to use energy, raw materials and natural resources more efficiently and effectively. We strive to develop more sustainable practices.*
- *Baffinland ensures that an effective closure strategy is in place at all stages of project development to ensure reclamation objectives are met.*

3.0 UPHOLDING HUMAN RIGHTS OF STAKEHOLDERS

- *We respect human rights, the dignity of others and the diversity in our workforce. Baffinland honours and respects the unique cultural values and traditions of Inuit.*

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- *Baffinland does not tolerate discrimination against individuals on the basis of race, colour, gender, religion, political opinion, nationality or social origin, or harassment of individuals freely employed.*
- *Baffinland contributes to the social, cultural and economic development of sustainable communities in the North Baffin Region.*
- *We honour our commitments by being sensitive to local needs and priorities through engagement with local communities, governments, employees and the public. We work in active partnership to create a shared understanding of relevant social, economic and environmental issues, and take their views into consideration when making decisions.*
- *We expect our employees and contractors, as well as community members, to bring human rights concerns to our attention through our external grievance mechanism and internal human resources channels. Baffinland is committed to engaging with our communities of interest on our human rights impacts and to reporting on our performance.*

4.0 TRANSPARENT GOVERNANCE

- *Baffinland will take steps to understand, evaluate and manage risks on a continuing basis, including those that may impact the environment, employees, contractors, local communities, customers and shareholders.*
- *Baffinland endeavours to ensure that adequate resources are available and that systems are in place to implement risk-based management systems, including defined standards and objectives for continuous improvement.*
- *We measure and review performance with respect to our safety, health, environmental, socio-economic commitments and set annual targets and objectives.*
- *Baffinland conducts all activities in compliance with the highest applicable legal & regulatory requirements and internal standards.*
- *We strive to employ our shareholder's capital effectively and efficiently and demonstrate honesty and integrity by applying the highest standards of ethical conduct.*

4.1 FURTHER INFORMATION

Please refer to the following policies and documents for more information on Baffinland's commitment to operating in an environmentally and socially responsible manner:

- *Health, Safety and Environment Policy*

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- *Workplace Conduct Policy*
- *Inuktitut in the Workplace Policy*
- *Site Access Policy*
- *Hunting and Fishing (Harvesting) Policy*
- *Annual Report to Nunavut Impact Review Board*
- *ArcelorMittal Canada Sustainability and Corporate Responsibility Report*

If you have questions about Baffinland's commitment to upholding human rights, please direct them to contact@baffinland.com.

Brian Penney
Chief Executive Officer
March 2016

18.3 Current Project Approvals

The Stage 3 Project will comply and meet Nunavut and federal regulatory requirements. Authorizations for the existing operation were identified through consultation with the applicable regulatory agencies, conformity to the North Baffin Regional Land Use Plan (NBRLUP) under the jurisdiction of the Nunavut Planning Commission (NPC), and conformity to the guidelines for the development of an environmental and socio economic impact statement as directed by the Nunavut Impact Review Board (NIRB).

A comprehensive list of current Project approvals and authorizations are included in Table 18-1 with discussion on the of key approval instruments in the proceeding sub-sections.

Table 18-1: Current Project Approvals

Permit Name	Permit Number	Regulatory Agency	Expiry
Project Certificate and Amended Project Certificate	005	Nunavut Impact Review Board	No Expiry
Inuit Impact Benefit Agreement	N/A	Qikiqtani Inuit Association	No Expiry
Commercial Lease	Q13C301	Qikiqtani Inuit Association	31-Dec-43
Amendment No.1 Type A Water Licence [1]	2AM-MRY1325	Nunavut Water Board	10-Jun-25
Type B Water License - Exploration	2BE-MRY1421	Nunavut Water Board	16-Apr-21
Land Use Permit - Steensby and Milne	N2014C0013	Indigenous an Northern Affairs Canada	30-Jun-17
Land Use Permit - Milne Foreshore	N2014X0012	Indigenous an Northern Affairs Canada	30-Jun-17
Land Use and Quarrying Permit - Tote Road (Borrow P1 at Km 63)	N2014Q0016	Indigenous an Northern Affairs Canada	30-Jun-17
Land Use Permit - Bruce Head	N2014J0011	Indigenous an Northern Affairs Canada	30-Jun-17
Land Lease - Milne Foreshore	47H/16-1-2	Indigenous an Northern Affairs Canada	30-Jun-35
Permitted Quarries and Borrows on Inuit Owned Land: Quarries Q1,	N/A	Qikiqtani Inuit Association	N/A

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Permit Name	Permit Number	Regulatory Agency	Expiry
QMR2,Q7, Q11, Q19, Borrows KM104, Km 2, and Km 97			
Fisheries Authorization - Ore Dock	14-HCAA-00525	Department of Fisheries and Oceans	31-Dec-20
Fisheries Authorization - Tote Road	NU-06-0084	Department of Fisheries and Oceans	No Expiry
Fisheries Authorization – Crossings	06-HCAA-CA7-00084	Department of Fisheries and Oceans	31-Dec-16
Fisheries Crossings along Tote Road and Quarries, culvert extensions and replacements	Various Letters of Advice	Department of Fisheries and Oceans	No Expiry
Licence to Fish for Scientific Purposes and Animal Use Protocol[2]	S-16/17-1016-NU, S-16/17-1019-NU, AUP 2016-027 FWI-ACC-2016-017	Department of Fisheries and Oceans	-
Navigable Waters - Crossings	8200-07-10273, 10267, 10269, 10268, 10274, 10272, 10266, 10271	Transport Canada	Until work completed
Marine Facility	4306-2-6- P/B	Transport Canada	24-June-20
Scientific Permit [3]	02 008 15R-M	Government of Nunavut	-
Archaeology Permit [4]	2016-29A	Government of Nunavut	-
Factory Licence [4]	F76068	National Resources Canada	-

NOTE:
[1] Previously held Type 'B' Water Licence 8BC-MRY1416 was cancelled in February 2016 as all activities therein are now covered by the amended Type 'A' Water Licence.
[2] Held by Minnow Environmental Inc. and North/South Consulting for Licence to Fish for Scientific Purposes associated with the Stage 3 Project
[3] Held by Knight Piésold for performance of IQ and Traditional Harvest Studies associated with the Stage 3 Project
[4] Held by Claude Pinard for performance of archeology work associated with the Stage 3 Project
[5] Held by Dyno Nobel, the explosives contractor on behalf of the Stage 3 Project

18.3.1 Project Certificate and Amended Project Certificate

On December 28, 2012, the Nunavut Impact Review Board (NIRB) pursuant to Section 12.5.12 of Article 12 of the Nunavut Land Claims Agreement, issued Project Certificate No. 005 for the Mary River Project to Baffinland. The basis for this Project Certificate is Baffinland's Final Environmental Impact Statement (FEIS) which presented in-depth analyses and evaluation of potential environmental and socio-economic effects associated with mining of the reserves of Deposit No. 1 at a nominal rate of 18 Million tonnes per year (Mtpa). Development of this project includes the construction, operation, closure and post-closure activities associated with the Mine and its related infrastructure, the construction of a 150km railway from the Mine Site to a new port facility at Steensby Inlet, and the construction of the Steensby Port. The FEIS for the approved Mary River Project was prepared in adherence to Guidelines for the Preparation of an Environmental Impact Statement for the Baffinland Iron Mines Corporations Mary River Project (NIRB file No. 08MN053; the Guidelines), issued on November 16, 2009; and the NIRB's Preliminary Hearing Conference Decision for Baffinland Mary River Project, December 9, 2011.

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18.3.1.1 Final Environmental Impact Statement Amendment No.1

Following receipt of the original Project Certificate, and as Baffinland noted in January 2013 with correspondence to the NIRB, a decision was made to postpone full development of the Mary River Project as described in the FEIS and rather move the Mary River Project forward in a phased approach due to the current economic climate at that time. This phased approach resulted in Baffinland proposing an Early Revenue Phase (ERP) to the Mary River Project. The ERP includes development of a nominal 4.2 Mtpa road haulage operation from the Mary River Mine Site to a port facility at Milne Inlet for shipping of iron ore during the open water season only. These activities were included in the Addendum to the FEIS submitted by Baffinland on June 20, 2013. Pursuant to Sections 12.5.12 and 12.8.3 of Article 12 of the Nunavut Agreement and based on the Addendum to the FEIS submitted and subsequent hearings and consultation, the NIRB issued an amended Project Certificate for the Mary River Project, including the ERP, to Baffinland on May 28, 2014, subject to the terms and conditions. This is the current Project Certificate the Mary River Project is operating under.

18.3.2 Inuit Impact Benefit Agreement

On September 6, 2013, the QIA and Baffinland signed the terms of the Inuit Impact Benefits Agreement (IIBA). Underlying the provisions of this Agreement is the principle of mutual benefit, collaboration and consultation for both Inuit and the Company from the Mary River Project. As per the IIBA, benefits for Inuit shall include financial participation, a comprehensive training strategy, target levels of Inuit employment, capacity building, business opportunities and Inuit content considerations in contracting. To the extent that Inuit achieve these benefits the Company will then be able to rely on efficient, high quality Inuit firms, a well-trained local work force, Project support and stability. Baffinland is required to adhere to the terms and conditions of the agreement throughout the life of the Stage 3 Project.

18.3.3 Commercial Lease Agreement No.Q13C301

Milne Port, most of the Milne Inlet Tote Road and the Mine Site are located on Inuit-owned land administered by the Qikiqtani Inuit Association (QIA). On September 6, 2013, the QIA, acting as the Landlord, and Baffinland, acting as the Tenant, signed a Commercial Lease for Inuit Owned Lands. Subject to terms and conditions, the Commercial Lease authorizes Baffinland to have and to hold, for and during the term of the lease, the land identified in the agreement. These areas encompass the vast majority of the current Mary River Project site. The terms and conditions of the Commercial Lease establish expectations between Baffinland and QIA regarding management of these areas. This includes the rent, boundaries, water use fees, quarry concession agreement, environmental conditions, authorities for QIA inspectors and auditors, required plans and reporting, and the amount and type of financial security required. The Commercial Lease expires on December 31, 2043.

18.3.4 Type A Water Licence (2AM-MRY1325)

On July 15, 2013 the Nunavut Water Board (NWB) issued a Type A Water Licence (2AM-MRY1325) for the Mary River Project. The Type A Water Licence authorizes Baffinland to use

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water and deposit waste in support of a mining and milling undertaking at the Mary River Project. The original Type A Water Licence granted approval for the activities as described in the FEIS. Similar to the amendment process for the Project Certificate, in order to account for the ERP of the Mary River Project, an amendment to Type A Water Licence 2AM-MRY1325 was applied for to reflect the changes in project activities. Based on this application for the ERP, the Type A Water Licence was amended on July 21, 2015. In addition to the terms and conditions set forth in the Type A Water Licence which Baffinland is required to adhere to the, amended Type A Water Licence 2AM-MRY1325 allows for 689,000 cubic metres annually during the Construction Phase; 547,500 cubic metres annually during the ERP; and 353,000 cubic metres annually during the Operations Phase. This is the current Type A Water Licence the mining operation of the Mary River Project operates under and it is valid until June 10, 2025.

18.3.5 Type B Water Licence (2BE-MRY1421)

Type B Water Licence No. 2BE-MRY1421 authorizes Baffinland to undertake mineral exploration, geotechnical drilling programs, ongoing operation, maintenance and upgrades to existing pioneer camps at Steensby Inlet and Mid Rail. Under his water licence Baffinland is authorized to use two hundred and ninety-nine (299) m^3 per day of water for all the activities mentioned above. The licence is valid until April 16, 2021 and requires Baffinland to be in compliance with all the terms and conditions set forth in the Licence. This is the current Type B Water Licence exploration and drilling activities associated with the Mary River Project operate under.

18.3.6 Use of Crown Land

Current project components on Crown land include a small portion (about 4.7 km) of the Milne Inlet Tote Road south of Katiktok Lake and exploration sites. Land use authorizations on Crown land are obtained from Indigenous and Northern Affairs Canada (INAC) pursuant to the *Territorial Lands Act* and include Class A land use permits for Project infrastructure and activities on Crown Land, quarry permits for construction and quarry leases to support operation and maintenance of the quarries, and a water lot lease for Project activities, docks, and infrastructure in near-shore waters at Milne Port. There are four (4) Class A land use permits that currently authorize the use of Crown Land associated with the Mary River Project. These four (4) permits include:N2014C0013 for the Crown Land associated with the exploration components of the Project, N2014Q00169 for quarrying along the Crown Land portion of the Tote Road, N2014X0012 for the ore dock and Milne Port foreshore area, and N2014J0011 for the Bruce Head monitoring camp. These Class A land use permits are required to be renewed annually.

In addition to the Class A land use permits mentioned above, a Nunavut Land Lease for the Milne Foreshore area (47H/16-1-2) was obtained from INAC on July 1, 2014 to allow for the development and ongoing operation of the ore dock and ship loader. This Land Lease requires Baffinland to adhere to its terms and conditions and is valid until June 30, 2035.

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18.3.7 Fisheries Authorization

Impacts on fish and fish habitat resulting from the Mary River Project must be authorized by the Department of Oceans and Fisheries (DFO) under the *Fisheries Act*. Works for which DFO have oversight on include: water intake structures and sewage outfall structures at construction camps, the Mine Site and Port sites, construction docks and permanent dock structures at Milne Port to support ore and freight operations, as well as numerous watercourse crossings along the Tote Road.

A description of all current potential impacts on fish and fish habitat resulting for the Project have been submitted to the DFO and the DFO has provided direction on a case by case basis. All other future authorizations required from DFO will also be dealt with on a case by case basis.

18.3.8 Explosives

All applications for permits required for the transportation, storage, and use of explosives are submitted directly by the designated explosives contractor for the Project directly to Natural Resources Canada (NRCAN).

18.4 Anticipated Environmental Effects of Stage 3

The authorizations highlighted above have been obtained to account for current activities. In addition to these current activities, the Stage 3 Project is expected to impact the following key biophysical and socio-economic components which will require corresponding changes to approvals. Key impacts that have to be addressed through amended authorizations include:

- Increased employment.
- Increased water consumption.
- Increased waste generation.
- Increased fuel consumption and storage requirements.
- Increased shipping activity.
- Increased power consumption.
- Increase in explosives production and consumption.
- Dust deposition changes.
- Spill risk changes.
- Air emissions changes.

18.4.1 Increased Employment and Skill Development Opportunity

With the increase in activities during the Construction Phase and an increase of tonnes of ore mined, crushed, transported, stockpiled and shipped during the Operations Phase, there will be a corresponding increase in employment opportunities for both skilled and unskilled

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labour. Employment opportunities range from ore truck drivers, mechanical and maintenance people to chefs, administration and cleaning staff of the larger accommodation camps.

18.4.2 Increased Water Consumption

There may be an increase in water consumption at both the Mine Site and Milne Port, especially during the Construction Phase. This is a direct result of the increase in manpower, equipment, and infrastructure required to support the development of the Stage 3 Project. As each person and piece of equipment requires a volume of water each day, an increase in the equipment or site population will result in an increase in water consumption.

18.4.3 Increased Waste Generation

The amount of waste generated onsite is expected to increase with the construction of the Stage 3 Project. From a domestic standpoint, this can largely be attributed to increased camp populations at both sites, more equipment, and the importation of greater numbers of perishable and non-perishable goods required onsite. The Operations phase of the Stage 3 Project is expected to see similar waste generation as current operations. From a mine waste standpoint, the Stage 3 Project is expected to see a similar cumulative mine waste generation amount as presented in the FEIS.

18.4.4 Increased Fuel Consumption and Storage Requirements

Project wide fuel storage requirements will increase for the Stage 3 Project. This can be attributed to the addition of locomotives, increased production and mobile equipment usage, and other construction activities onsite.

18.4.5 Increased Shipping Activity

An increase in shipping activity to allow for the winter re-supply of freight and increased open water ore shipment will occur. The main consideration of this is the impact shipping will have on marine mammals and community perception. The increase in traffic will need to be approved by the NIRB and NPC in addition to being discussed with the affected communities, Transport Canada (TC), the Canadian Coast Guard (CCG), Environment Canada (EC) and the Department of Fisheries and Oceans (DFO).

18.4.6 Increased Power Consumption

As a result of the increased infrastructure, camp capacity and workforce, the power consumption will increase.

18.4.7 Increase in Explosives Production and Consumption

Given the increase in production rate it is to be expected that explosives consumption, and therefore, production, will increase proportionally. At this time it has been assumed the current emulsion plant will have sufficient capacity to meet this need.

18.4.8 Increase Disturbance to Fish and Fish Habitat

The development of the Stage 3 Project will result in additional impacts on fish and fish habitat which must be authorized by the DFO under the *Fisheries Act*. Works for which DFO have oversight associated with the Stage 3 Project include: water intake structures and

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sewage outfall structures at construction camps, construction docks and permanent dock structures at Milne Port to support ore and freight operations, as well as numerous watercourse crossings along the Tote Road and north rail alignment.

18.4.9 Changes to Dust Fall

There will be increased dust deposition and sedimentation during the Construction Phase of the Stage 3 Project from both trucks' tires along the Tote road surface, until the railway is operational, and from increased crushing and screening of ore and aggregate.

Upon commencement of the Operations Phase of the Stage 3 Project, dust and sedimentation levels are expected to decrease relative to generation levels associated with the current operation based on use of rail vs. truck for terrestrial transportation of ore.

18.4.10 Changes to Risk of Spills

During the Construction Phase of the Stage 3 Project, increased usage of mobile construction equipment will result in an increased risk of hydrocarbon spills.

During the Operations Phase of the Stage 3 Project, the proposed development of the north rail is expected to results in a decrease of risk of trucks overturning. Other changes to spill risks would include:

- Change of spill risk physical locations and management of potential impacts on corresponding nearby sensitive habitats, if any, due to development of new areas for project infrastructure.
- Increase in the risk of spillage of ore into the marine environmental from ship loading conveyors associated with the proposed second ore dock.
- Increase risk of hydrocarbon and iron ore spills in the ocean as a result of increased traffic of freight and ore within Eclipse Sound.

18.4.11 Changes to Air Emissions

Stage 3 construction activities will results in increased fuel usage on site. This additional fuel usage will have a corresponding impact to air quality (excluding PM/Dust – see Section 18.4.9).

During the Operations Phase of the Stage 3 Project, the proposed development of the north rail is expected to represent a positive impact on air quality relative to existing operations based on the use of rail vs trucks to haul ore.

In regards to air emission in the marine environment, in both the Construction and Operations phases of the Stage 3 Project, the number of vessels transiting Eclipse Sound during the open water months will increase. This will result in increased SO_2 and NOx emissions from ore carriers and freight vessels.

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18.4.12 Increased Noise

The additional shipping activities associated with the Construction and Operations phases of the Stage 3 Project are likely to result in increased noise and vibration, in the marine environment.

In the terrestrial environment, Stage 3 construction activities are expected to generate localized noise and vibration increases related to construction activities and aggregate production. During the Operations phase, the development of the rail and the eventual discontinued use of trucks to haul ore is expected to change to the noise and vibration profile along the terrestrial transportation corridor.

18.5 Sustainable Development External Approval Requirements for Stage 3

The proposed project changes, and their associated increases and/or decreases in potential environmental and social impacts (see Section 18.4), will require additional or amended project permits and authorizations to be obtained prior to the Stage 3 Project gaining regulatory approval (see Section 18.3 for status of existing approvals) and compliance with Baffinland's Sustainable Development Policy (see Section 18.2). The key activities, permits and authorizations anticipated to be required to be amended or obtained prior to the Stage 3 Project gaining regulatory approval, are described in the subsection below. For the anticipated sequence and schedule of the regulatory approval process, see Section 12.

18.5.1 Consultation

Baffinland is committed to conducting meaningful engagement with stakeholders potentially affected by the Stage 3 Project, including the five North Baffin Inuit Communities and QIA, applicable regulatory agencies and the general public. Baffinland's engagement efforts are guided by a Stakeholder Engagement Plan (SEP) which was most recently revised in 2016. Strong community engagement to identify concerns and develop appropriate mitigation measures to address them is critical for Stage 3 Project execution and regulatory approval.

The objectives of Stage 3 Project engagement activities are to:

- Provide communities with the opportunity to review Project information in a timely manner and identify issues of concern and potential mitigation.
- Facilitate effective implementation of and compliance with commitments contained in the Inuit Impact and Benefit Agreement (IIBA).
- Allow traditional and local knowledge to be taken into consideration to improve internal decision-making processes.
- Reduce business and reputational risks and contribute to the "social licence".
- In order to achieve these objectives as it relates to the Stage 3 Project, a range of engagement methods will be employed by Baffinland, including:
    - Employment of Baffinland Community Liaison Officers (BCLOs), who are local community representatives that bridge the cultural gap between their specific

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community and Baffinland and who are the “face” of the company in the local communities.

- Community and employee surveys.
- Open Houses and Community Meetings.
- Community focus group discussions.
- Targeted consultation through meetings with specific stakeholder groups (Hamlets, local Hunters and Trappers Organizations, the Mary River Community Group).
- Technical workshops in the North Baffin communities, including workshops focused on specific issues or concerns that have been identified during the environmental assessment process and other consultation and engagement activities, such as Inuit Qaujimajatuqangit (Traditional Knowledge), caribou, marine mammals, and land use and socio-economic matters.
- Participation in multi-stakeholder groups such as the Terrestrial Environment Working Group (TEWG) and the Marine Environment Working Group (MEWG), Qikiqtaaluk Socio-Economic Monitoring Committee (QSEMC), and the IIBA Annual Community Forum.
- IIBA Joint Management and Executive Committees.
- Project website and newsletters, newspapers, radio and TV broadcasts.
- Site visits.

Since the original notification of Baffinland’s expansion intentions to the NIRB in October 2014, Baffinland has regularly and directly engaged with the five North Baffin communities and community groups to provide information on the Stage 3 Project and to discuss any issues of concern. These engagement activities have included the following:

- February, 2015: Community tour of the five North Baffin communities.
- January, 2015: Open House in Pond Inlet.
- March - November, 2015: Workshops in Pond Inlet on Contemporary Inuit Land Use of the Eclipse Sound and Navy Board Inlet Areas, Shipping through Ice, Open Water Shipping, and Caribou.
- April, 2015: Tour of the Voisey’s Bay winter shipping route with key individuals to personally observe shipping through ice.
- May, 2016: Workshop on Phase 2 in Arctic Bay.
- May, 2016: Meeting with Pond Inlet Youth Council.
- July, 2016: Shipping Update delivered in Pond Inlet.

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- September, 2016: Community Survey of the five North Baffin communities.
- November, 2016: Community tour of the five North Baffin communities, meetings with each hamlet and meetings with the Hunters and Trappers Organizations (HTO) of Pond Inlet and Arctic Bay.

The workshops held in Pond Inlet between March and November 2015 on Shipping Through Ice and Open Water Shipping, have provided valuable feedback to Baffinland regarding community views around the timing, routing and conduct of the shipping component of the the Stage 3 Project. With respect to possible shipping through ice, potential effects upon the marine environment (including marine mammals) and potential interference with Inuit travel routes and land use activities arising from ice breaking activities were identified as key concerns. In order to mitigate these, participants suggested that Baffinland avoid shipping in June, as this month is the peak period for Inuit hunters and families going out on the ice to hunt, travel and camp. Similarly, it was also recommended that shipping through Eclipse Sound occur only after community travel to the floe edge was shut down by the Pond Inlet HTO. Shipping during March was a concern for some participants (due to seal pupping) and it was suggested that shipping be avoided during this period. Other participants proposed that shipping be avoided in April and May and that ship traffic should be stopped during times when Nunavut Quest dog team racers would be crossing the ship track. It is also particularly noteworthy that some individuals also advocated for an increase in open water transits to reduce the necessity of shipping through ice.

Although participants at the Shipping Though Ice and Open Water Shipping Workshop also identified some concerns about the possible effects of the Stage 3 Project on the marine environment (including marine mammals) and on Inuit land use activities, open water shipping raised far fewer concerns than shipping through ice. Open water shipping was regarded far more favourably by the community since Pond Inlet residents had past experience with this type of shipping and because similar open water shipping activities through Pond Inlet had already been approved by regulators (including in the ERP).

More recently, between November 21 and 26, 2016 representatives of Baffinland conducted a community tour of the five North Baffin communities of Pond Inlet, Clyde River, Arctic Bay, Igloolik and Hall Beach. Open houses and public meetings were held in each community, and Baffinland also met separately with the five Mayors and Councils and with the Mittimatalik HTO (Pond Inlet) and the Ikajutit HTO (Arctic Bay). The purpose of these meetings was to provide a Project update, including a preliminary introduction to and overview of the proposal to transport ore from the mine site to Milne Inlet by rail rather than by the Tote Road. During these sessions no objections to the rail alternative were raised in any of the meetings. One question was asked about the potential impact of the railway on trucking employment opportunities. As was noted in Baffinland's response, while the overall number of truck drivers would be reduced with the substitution of rail for road transport, the transition to rail would ultimately increase the number and duration of potential jobs in other aspects of the production, transport and shipping of ore to overseas markets.

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To ensure that community views continue to be taken into account, Baffinland will continue to undertake an active and ongoing approach to engagement with the communities and other stakeholders as it relates to the the Stage 3 Project. Baffinland has specifically committed to return to the five North Baffin communities early in 2017 to provide further and more detailed information respecting the Stage 3 Project update and associated regulatory processes. Relevant documentation will be provided in advance of any community, hamlet and HTO meetings to ensure that stakeholders have a meaningful opportunity to identify and discuss issues of concern. All stakeholder engagement activities will be documented through Staketracker consultation software and issues will be addressed and reported as required.

18.5.2 Local Content

In addition to strong engagement, active participation of local communities in the development and implementation of the Stage 3 Project is also critical for Stage 3 Project execution and regulatory approval. Local content requirements (e.g. employment targets, contracting opportunities, education and training, support for communities) are governed by the IIBA and are required to be adhered to during the Stage 3 project execution. Compliance with requirements will be achieved adherence to two (2) key mechanisms, the Inuit Human Resource Strategy and Inuit Procurement and Contracting Strategy.

18.5.2.1 Inuit Human Resource Strategy

Baffinland has worked in collaboration with the QIA on the development of an Inuit Human Resources Strategy (IHRS) and an associated action plan that will have to be implemented during Stage 3 Project execution. The plan has been circulated to the Joint IIBA Executive Committee for approval and implementation will begin following receipt of approval.
The IHRS sets out a number of high-level actions associated with the following matters:

- Strengthening stakeholder collaboration.
- Engagement and development.
- Workforce readiness.
- Recruitment and hiring.
- Employee retention.
- Gender balancing.
- Students and youth.
- Continuous improvement.

The principal goal of the IHRS is to maximize Inuit participation in project workforce through the identification of barriers to employment, assessment of skills and training needs, design and development of targeted training and educational programs (both pre-employment and employment) and career advancement initiatives with a particular focus upon Inuit women and youth. Baffinland will work in cooperation with a wide range of stakeholders, including

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QIA, the federal and territorial governments, regional educational institutions, other industry players and community groups to implement best practices in training and employment during the execution of the Stage 3 Project. For further information on Human Resource considerations related to the Stage 3 Project, please see Section 14.

18.5.2.2 Inuit Procurement and Contracting Strategy

The Inuit Procurement and Contracting Strategy (IPCS) focuses on engagement with Inuit Firms and local contractor employees through five stages of the contracting process: pre-qualification, tender development, request for proposals, execution, and reporting. The IPCS is pending approval by the Joint IIBA Executive and implementation will begin following receipt of approval.

The salient aspects of the IPCS as it relates to Stage 3 project execution are as follows:

- Pre-qualification of Inuit Firms via the completion of a questionnaire which seeks information such as past project experience, core competencies, and contractor health and safety / quality control / risk management programs. This allows Inuit Firms to communicate their strengths to Baffinland so that Baffinland may actively seek contracting opportunities suitable for each Inuit Firm. This also allows Baffinland to promote subcontracting / partnership opportunities between Inuit Firms and southern firms.
- Establishment of contract-specific Minimum Inuit Employment Goals (MIEG) during tender development. This ensures that potential Inuit employment opportunities through contractors are maximized by setting realistic, achievable goals for each contract based on labour requirements of each contract. Penalties and incentive clauses associated with the MIEG are also developed during this stage to ensure appropriate enforcement clauses are present to support the MIEG.
- Negotiation and finalization of the MIEG and associated penalties and incentives during contract negotiations to ensure contractor buy-in. Review of project-specific Contractor Inuit Content Plans to ensure contractor commitment to maximizing local content and to ensure that the contractor has a plan to achieve the MIEG.
- Monthly reporting of contractor Inuit content during execution of the work, and consistent feedback from Baffinland. If a contractor has failed to achieve the MIEG, Baffinland will provide support to the contractor, including provision of resumes of local workers and further improvement and refinement of contractor recruitment / retention / training strategies.

Baffinland's procurement and sustainable development teams will work in cooperation with a wide range of stakeholders, including QIA, Contractors, the federal and territorial governments and other industry players to implement these aspects during the execution of the Stage 3 Project. Ensuring local content commitments and requirements are met in

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procurement and contracting initiatives during Stage 3 execution, through adherence to the IPCS, will be critical for project success and approval.

18.5.3 Land Use Plan

The Nunavut Planning Commission (NPC) is responsible for the development, implementation and monitoring of land use plans that guide and direct resource use and development in Nunavut. Stage 3 Project land use changes have been reviewed by the NPC to determine alignment and compliance with the established North Baffin Regional Land Use Plan (NBRLUP). The NPC has determined Stage 3 Project land use changes are not in conformance with the existing NBRLUP. As a result, Baffinland is seeking amendment to the NBRLUP to allow for Stage 3 Project activities. This amendment process is expected to take 3 to 6 months although there is some uncertainty regarding the NPC process and the likelihood for potential delays, therefore, this approval should be well planned and managed for the Stage 3 Project.

18.5.4 Final Environmental Impact Statement – Amendment No. 2

The Environmental Impact Statement (EIS) is part of the environmental assessment process established for a project under the Nunavut Agreement in order to obtain a Project Certificate or amended Project Certificate. Under this environmental assessment process, the proponent of a project describes the surrounding environment and the proposed development. Potential effects are then predicted and mitigation plans are developed. The severity or “significance” of residual effects (effects remaining after mitigation measures have been applied), are evaluated based on established criteria and expert opinion. The Stage 3 Project EIS addendum will need to be prepared using this methodology, and as prescribed in detail by project-specific NIRB EIS Guidelines, considering all project changes and additional environmental and social impacts associated with Stage 3 (e.g. increased shipping traffic, infrastructure changes, workforce changes) and evaluate the potential severity or “significance” of residual effects. Based on expert review and regulatory approval an amended Project Certificate will be issued based on the findings and results of the EIS Addendum review. The Stage 3 Project addendum is in addition to the addendum submitted for ERP.

Main project changes and additional environmental effects associated with the Stage 3 Project that will have to be considered in the EIS Addendum are described in Section 18.4. Once the Stage 3 Project EIS addendum is submitted to the NIRB and stakeholders, consultation, review and processing would be expected to take approximately one (1) year prior to receipt of an amended project certificate. Efficiencies may be achieved as baseline studies have been already conducted and the familiarity the Stage 3 Project Team has with regulators and the EIS Process.

18.5.5 Type A Water Licence

As detailed in Section 18.4, the Stage 3 Project will result in environmental impacts including greater water consumption, fuel consumption and waste generation. Due to these increases, regulatory authorization would be required for the Stage 3 Project scope of work in the form

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of an approved amendment to the current Type A water license. To gain this authorization, a Type A Water Licence amendment application is required to be prepared considering all project changes and be submitted to Nunavut Water Board (NWB) for review and approval. The NWB is responsible for the issuance of all water licences in the territory of Nunavut which govern authorization of water consumption, waste generation, and other associated activities. Once the application is submitted review and processing would be expected to take 3 to 6 months after the Stage 3 Project Certificate is amended. If technical meetings and/or hearings are deemed required by the NWB however, this process could take longer. The Type A Water License application process can only commence upon receipt of an Amendment to the Project Certificate to reflect Stage 3 Project activities and components. It is expected efficiencies may be achieved in the application development process due to the familiarity the Stage 3 Project Team has with regulators and the NWB Type A Water Licence application process.

18.5.6 Rail Approval

The Mary River Mine to the Milne Port Railway is not contained within the confines of the mine but extends out to cross public lands for a distance over 100 km and thus, it is not considered a mine railway. Further, the Nunavut Agreement does not devolve authority to incorporate railways to the territory and the railway will therefore be regulated by the Federal Government under the Railway Safety Act. Accordingly, the railway will fall under the jurisdiction of the Canadian Transportation Agency (CTA) and Transport Canada and will be subject to requirements for submissions to obtain approvals to construct, commission and operate the railway.

As a railway under Federal Jurisdiction, the following submissions will be required:

- The filing of a Notice of Railway Works (administered by Transport Canada) – this will be required to allow construction to be commenced.
- The filing of an Application to Construct a Railway Line (administered by the CTA) – this will be required to allow construction to commence.
- The creation of a railway authorized to operate service on the infrastructure (administered by the CTA and Transport Canada) – this will be required to allow the railway to be operated.
- The Approval of Alternate or Supplementary Practices necessary for the signaling system (administered by Transport Canada) – this will be required to allow commissioning of the signaling system into service, if any deviation from standard American Railway Engineering and Maintenance-of-Way Association (AREMA) practice is encountered.

It should be noted that the filing of Notice of Railway Works and the request for Approval of an Application to Construct a Railway Line are both required to be completed for construction to commence.

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18.5.7 Fisheries Act Authorization

A DFO authorization is required to be obtained from the DFO for any additional in-water work associated with the Stage 3 Project scope of work. The approval process is not expected to be more restrictive in terms of requirements or timing than that already known and planned for by the Stage 3 Project Team.

18.5.8 Arctic Waters Pollution Prevention Act

Navigation in coastal waters within Canadian jurisdiction north of latitude 60°N is governed by the Arctic Shipping Pollution Prevention Regulations (ASPPR), under the Arctic Waters Pollution Prevention Act. All vessels above 100 tonnes that navigate Canadian Arctic waters must comply with, including reporting requirements, ASPPR requirements. All vessels used in the Stage 3 Project would therefore have to ensure compliance with both ASPPR, comply with the Arctic Waters Pollution Prevention Act, and ensure no waste is deposited in arctic water, including during the trans-shipment process. The Arctic Waters Pollution Prevention Act defines waste as any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water to an extent that is detrimental to their use by man or by any animal, fish or plant that is useful to man. It would have to be ensured that spilled ore does not meet this criteria or an exemption is issued.

18.6 Operational Control for Sustainable Development of Stage 3

In addition to the key project permits and authorizations anticipated to be required to be amended or obtained prior to the Stage 3 Project gaining regulatory approval, Baffinland must also ensure its operational control mechanisms for sustainable development are also updated to reflect project changes (as detailed in Section 18.4). Management plans are the primary mechanism Baffinland uses to ensure operational control of site development from a sustainable development perspective. The documents that have been identified which will require update prior to Stage 3 Project execution include, but are not limited to:

- Contractors Environmental Management Requirements.
- Waste Management Plan for Construction, Operation and Closure.
- Hazardous Material and Hazardous Waste Management Plan.
- Fresh Water Supply, Sewage and Wastewater Management Plan.
- Emergency Response Plan and Spill Contingency Plan.
- Surface Water and Aquatic Ecosystems Management Plan.
- Oil Pollution Emergency Plan – Milne Inlet Fuel Storage Facility.
- Environmental Management Plan.
- Environmental Monitoring Plan.
- Construction Environmental Protection Plan

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- Interim Mine Closure and Reclamation Plan.
- Shipping and Marine Wildlife Management Plan.
- Terrestrial Management Plan (due to additional road/rail traffic).

The subsection below provides discussion on the objective and scope of these plans and the anticipated updates required to reflect the Stage 3 Project. Once these updates are developed and approved, they will have to be communicated and implemented by site based personnel.

18.6.1 Contractors Environmental Management Requirements

The objective of the contractors environmental management requirements is to identify and establish the procedures, roles and responsibilities, as it relates to the environment, that the Contractor will be required to follow during all Project-related aspects of their work activities. This will be accomplished through the implementation of the Project's EMS (Environmental Management System) or, the Contractor(s) own EMS, which conforms to the Project's EMS and management plans. See Section 18 for further discussion regarding contractors environmental management requirements.

18.6.2 Environmental Protection Plan

The Environmental Protection Plan includes all the work instructions, standard operating procedures and protocols that are implemented to ensure that environmental impacts are minimized throughout the life of the Project. The plan provides an overview of both preventative measures taken to protect the environment as well as mitigation measures that will occur in the event that any environmental damages do occur. This plan may require minor updates to take into account any developed mitigation strategies from monitoring programs/ baseline studies, as well as, incorporate any applicable project conditions, requirements or commitments dictated in the FEIS Amendment #2 (Stage 3 Project) and Type A Water Licence amendment process.

18.6.3 Shipping and Marine Wildlife Management Plan

The Shipping and Marine Wildlife Management Plan has been developed to address the issues of concern to Inuit with respect to shipping; establish rules and procedures applicable to shipping during the construction, operational and decommissioning phases of the Project; and, provide for Inuit involvement in the planning, environmental management and decision-making processes related to shipping. Due to changes in shipping schedule and strategy for the Stage 3 Project, the Shipping and Marine Wildlife Management Plan will have to be updated to ensure that:

- It incorporates and describes the means whereby Baffinland will ship construction materials and equipment to the Milne Port Site during all shipping seasons.
- Describes the management of the shipping operation, including the design and contract of a larger Cape-size iron ore carriers, to be employed for during the open water.

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- Address the management, routing and operation of ships and describes how the vessels will navigate reflective of the Stage 3 Project shipping strategy; and
- Describe the monitoring and mitigation measures to be employed in addressing concerns related to marine wildlife, including mammals and birds that have been raised from baseline studies, any applicable project conditions, requirements, or commitments dictated in the FEIS Amendment #2 (Stage 3 Project) process.

18.6.4 Interim Mine Closure and Reclamation Plan

The current Interim Mine Closure and Reclamation Plan has been created in accordance with all applicable requirements including the Qikiqtani Inuit Association (QIA) Abandonment and Reclamation Policy for Inuit Owned Lands and commitments made by Baffinland during previous technical meetings with stakeholders and government. The Interim Mine Closure and Reclamation Plan addresses all project-related activity areas and infrastructure related to the Mary River Project. In order to effectively plan for project closure and reclamation of Stage 3 activities, changes to site infrastructure, equipment, site layout, and storage facilities, etc. will need to be addressed in the Interim Mine Closure and Reclamation Plan to ensure all Stage 3 scope of work is considered and reclamation activities are planned for to demonstrate that stated reclamation objectives can still be met.

Also, in association with the Interim Mine Closure and Reclamation Plan, a closure and reclamation security liability estimate that considers the reclamation cost estimated to be required to meet reclamation objectives stated in the Interim Mine Closure and Reclamation Plan. This closure and reclamation security liability estimate is required to be updated annually to take into consideration all project changes anticipated for the upcoming project year. This security estimate will have to be updated on an annual basis throughout the life of the Stage 3 Project based on the scope of work anticipated to occur in an upcoming year.

18.6.5 Terrestrial Wildlife Management Plan

This document has been developed to provide management guidelines and strategies to deal with all terrestrial based environmental issues facing the Mary River Project.

The main issues addressed in this document are the interaction with and monitoring of vegetation, birds and terrestrial wildlife. This is particularly relevant to both the caribou and bear population on Baffin Island. Given the sensitive nature of the arctic ecosystem it is essential that these species be monitored closely to ensure that the Stage 3 Project has a minimal impact on their safety and lifecycle.

As a management plan the Terrestrial Environmental Management Plan details the required techniques and procedures for monitoring local wildlife, recording results, and reporting procedures.

This management plan needs to be updated to reflect the mitigation strategies required to safeguard terrestrial fauna and flora from the impacts of rail traffic.

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18.6.6 Emergency Response Plan and Spill Contingency Plan

The Emergency Response Plan and Spill Contingency Plan has been developed to identify potential spills and emergencies that could arise during construction and operation of the Mary River project on land or freshwater and to establish the framework for responding to these situations. The response procedures are specific to spills on land, water, snow and ice. However, the general procedure involves the following steps: source control, control of free product, protection, cleanup of the spill and reporting the spill. The Plan also identifies roles and responsibilities, potential spill analysis, and reporting requirements.

Given the increased fuel storage, infrastructure and mobile equipment, this plan will need to be revaluated to ensure that current procedures and equipment are capable of adequately handling spills of the appropriate volume. Any applicable project conditions, requirements or commitments dictated in the FEIS Amendment #2 and Type A Water Licence amendment process would also have to be included.

18.6.7 Surface Water and Aquatic Ecosystems Management Plan

This Plan outlines the processes and procedures to document the quality and quantity of water that will interact with Project components, and includes the management practices to minimize the adverse effects on receiving water systems, as well as the aquatic ecosystems and fish and fish habitat. The Plan details the management of runoff collection systems at Project facilities and addresses point and non-point discharges to surface waters from Project components and discharge quality and quantity relative to the receiving water system. It outlines specific mitigation measures required for stream/river crossings works, as well as, for general operation and construction activities in proximity of water courses. The general mitigation measures for sediment and erosion control that will be applied throughout the duration of the Project construction phase are discussed.

This Plan will have to be updated considering changes to project drainage and discharges resulting from Phase 2 scope of work. In addition, the incorporation of any ongoing baseline study results, applicable project conditions, requirements or commitments dictated in the FEIS Amendment #2 and Type A Water Licence amendment process, would also have to be included.

18.6.8 Aquatic Effects Monitoring Plan

This Aquatic Effects Monitoring Plan (AEMP) describes how monitoring of the aquatic environment will be undertaken. The AEMP was identified as a follow-up monitoring program in Baffinland`s FEIS and is prescribed by Baffinland`s Type A Water Licence Amendment #1. The AEMP is a monitoring program designed to:

- Detect short-term and long-term effects of the Project’s activities on the aquatic environment resulting from the Project.
- Evaluate the accuracy of impact predictions.
- Assess the effectiveness of planned mitigation measures.

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- Identify additional mitigation measures to avert or reduce unforeseen environmental effects.
- The AEMP focuses on the key potential impacts to freshwater environment valued ecosystems components (VECs), as identified in the FEIS and Addendum #1 to the FEIS for the Early Revenue Phase (ERP). The freshwater VECs are:
  - Water quantity.
  - Water and sediment quality.
  - Freshwater biota and fish habitat.

The AEMP has been structured to serve as an overarching 'umbrella' that conceptually provides an opportunity to integrate results of individual but related aquatic monitoring programs. This plan will need to be updated to reflect monitoring program changes required to cover all activities included in the Stage 3 Project in addition to any applicable project conditions, requirements or commitments dictated in the FEIS Amendment #2 (Stage 3 Project) and Type A Water Licence amendment process.

18.6.9 Oil Pollution Emergency Plan – Milne Inlet Fuel Storage Facility

The Milne Inlet Port Oil Pollution Emergency Plan (OPEP) was developed to specifically assist in implementing measures to protect the marine environment and minimize impacts from potential spill events. The plan outlines potential spill scenarios, and provides specific procedures for responding to spills while minimizing potential health and safety hazards, environmental damage, and cleanup costs. The OPEP provides instructions to guide all personnel in emergency spill response situations, defines the roles and responsibilities of management and responders, and outlines the measures taken to prevent spills, the related exercise and evaluation program, and the mechanism for regular updates to the plan. The OPEP is updated on an annual basis. The current OPEP plan will need to be updated to account for the increased mobile equipment, shipping, fuel transfers, infrastructure, and fuel storage requirements associated with the Stage 3 Project.

18.6.10 Waste Management Plan for Construction, Operation and Closure

The aim of the Waste Management Plan for Construction, Operation and Closure is to implement a sound waste management program that will focus upon the principles of Reduction/Recovery/Reuse/Recycling. The residual waste generated by the Stage 3 Project activities will be disposed of in a landfill/landfarm, incinerated or shipped off-site to southern Canada for final disposal, treatment, or recycling. This Waste Management Plan deals with waste generated by the Mary River Project including solids, semi-solids and sludge. The Waste Management Plan presents the various disposal methods, the types and expected quantities of waste produced and the ultimate disposal of the waste stream. The Plan also defines the roles and responsibilities, specific requirements, and monitoring controls for managing solid and hazardous wastes generated by the Project. It also presents a strategy

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for adaptive management and continuous improvement. The Waste Management Plan Annex's include:

- Incinerator Operation Information.
- Mary River Project Landfill Operating Manual.
- Landfarm Operation Information.

Prior to execution of the Stage 3 Project, this plan would need to be adjusted accordingly to reflect project changes and any applicable project conditions, requirements or commitments dictated by both FEIS Amendment #2 (Stage 3 Project) and Type A Water Licence amendment process. Any changes to capacity of waste management and incineration facilities would also need to be reflected and change communicated to pertinent staff and contractors.

18.6.11 Hazardous Material and Hazardous Waste Management Plan

This Hazardous Materials and Hazardous Waste Management Plan deals with wastes generated by the Mary River Project including: fuel, used oils, explosives, antifreeze, used chemical products, biomedical waste and spills clean-up materials. The management of sewage effluent and sludge from the sewage treatment plants is the subject of the Waste Fresh Water Supply, Sewage and Wastewater Management Plan.

The Hazardous Waste Management Plan presents the various disposal and treatment methods, the types and expected quantities of waste produced and the ultimate disposal of the waste stream. The Plan also defines the roles and responsibilities, specific requirements, monitoring controls for managing solid and hazardous wastes and strategies for adaptive monitoring and continuous improvement. The volumes of all hazardous waste streams as well as the size/capacity of both treatment and storage facilities, would need to be adjusted to handle the increased waste generation as a result of increased project activities and workforce which would have to be reflected in the document.

18.6.12 Fresh Water Supply, Sewage and Wastewater Management Plan

The management of sewage effluent and sludge from the sewage treatment plants is the subject of the Fresh Water Supply, Sewage and Wastewater Management Plan. This document was developed to provide a management strategy for fresh water supply and wastewater treatment/disposal at the various camps to be developed for the Mary River Project during the construction and operation phases. In addition, contingency measures are addressed and details given in regards to sampling, monitoring and reporting requirements.

All expected volumes of water consumed and sewage treated and discharged will need to be updated to reflect the Stage 3 Project. In addition, the capacities of the various plants, pumps, and other infrastructure would need to be revaluated to ensure that increased demand can be met and be reflected in the document. Any applicable project conditions, requirements or commitments dictated in the FEIS Amendment #2 and Type A Water Licence amendment process would also have to be included.

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18.7 Conclusion

As the Stage 3 Project represents an expansion to an existing operation, the intention of this section has been to summarize the current operational control and regulatory approval mechanisms obtained by the Mary River Project for its existing operation and identify the changes required to them to account for the anticipated changes to the biophysical and socioeconomic environment resulting from the Stage 3 Project.

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 19 – Financial Analysis and Evaluation

2017-05-01	0	Approved for Use	N. Patel	R. Cote	N. Mason	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
HATCH						

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This report is meant to be read as a whole, and sections should not be read or relied upon out of context. While it is believed that the information contained herein is reliable under the conditions and subject to the limitations set forth herein, this Report is based in part on information not within the control of Hatch and Hatch therefore cannot and does not guarantee the accuracy of such information based in whole or in part on information not within the control of Hatch. The comments in it reflect Hatch’s professional judgment in light of the information available to it at the time of preparation.

This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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1. Executive Summary

The objective of the analysis is to investigate value of the mine life project feasibility to increase production from 5 Mtpa (currently) to 12 Mtpa (planned) for the Mary River Project.

Average, undiscounted average unit cash flows for the life of mine are shown below. Working capital is excluded as it is negligible over the life of mine.

Table 1-1: Cash flow summary over life of mine

Cash flow summary, $US/t	Average, LoM
Revenue	$71.62
Operating costs	(18.06)
Freight and port charges	(6.14)
Royalties and overheads	(1.82)
EBITDA	45.60
Capital spending	(5.12)
EBITDA less Capital Spending	40.48

The resulting project net present value (NPV) is summarized in the tables below. NPVs include impact of pre-existing selling price, tax, royalties and financing supplied by Baffinland and included in their financial model.

Table 1-2: NPV summary, $US millions (excluding sunk costs)

Discount rate	Pre-tax unlevered	After-tax levered
7%	5,869	3,549
8%	5,233	3,156
10%	4,201	2,513

A sensitivity analysis was performed to examine the impact to after tax, levered NPV from changes in forecast benchmark price, exchange rate, capital costs and operating costs.

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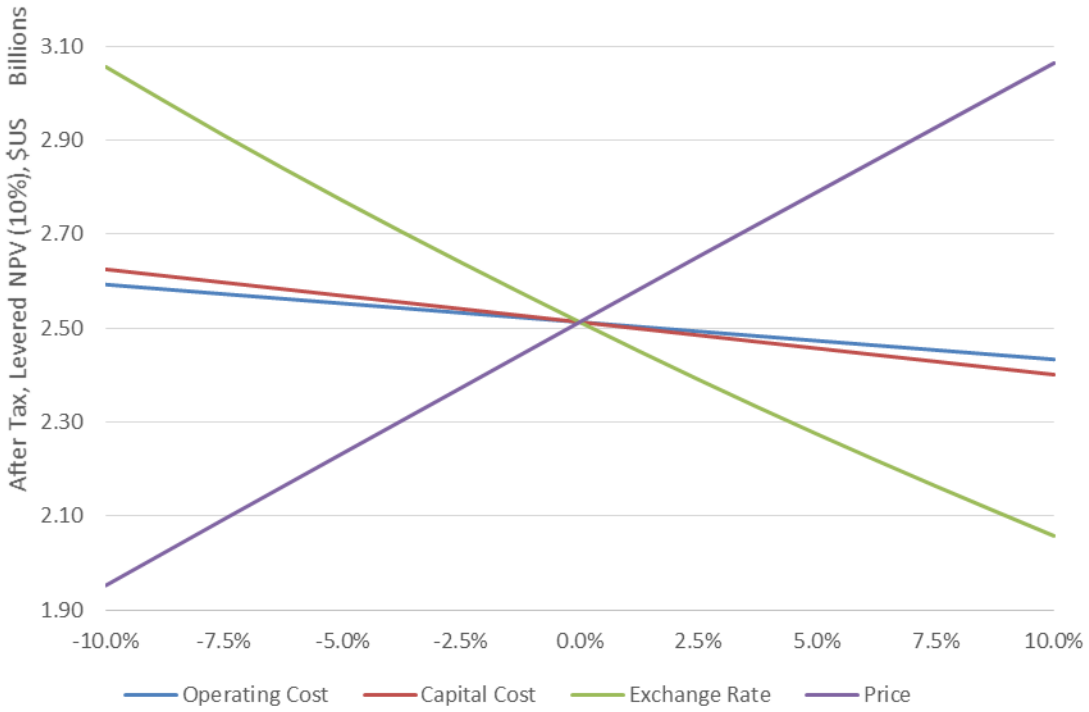
Figure 1-1: Net Present Value Sensitivity at 10% of After Tax, Levered Cash Flow



Benchmark prices which directly impact revenue are the largest sensitivity. Capital costs and operating costs are largely denominated in Canadian Dollars, while revenues are in US Dollars. Exchange rate showing the second largest sensitivity is therefore expected.

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19. Financial Analysis

19.1 Introduction

This section covers the assumptions and results of the financial analysis for the Mary River Stage 3 expansion project. It includes estimates of:

- Quarterly and annual cash flows, including selling prices/revenues, operating costs, initial capital spending and sustaining capital
- Net present value (NPV) based on 7%, 8% and 10% weighted average cost of capital
- Sensitivity analysis

The objective of the analysis is to investigate value of the mine life project feasibility to increase production from 5 Mtpa (currently) to 12 Mtpa (planned) for the Mary River Project.

19.1 Model Setup and Key Assumptions

The financial analysis was completed based on a financial model provided by Baffinland for update.

The model was set up in 3 phases:

- Phases 1 and 2: a Baffinland forecast for its current, ongoing operations
- Phase 3: incremental production, from 2019 onwards

Some key assumptions are detailed below, with further details provided in the following sections.

- Total production from all phases (1-3): 12 Mtpa.
- Production, grade, stripping ratio an life of mine (LoM): as per material balances
- Units: All unit revenues and costs are given in $US/wmt unless otherwise noted
- Inflation: none, all estimates are in 2017 dollars.

19.2 Exchange Rate and Pricing

19.2.1 Exchange Rate

A Bloomberg exchange rate curve was used (April 4, 2017) for the financial analysis, as summarized in the table below.

Table 19-1: Exchange rate projections, Source: Bloomberg

Year	2017	2018	2019	2020	2021	2022+
$US:$C	0.752	0.755	0.761	0.766	0.771	0.775

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19.2.2 Pricing

Iron ore is priced starting with the Consensus Economics forecast (Q1, 2017) for the "Platts IODEX 62% Fe CFR North China Midpoint Average" benchmark. A comparison of this curve with estimated prices realized by Baffinland is illustrated below alongside CRU forecast prices for the Atlantic blast furnace pellet premium.

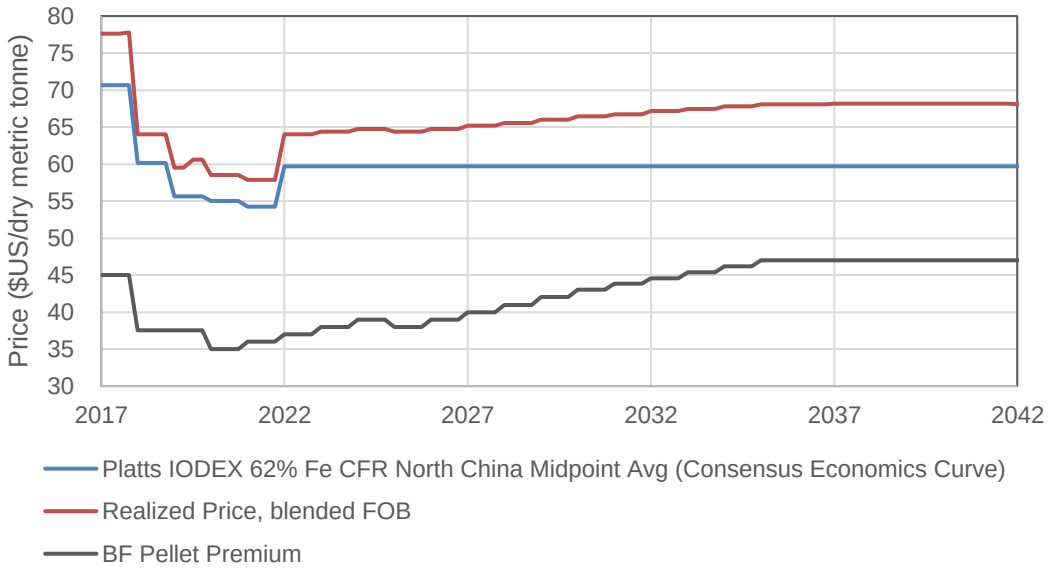

Figure 19-1: Comparison of benchmark price series and realized price

Iron ore is priced starting with the benchmark price noted above. To estimate an indicative selling price the benchmark price is scaled based on ore grade and adjusted for penalties and premiums for high or low levels of impurities, freight, value-in-use and moisture during negotiations between the seller and purchaser of the ore.

Realized prices have been estimated using conversions from benchmark pricing to realized price supplied by Baffinland.

19.3 Production Ramp-up

Table 19-2 below summarizes the annual production ramp-up for the project. The graphical representation in Figure 19-2 shows the ramp-up details on a quarterly basis, to achieve the target annual production of 12 Mtpa.

Table 19-2: Annual production ramp-up to 12 Mtpa

	2017	2018	2019	2020	2021+
Finished Ore Production, Mt	5,2	5.3	7.2	12.0	12.0
Ore Shipped, Mt	4.8	5.2	5.5	11.9	12.0

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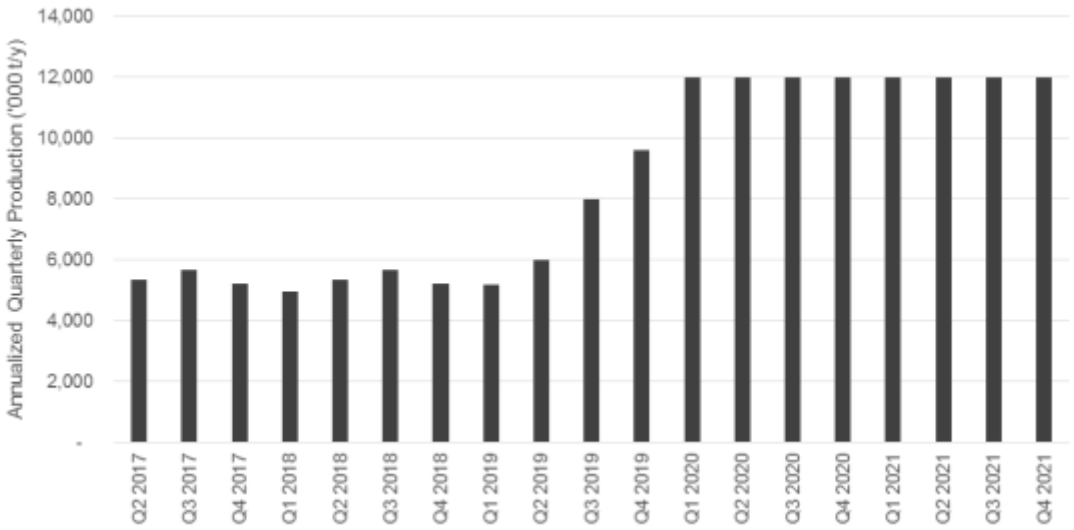

Figure 19-2: Quarterly finished ore production, annualized rates

Finished ore production is forecast to reach a rate of 60% of nameplate (7.2 Mtpa) on a sustained basis from Q3 2019. Shiploading is expected to cross the same threshold in the 2020 shiploading season.

19.4 Operating Costs

The detailed development of the operating costs is discussed in section 14 of this report. A summary of the operating costs used in the financial analysis is presented below. Unit costs have been adjusted from those reported in section 14 to account for changes in fuel price and foreign exchange rates.

Table 19-3: Annual operating cost summary during ramp-up

	Units	2017	2018	2019	2020	2021	2022
Finished Ore Production	Mt	5.2	5.3	7.2	12.0	12.0	12.0
Unit operating costs	$US/t wet	34.69	33.70	25.25	14.84	15.93	15.60

Operating costs vary year to year, in accordance with the mine plan (stripping ratio and amount of waste to be moved) and the average haul distance varying over the life of mine. Unit operating costs are higher during production ramp up, and towards the end of the mine's life, when production is low but fixed costs such as labour are the same as during full production.

19.5 Capital Costs

19.5.1 Expansion Project Capital

The capital cost estimate, incurred cost curve used in the preparation of this financial model, and other related items are covered in section 12 of this report.

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The following table summarizes the different currencies used (US Dollars, Euros and Canadian Dollars), and their relative contributions to the total capital cost.

Table 19-4: Capital Cost Foreign Exchange Mix

Currency	Conversion Rate	Total ($US millions)	% of Total Installed Cost
United States Dollar	1	144.21	15%
Canadian Dollar	0.7355	724.08	77%
European Euro	1.0867	68.55	7%

When reforecasting capital spending using a varying exchange rate and performing exchange rate sensitivity analysis, Euros and Canadian dollars were assumed to move in tandem relative the US Dollar.

19.5.2 Sustaining Capital

See section 14 of this report.

19.5.3 Working Capital

Working capital changes were estimated using assumptions included in Baffinland's financial model. These include the following:

- Expansion project accounts payable: Average 180 days outstanding
- Operations accounts payable: Average 60 days outstanding
- Fuel is purchased on consignment annually

Based on the above assumptions, and the amount and timing of project funding considered for project development, working capital is not forecast to have a negative impact on overall corporate cash flow during project development.

19.6 Results

Using the inputs as described above, the following summary provides an overview of the production, key costs and other assumptions during the ramp-up period.

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Table 19-5: Project overview summary ($US millions, unless otherwise indicated)

	Units	2017	2018	2019	2020	2021
Production	*Mt*	5.2	5.3	7.2	12.0	12.0
Shipments	*Mt*	4.8	5.2	5.5	11.9	12.0
Exchange rate	*US$/C$*	0.75	0.76	0.76	0.77	0.77
Iron Ore prices						
Index - CFR China	*US$/t*	$ 71	$ 60	$ 56	$ 55	$ 54
Realized price	*US$/t*	78	64	60	59	58
Revenues		$ 410	$ 331	$ 447	$ 759	$ 758
Costs						
Operating		183	182	186	182	195
Freight and port charges		27	31	35	68	69
Royalties and overheads		27	28	18	17	17
EBITDA		$ 174	$ 89	$ 208	$ 492	$ 478
Capital Spending		$ 335	$ 452	$ 254	$ 42	$ 12
Unit operating cost	*US$/t*	$ 35	$ 34	$ 25	$ 15	$ 16

19.6.1 Net Present Value (NPV)

Average, undiscounted average unit cash flows for the life of mine are shown below:

Table 19-6: Cash flow summary over life of mine

Cash flow summary, $US/t	Average, LoM
Revenue	$71.62
Operating costs	(18.06)
Freight and port charges	(6.14)
Royalties and overheads	(1.82)
EBITDA	45.60
Capital spending	(5.12)
EBITDA less Capital Spending	40.48

The resulting project NPV is summarized in the tables below. NPVs include impact of pre-existing financing included in Baffinland's financial model.

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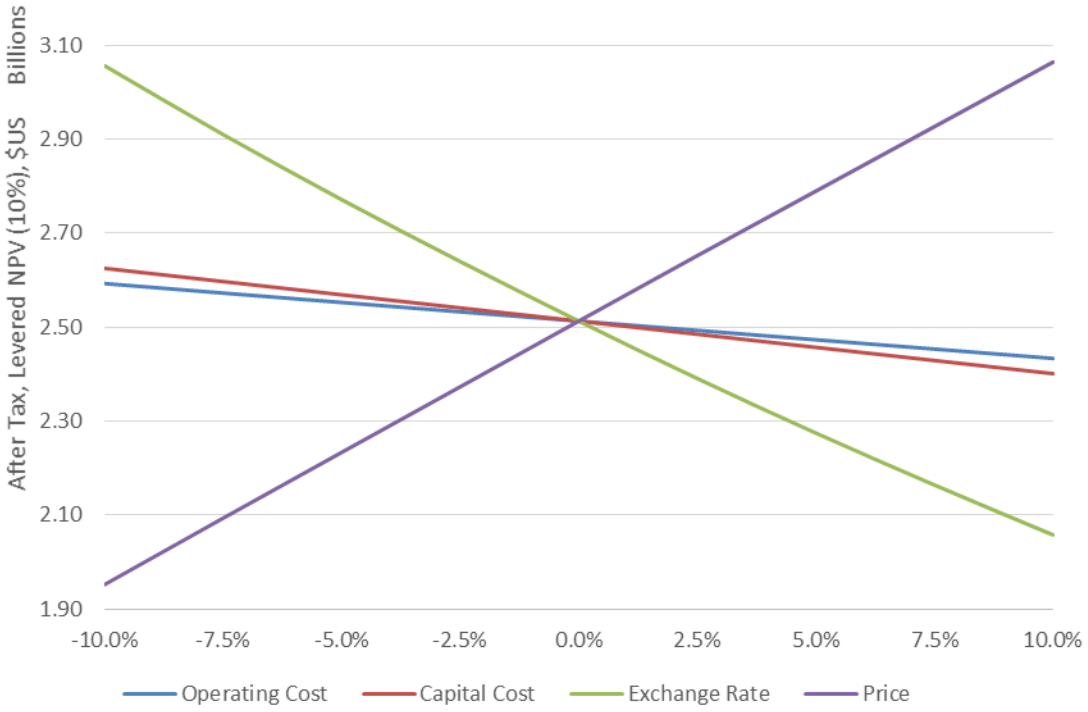
Table 19-7: NPV summary, $US millions (excluding sunk costs)

Discount rate	Pre-tax unlevered	After-tax levered
7%	5,717	3,437
8%	5,044	3,017
10%	3,975	2,346

19.6.2 Sensitivity Analysis

A sensitivity analysis was performed to examine the impact to after tax, levered NPV from changes in forecast benchmark price, exchange rate, capital costs and operating costs.

Figure 19-3: Net Present Value Sensitivity at 10% of After Tax, Levered Cash Flow



Benchmark prices which directly impact revenue are the largest sensitivity. Capital costs and operating costs are largely denominated in Canadian Dollars, while revenues are in US Dollars. Exchange rate showing the second largest sensitivity is therefore expected.

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19.2 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
	Financial Model			A19-1

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 20 – Project Risks and Opportunities

2017-05-01	0	Approved for Use	C. Bucur	N.Mason	S.Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
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20. Risks and Opportunities

Effective risk management is integral to the capital investment cycle, from evaluation of a business development opportunity through basic and detailed engineering, project execution, operations and, ultimately, closure. A structured and thorough understanding of the key risks of the investment allows the Project team to focus their attention and allocate resources effectively.

Aligned with the Baffinland Iron Mine (BIM) risk management guidelines and the Hatch risk management framework, the concept of risk during the Stage 3 Definitive Study considered all aspects related to engineering, cost and schedule, environment, communities, health and safety, human resources, procurement, construction, project strategy and economics. The risk management process was forward-looking, structured, consistent and continuous, and allowed for a clear and unambiguous communication of Project risks to all Project stakeholders, and established the framework for managing those risks during Project execution.

The primary focus of risk management during the Stage 3 Definitive Study was to:

- Update the project risk register developed in the previous project phases to ensure that risk information was valid, accurate and complete, and all project risks which could occur, or which must be mitigated during the Stage 3 Definitive Study and project execution, were identified and evaluated;
- Develop the project quantitative capital cost risk profile and determine the cost contingency to be included in the capital cost estimate.

The risk management strategy developed for the Stage 3 Definitive Study was consistent with the project strategic goals and objectives, which includes:

- No harm to people, equipment and environment.
- Ensure project schedule is maintained to commence functional testing of ship loader with material prior to end of 2019 shipping window and ship loader production feed to ore carriers in 2020.
- Ramp up of ore shipping to ensure 12 Mtpa sustainable performance is achieved.
- Minimize and delay capital expenditure to as much as possible.
- Minimize interruptions to existing operations.
- Maximize opportunities for early revenue generation.

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20.1 Scope of Risk Management

Qualitative and quantitative risk assessments were completed during the Stage 3 Definitive Study to adequately characterize project uncertainties and develop appropriate response plans to eliminate or reduce the identified risks to a level that falls within BIM's tolerable limits. These assessments are described in the following sections.

20.1.1 Qualitative Risk Assessment

Qualitative risk assessment consisted of risk register reviews and updates conducted with key project team members to ensure that the risk information was current, accurate and complete, and the risk mitigation measures developed for key project risks were effective and implemented as planned.

New project risks were identified during risk register reviews and risks that were no longer applicable due to changes in project conditions and circumstances, risks which have been "designed out" or risks which occurred were closed.

Risks were assessed in terms of likelihood and impact using a project-specific risk likelihood and impact rating scales and matrix (Appendix A20-1).

The project team has identified measures to eliminate or reduce the most significant Project risks to a level that falls within BIM's tolerable limits. The risk mitigation measures, including their status and completion date, are documented in the Project Risk Register (Appendix A20-2).

As the Project progresses into the execution phase and more detailed information becomes available, including vendor data, assumption validation, completion of testwork, the Project team will identify and implement additional cost effective and practical measures to reduce the Project risk profile to a tolerable level.

Table 20-1 summarizes the qualitative and quantitative risk assessments conducted during the Stage 3 Definitive Study.

Table 20-1: Qualitative and Quantitative Risk Assessments Completed during Stage 3 Definitive Study

Risk Assessment Date	Risk Assessment	Risk Assessment Scope
March 2017	Project risk register review	Review and update of the project risk register
April 2017	Quantitative Risk Analysis (QRA)	Development of the project capital cost risk profile and assessment of cost contingency requirements to support project financing

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Following the assessments listed above, eighty-three (83) risks remain open at the end of the study, as shown in the project risk register presented in Appendix SE21_AP0B. The project team has effectively managed the most significant project risks during the study and additional measures will be taken in project execution to further reduce the project risk exposure to tolerable limits.

The major risk elements can be summarised as;

- Capital cost increase due to:
  - Schedule Delay
  - Rail Earthworks Cost (quantity and/or unit cost variations).

  The receipt of lump sum bids for major contracts with liquidated damages provisions for performance and schedule provide a substantial mitigation to this risk element. Aggressive pursuit of permits remains the mitigation to ensure permit approvals do not slip beyond provisions contained in the schedule.
- Project schedule delay possible due to:
  - Project Certificate and Associated Environmental Permit Delay's
  - Project Funding Release
  - Major Equipment Lead Times
  - Ship Loader Installation and Commissioning.

  Firm bids received for the supply of the majority of the equipment supply along with liquidated damages terms provide strong risk mitigation measures put in place during the Study.
- Operations cost/production impact due to:
  - Iron Ore Market Price
  - Product Quality
  - Unable to Achieve Design Capacity
  - Rail Tie Replacement.
- Health and Safety risk from:

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- Plane Crash
- Rail Collision.

As the project advances through the next stage, increased definition will change the project risk profile and allow the project team to develop appropriate treatment plans for all key project risks to a higher level of detail. Opportunities to improve project economics and parameters even further will also be considered in the next phases.

20.2 Quantitative Risk Analysis (QRA)

A Capital Cost Quantitative Risk Analysis (QRA) was completed during the Stage 3 Definitive Study to determine the project capital cost risk profile. The results of this analysis assisted the team to determine the level of capital cost contingency and estimate accuracy and was a key input into the project financial model.

Following the analysis a contingency of USD $40.3 or 4.49% at the P75 level (where there is a 75% probability of cost underrun and 25% probability of cost overrun) was added to the base estimate of USD $896.5M.

Figure 20-1 shows the project capital cost risk profile resulting from the analysis.

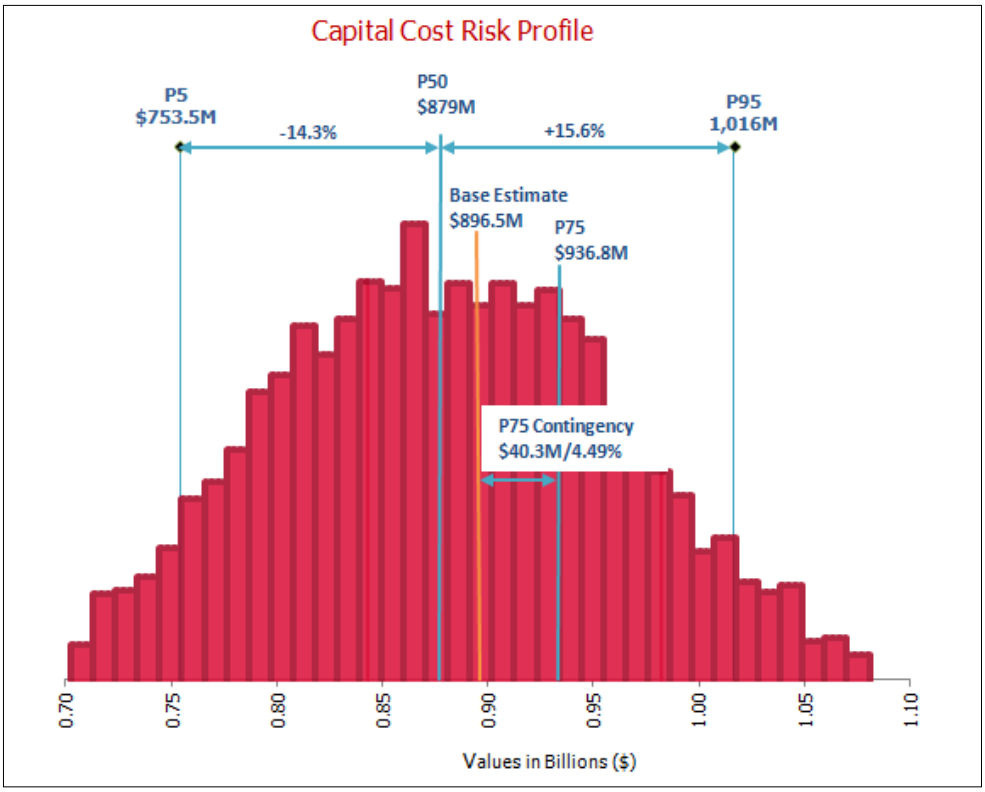

Figure 20-1: Mary River Expansion Stage 3 – Capital Cost Risk Profile

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The “Tornado” graph shown in Figure 20-2 displays the cost elements that have the greatest impact on the project capital risk profile. These items represent the main uncertainty sources that the project team will focus on during project execution in order to reduce the risk profile.

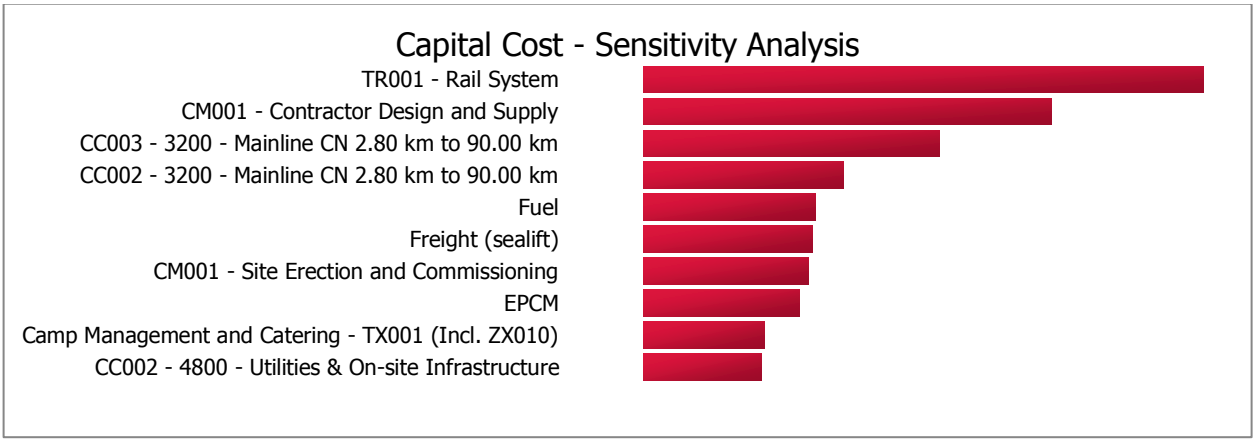

Figure 20-2: Mary River Expansion Stage 3 – Capital Cost Sensitivity Analysis

The Capital Cost Contingency Analysis results are discussed in detail in the QRA Report, refer to Appendix A20-2.

20.3 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
	Risk Rating Matrix	0	04/21/2017	A20 - 1
	Project Risk Register		04/21/2017	A20 - 2
H353004-00000-140-0566-0001	QRA Report	A	04/21/2017	A20 - 3

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 21 – Execution Plan

2017-05-01	0	Approved for Use	N. Mason	S. Heiner	S. Heiner	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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21. Project Management

The project will be executed by a small Owner Team supported by an EPCM contractor. The contractual relationships are shown in Table 21-1.

The EPCM contractor is responsible for project delivery from receipt of Run of Mine ore (ROM) at the primary crusher pad at Mary River Mine to lump ore discharge onto ships at Milne and fine ore reclaim at the port at Milne (a detailed RACI matrix defining EPCM responsibilities is contained in the PEP – Part A (Appendix A21-1)). Baffinland Iron Mines (BIM) is responsible to provide, but not limited to the following;

- provision of funds for project execution and timely payment of approved invoices so as to maintain the project schedule
- provision of approvals in a timely fashion to enable effective discharge of EPCM duties and responsibilities
- maintaining current operations including sustaining capital works and capital works not defined within this report
- ensuring the current operation is capable and proven to export 5Mtpa of DSO iron ore annually
- mine development including commissioning and ramp up of new mine equipment
- maintaining and extending existing contracts for supply of explosives, fuel, air transport services for personnel, materials and equipment necessary to support the construction program.
- provision of all licences, permits and approvals relative to construction and operations work, including liaising with regulatory bodies and the community
- community relations and management of Inuit Impact and Benefits Agreements (IIBA)
- provision of all marine services and contracts related to export of iron ore, import of fuel and sustaining capital works.

All contracts for provision of materials, equipment, construction services and other things necessary to the construction of the Project will be let by BIM with BIM as the Owner contracting party and the EPCM contractor appointed to act as agent for BIM in the management and execution of contracts within the EPCM contractor's scope.

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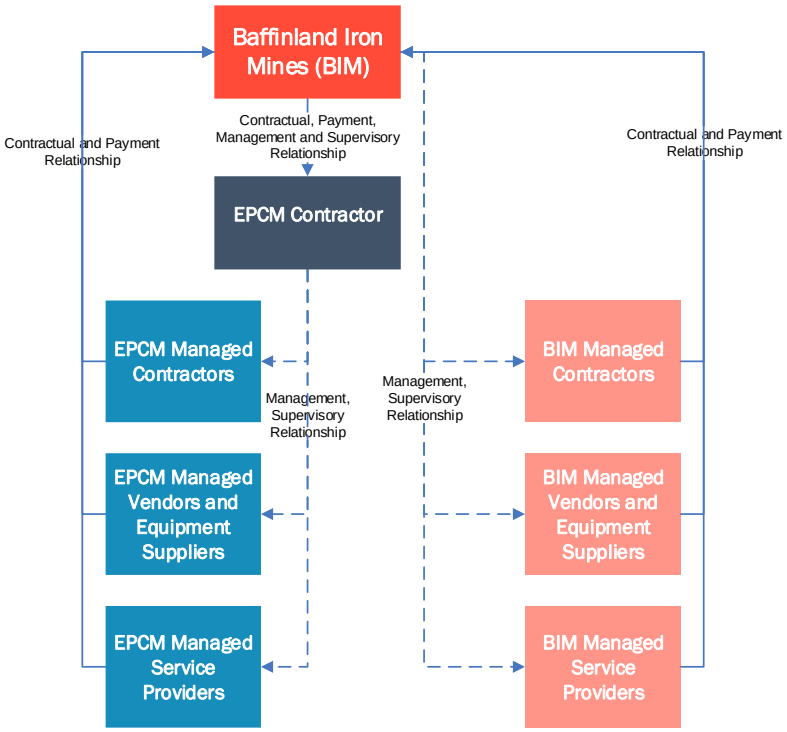

Table 21-1: Project Management Structure

21.1 Execution Strategy

21.1.1 Project delivery Strategies

Six objectives drive the execution plan for the implementation phase of the project. The project delivery objectives are:

1. to cause no harm to people, equipment and environment.
2. to deliver the Project, within scope, schedule and cost baselines defined in the FS Study Report and PEP.
3. to start functional testing of train unloading, crushing screening, stockpiling reclaim systems and one ship loader with ore before the end of the 2019 shipping window and completion of ship loader performance test at 12mtpa rate in the 2020 shipping season to enable ramp up to an ore production and shipping rate of 12mtpa in 2020.
4. to minimize and delay capital expenditure as much as possible.
5. to minimize interruptions to existing operations so that BIM can maintain planned production rates throughout the construction phase.
6. to maximize opportunities for early revenue generation, ahead of schedule without increasing project cost.

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The driving delivery strategies for the project are detailed within PEP Part A contained in Appendix A21-1. The driving delivery strategies for the project are developed in the following.

1. **Project Delivery Objective #1:** No harm to people, equipment and environment

1.1 Minimize site hours in order to reduce risk potential for injury to the operations or construction workforce. This will be done by deploying a comprehensive modularization, pre-assembly, pre-cast program, and where applicable, commissioning the modules off-site. Non-critical site resources will be retained in the Hatch home office.

1.2 Contractor's will be held responsible for compliance with project H&S and environmental requirements.

1.3 No construction work on fish bearing streams will be permitted in the breeding season. This will be done by including the requirements in the contract documents and project schedules, and verification of compliance during construction.

2. **Project Delivery Objective #2**: Delivery of the Project, within scope, schedule and cost baselines defined in the FS Study Report and PEP.

2.1. Engagement of an EPCM contractor by 1 May 2017 released to deliver the full Project scope defined in the PEP.

2.2. Completion of enabling early Works before the start of the 2017 sea lift. The early works program relies heavily on the free issue of equipment and beds by BIM Operations and this aspect will influence the success of the early works program.

2.3. Require major construction contractors to adopt an offsite focus to construction work to reduce indirect costs by implementing:

2.4. Shipping complete ship loads from a single supplier/contractor directly to Milne and avoiding trans-shipment at the Consolidation Hub. As a corollary, only North American sourced materials and equipment outside the scope of CM001, will be shipped to Milne via the consolidation hub.

2.5. EPCM site based contractor turnover to be minimized to create an effective, contiguous team effort without loss in coordination/productivity.

2.6. Completion and operationalizing of construction camps to ramp up for earthworks contractors' personnel (CC002/CC003) to full occupancy by October 2017.

2.7. To allow contract award in the time-frame required to support the project schedule, our packaging strategy must allow for early issue of functional specifications to support design/build basis bids by the OEM's.

2.8. The packaging strategy must also maximize the allocation and receipt of firm bid pricing for critical and long lead project components so as to accommodate the D-B approach and quick turnaround to contract award. To do this we need to ensure the scope definition supports firm pricing, and the validity period supports the planned commitment dates.

2.9. Contract formation and award is to be expedited for critical packages, recognizing the level of engineering definition and shipping requirements. Where required for receipt of critical vendor information, 2 stage orders may be required.

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2.10. To execute the project within the budget allocation for EPCM services, a lean and minimalist EPCM approach is required. This impacts the division of responsibility between all contractors.

3. Project Delivery Objective #3: To start functional testing of train unloading, crushing screening, stockpiling reclaim systems and one ship loader with ore before the end of the 2019 shipping window and completion of ship loader performance test at 12mtpa rate in the 2020 shipping season to enable ramp up to an ore production and shipping rate of 12mtpa in 2020.

3.1 Engage vertically integrated design build contractors to undertake delivery of core Project elements complete with a performance warranty (Ore Dock and Ore Processing/BMH plant)

3.2 Engage two earthworks contractors to spread risk and maintain focus on the requisite port/mine elements,

3.3 Validating the integrity of Design Build supplied equipment/systems through:

3.4 Bolster Operations knowledge of the new process equipment to enable efficient ramp up.

4. Project Delivery Objective #4: Minimize and delay capital expenditure as much as possible.

4.1 Contract on basis of minimal upfront payments, and 45 day payment cycle from approval of payment certificate to cash flow.

4.2 Delay orders of mining / rail equipment to “late as possible” to meet required ramp up. We will advance the schedule development of these packages to enable detailed planning activities and identification of required-on-site (ROS) dates of all mining and rail equipment. The planning of the procurement and fabrication activities will integrate with the appropriate sealift to ensure just-in-time delivery for shipping.

4.3 Opportunities to transfer capital to operating or lease charges will be investigated for rail operations and maintenance, including rolling stock and maintenance workshop.

5. Project Delivery Objective #5: Minimize interruptions to existing operations so that BIM can maintain planned production rates throughout the construction phase.

5.1 Project travel/accommodation burden must not over-extend Operations systems, and comprehensive integrated planning with Operations upon receipt of contractors’ resource loading and rotational schedules will be required.

5.2 The EPCM will ensure strict implementation of “Readiness Review Process” to ensure an efficient and safe execution of the tie-in/ shutdown work by the contractors engaged in the work.

5.3 Strong Leadership from the part of the EPCM Site Management, and the planning, preparation and execution of the works.

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6. Project Delivery Objective #6: Maximize opportunities for early revenue generation

6.1 Rail to be expedited (where possible without cost implication) to decrease opex cost by transferring ore transport on trucks to rail. To achieve this, we will have to negotiate an expedited rail and rail unloader schedule and include in the contracts, and consider constructing bridges in parallel instead of in sequence

6.2 Crushing/Screening/Stacking to be expedited (where possible without cost implication) to increase revenue earned from increased stockpile size at the port. To achieve this, we will have to negotiate best secondary crushing / screening completion date and include in the contract, and schedule the changeover of the 1st primary crusher to align with timing of <100m requirement for secondary crushing / screening commissioning at the port.

21.1.2 EPCM Functional Execution Plans

The following outlines key elements of the EPCM's functional execution plans .

21.1.2.1 Health and Safety Management (refer to Appendix A21-2)

- Individual Contractors are responsible for the management and administration of Health and Safety relevant to their scope and will adhere to the project Functional Guide for Contractor Safety Management (refer to Appendix A21-2).
- The Hatch site health and safety team is required to monitor, assess and report on the level of compliance with the project HS Plan and procedures. Additionally, the Hatch H&S team will provide guidance on safety trending, target risk management opportunities, provide advice on project training needs and status, and provide the oversight to assure that minimum H&S criteria are being met or exceeded.

21.1.2.2 Environment Sustainability and Community Interface Management (Refer to Appendix A21-3)

- Protection of the environment and demonstration of compliance with permits and regulations will be undertaken by contractors engaged for construction work. The EPCM will collect collate and transmit contractor documentation to BIM to meet BIM reporting requirements. BIM will provide functions to collect environmental data, audit contractor compliance and perform all reporting works to BIM and third parties.
- Inuit Engagement in the project. The role of the EPCM in this instance is only geared towards inclusion of the Inuit engagement requirements and opportunities in the contracts and ensuring the contractors provide regular reporting to BIM in this regard.
- BIM takes responsibility for all aspects of community interface management on the project and the EPCM has made no allowance for deliverables for sustainability and community interface management or reporting.

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21.1.2.3 Quality Management (ref Appendix A21-4)

- Quality management for EPCM related work will take the form of audits to assess compliance with EPCM procedures and workflows. Quality control for EPCM delivered services will be delivered through use of standard EPCM procedures for services provided by the EPCM.
- The quality function, as it relates to auditing and verifying contractor and vendor compliance to their Quality Plans and Inspection and Test Plans, will be undertaken by Package Coordinators and Site Construction Supervisors. Responsibility for providing quality control plans and discharging all work relative to those plans vests with the contractors and vendors, including sub-contractors and sub vendors engaged by those contractors.

21.1.2.4 Risk management (ref Appendix A21-5)

- The major contracts for equipment and material supply (CM001, CG001, CC002, CC003 and TR001) are being delivered on lump sum and variants of design build contracts; as such risk mitigation through construction will vest with the contractor. The EPCM will be responsible for management of cost and schedule risk as defines in the Project Controls Plan (Ref Appendix A21-10).
- EPCM risk management work will focus upon:
  - Qualitative Risk Analysis – Regular risk register updates to ensure the risk treatment plans are up to date and effective, identification of new project risks and closure of risks that have been mitigated or are no longer applicable.
  - Quantitative Risk Analysis (QRA) – Twice yearly updates of the capital cost risk profile developed during the Feasibility Study to update uncertainty factors related to work packages prices, quantities and duration, etc.
  - Technical risk management – consisting of Construction and Commissioning Safety workshops to identify and minimize hazards related to the construction and commissioning activities, procedures and sequence.
  - In addition, the engineering team will attend Hazard and Operability Studies (HAZOPs) lead by the major the contractor groups.

21.1.2.5 Engineering (refer to Appendix A21-6)

- In support of the project strategies, engineering will be implemented as a lean EPCM approach where:
  - Engineering design will primarily be executed by major vendors and design-build contractors with the EPCM team developing design for earthworks and wrap-around systems only.
  - The EPCM engineering team will be responsible to:
    - Finalize and issue IFC drawings for the rail earthworks.

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- Develop Mine Site and Port Site final layout, earthworks detailed design and earthworks IFC drawings.
- Finalize configuration of and develop detailed design of the Mine Site and Port Site power distribution systems.
- Develop detailed design for the water / effluent pipeline modifications at the Mine Site and Port Site.
- Complete detailed design for pre-cast elements outside the scope of major contracts and which will be included in package PC001.
- Finalize configuration of and develop detailed design of the Mine Site and Port Site communications / IT systems.
- Develop scopes of work and technical specifications for packages not issued for final bid during the Feasibility / Stage 3 Study.

- Mississauga will be the principal project implementation office where package leads will be based, however, Johannesburg will be the principal engineering design office where all detailed design included in the EPCM scope is carried out. Engineering design developed in Johannesburg will be supported by subject matter experts from Canada as required and, in particular, will be reviewed by a Nunavut registered Professional Engineer based in Canada who will ultimately stamp the drawing prior to release for construction.
- Engineering design carried out by vendors and contractors will be carried out in their preferred location. Generally smaller vendors and contractors are based in Canada, however, design by larger contractors, particularly CM001, will likely be carried out in multiple locations including Canada, Europe and potentially USA / Australia.
- The engineering execution plan is predicated upon completion of engineering design as defined in the table below;

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Package	Define Functional Requirements	Process Design (Size / Rate / Capacity)	Basic Design	Detail Design	Design Verification	Functional Compliance Review
CC001 – Early Earthworks	EPCM	EPCM	EPCM	EPCM	EPCM	EPCM
CC002 – Earthworks North	EPCM	EPCM	EPCM	EPCM	EPCM	EPCM
CC003 – Earthworks South	EPCM	EPCM	EPCM	EPCM	EPCM	EPCM
CM001 – BMH and Processing	EPCM	Contractor	Contractor	Contractor	Contractor	EPCM
CG001 – Ore Dock	EPCM	n/a	Contractor	Contractor	Contractor	EPCM
TM001 – Fuel Storage	EPCM	EPCM	EPCM	Contractor	Contractor	EPCM
TR001 – Rail System	EPCM	EPCM	Contractor	Contractor	Contractor	EPCM
TX001 – Construction Camp	EPCM	EPCM	Contractor	Contractor	Contractor	EPCM
TX002 – Permanent Camp	EPCM	EPCM	Contractor	Contractor	Contractor	EPCM
TX003 – Workshops	EPCM	EPCM	Contractor	Contractor	Contractor	EPCM
PA001 – Mine Site Camp						
PC001 – Pre-Cast Concrete	EPCM	n/a	EPCM	Vendor	Vendor	EPCM
PE001 – E-Houses	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PE002 – Power Generation	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PM007 – Jaw Crusher Upgrade	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PM100 – Mobile Eq't – HME	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PM200 – Mobile Eq't – Other	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PM201 – EPCM Vehicles	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PR001 – Locomotives	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
PR002 – Ore Wagons	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
BE001 – Power Cable	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
ZX006 – Coms & Data Services	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
ZR001 – Rail Operations	EPCM	EPCM	Vendor	Vendor	Vendor	EPCM
CX001 – (Wrap-around MEIP)	EPCM	EPCM	EPCM	EPCM	EPCM	EPCM
CX001 – (Reclaim Conveyor)	EPCM	EPCM	EPCM	Contractor	Contractor	EPCM
CX001 – (Rail Unload Tunnel)	EPCM	EPCM	EPCM	Contractor	Contractor	EPCM
CX001 – (Tote Road Comms)	EPCM	Contractor	Contractor	Contractor	Contractor	EPCM

Table 21-2: Design Responsibilities

- EPCM will be responsible for review vendor and contractor design documents for functional compliance with issued specifications.
  - Functional specifications developed during the Stage 3 study will be updated for award of vendor purchase orders and design-build contracts with limited technical development by the EPCM engineering team.

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- Design carried out by vendors and contractors will be subject to review to confirm compliance with project functional requirements.

21.1.2.6 Procurement and Contracting (refer to Appendix A21-7)

The EPCM will be responsible for completing the bidding process, contract award and administration of the packages noted in the Package List shown below.

Package Number	Package Title	Contractual arrangement	Pricing Basis	Package Status at completion of the Stage 3 Definitive Study
CONSTRUCTION CONTRACTS				
CC001	Early Earthworks	FIDIC for Construction	Cost Reimbursable	Awarded in execution
CC002	Earthworks North	FIDIC for Construction	Unit Rate Schedules	Final contract negotiation to be completed
CC003	Earthworks South	FIDIC Design-Build	Unit Rate Schedules	Final contract negotiation to be completed
CG001	Ore Dock	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Bids received - rebid to align with CM001 scope required.
CM001	Bulk Materials Handling & Processing	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Awarded and in execution
CX001	Wrap Around MEIP	FIDIC for Construction	Unit Rate Schedules	Final design to be completed ahead of bidding
TM001	Fuel Storage	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Awarded and in execution
TR001	Rail System	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Re bidding required to overcome lack of bids in Study
TX001	Construction Accommodation Camp and Services	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Awarded in execution
TX002	Permanent Accommodation Camp	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Awarded in execution
TX003	Workshops	FIDIC Design-Build	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
SUPPLY CONTRACTS				
PA001	Mine Site Camp Supply	Purchase order	Lump sum	Awarded in execution
PC001	Pre-Cast Concrete	Purchase Order	Unit Rate Schedules	Awarded in execution
PE001	Power Distribution E-Houses	Purchase Order	Pricing Schedule: Milestone Payments	Awarded in execution
PE002	Power Generation	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
PM007	Jaw Crusher Upgrade	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
PM100	Mobile Equipment - Mine Production	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed

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Package Number	Package Title	Contractual arrangement	Pricing Basis	Package Status at completion of the Stage 3 Definitive Study
PM200	Mobile Equipment - Other	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
PM201	EPCM Vehicles	Purchase Order	Pricing Schedule: Milestone Payments	
PR001	Locomotives	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
PR002	Ore Wagons	Purchase Order	Pricing Schedule: Milestone Payments	Final contract negotiation to be completed
BULK MATERIALS PURCHASE ORDERS				
BE001	Power Distribution Cable	Purchase Order	Pricing Schedule: Milestone Payments	Awarded in execution
SERVICE CONTRACTS				
ZG001	Site Survey	Service Level Agreement	Cost Reimbursable	
ZL001	Sea Lift - Standard Freight	Service Level Agreement	Unit Rate Schedules	Final contract negotiation to be completed
ZL004	Consolidation Hub	Service Level Agreement	Unit Rate Schedules	Final contract negotiation to be completed
ZX006	Communications and Data Services	Service Level Agreement	Unit Rate Schedules	Final contract negotiation to be completed
MATERIALS/SERVICES BY BIM				
TX007	Early Earthworks - Tormont Equipment Maintenance	Service Level Agreement	Unit Rate Schedules	Awarded in execution
TX008	Early Earthworks - Sandvik Equipment Maintenance	Service Level Agreement	Unit Rate Schedules	Awarded in execution
TX009	Early Earthworks - Explosives Supply	Service Level Agreement	Unit Rate Schedules	Awarded in execution
ZF001	Diesel Fuel Supply	Service Level Agreement	Unit Rate Schedules	
ZR001	Rail Operations	Service Level Agreement	Unit Rate Schedules	Bid received.
ZX004	Air Services - Passenger from Mirable to site	Service Level Agreement	Unit Rate Schedules	TBA
ZX005	Air Services - Freight	Service Level Agreement	Unit Rate Schedules	TBA
ZX009	Air Services - Passenger from regional aiports to Mirabel	Service Level Agreement	Unit Rate Schedules	TBA

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Package Number	Package Title	Contractual arrangement	Pricing Basis	Package Status at completion of the Stage 3 Definitive Study
ZX010	Camp catering existing installations (early works)	Service Level Agreement	Unit Rate Schedules	TBA
Packages for Placed and Managed by BIM				
YH001	EPCM Services Early works			Awarded in Execution
YH002	EPCM Services Execution			Final contract negotiation to be completed
YH003	EPCM Site indirects costs			Final design to be completed ahead of bidding
YE999	Third Party Vendor and Pre-Assembly Yard QA-QC			
VX999	Vendor Representative Support planning package			Included in packages above
ZX991	First fills - planning package			Included in packages above
ZX992	Capital and commissioning Spares - planning package			Included in packages above
WE001	Owners costs			
WE002	Upgrade of Owner's systems			
WO001	Quarry Royalties			
XC999	Contingency			
XT999	GST credit planning package			

Table 21-3: Package List

- The contract formation, purchase order formation and resultant contract management shall be undertaken from the EPCM home office.
- All freight originating from North America will be consolidated at the at a project Canadian Consolidation Hub (CCH) before shipment to Milne; the exception being for explosives and the 800 man camp.
- For freight received at the CCH, the EPCM will receive pre-packaged (containerised) loads for shipment. The EPCM will receive such materials as loads and then re-issue to either the source or target contractor on site. The EPCM has no responsibility for the content of loads delivered to the CCH.

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- For freight originating overseas (not North America and Canada) and where required specifically in the contract, contractors will freight goods, materials, equipment, pre-assemblies, modules, etc. directly to the port at Milne.
- Where specialty heavy lift vessels and offloading equipment is required, contract CM001 in particular, the contractor is responsible for all off load and site movement of goods and materials provided under the contract.
- For all other shipments arriving at Milne the seal lift contractor (ZL001) is accountable for material offload and transport to the high water mark at designated landing points at Milne. The EPCM contractor will register and issue all such loads to receiving contractors at Milne.
- Contractor CC002 will be accountable for:
  - receiving all shipments arriving from the CCH
  - moving the loads from the high water mark to either laydown areas at Milne or the Mine at Mary River for issue to receiving contractors.
- Once goods and materials have been transferred to contractors, the contractor will be responsible for all material management functions related to their site work.

21.1.2.7 Construction (refer to Appendix A21-8)

- The EPCM will coordinate the onsite infrastructure framework required for contractors to operate efficiently at site. Each contractor will be focussed on their contract, the work of the EPCM is to coordinate contractor activities and ensure efficient and safe completion of work.
- Construction oversight, that contractors are performing work in accordance with their contracts will be undertaken jointly by field supervisors, field engineers and package coordinators on site.
- The EPCM will be responsible for validating an ensuring the delivery of complete modules and pre-assemblies that have been pre-commissioned where appropriate: Specifically the EPCM will oversee and audit contractor plans to ensure contractor compliance with the contract and the project goals are met. Specifically the Construction team will provide oversight in respect to;
  - Extent of modularization/offsite fabrication and assembly including module configurations.
  - Procurement, contracting and fabrication strategies.
  - Vendors and fabrication/erection contractor pre-qualification criteria and availability.
  - Transportation, logistics and handling studies.
  - Coordination of vessel movements at Milne

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- Sequencing, scheduling and execution planning for modules and pre-assemblies by contractors.
- Development of modular specifications and responsibility matrices.
- Crane requirements including pre-inspection, qualifications and reservation of appropriate equipment and resources.
- Determine module/assembly hook-up, pre-commissioning and commissioning requirements.

The construction team will provide final releases for module shipment to site.

- Coordination of sealift contractor and CC002 will be undertaken to ensure a structured approach to receiving and issuing materials is delivered on site. There will be no EPCM managed warehouse; all materials shipped to site will be directly passed to end user contractors for their care custody and control.
- A third party quantity surveyor will be engaged to review and confirm installed quantities and quantities won (quarry work and ballast preparation) to confirm and validate contractor progress and charges presented on invoices.
- The construction management team will coordinate all site activities between contractors to ensure efficient delivery of construction works. In particular the management team will undertake overall coordination of manpower planning using plans prepared by contractors and coordinate people movements and accommodation needs. The site team will ensure personnel are mobilised to site after completion of all pre-requisite checks and pre-mobilisation activities. The site team will encourage the retention of non-skilled workers on site through manpower coordination activities and discussions with demobilising and mobilising contractors.
- The management team will manage the site services.

CC002 Earthworks South will be responsible for general site services at Mine consisting of the following:

- Sealift freight offload and delivery to laydowns.
- Raw water delivery to construction camp.
- Treated effluent pickup from STP and discharge.
- Project road and area snow removal and sanding.
- Garbage collection and delivery to incinerator and landfill.
- Bussing of passengers between the aerodrome and Milne Port construction camp.
- Minor carpentry and repairs to EPCM facilities.

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- Raw water delivery to construction camp.
- Treated effluent pickup from STP and discharge.
- Project road and area snow removal and sanding.
- Garbage collection and delivery to incinerator and landfill.
- Minor carpentry and repairs to EPCM facilities.
- EPCM pickup maintenance.

TX001 Construction camp and services will be responsible for services related to the construction camps at both Milne Port and the Mine site as follows:

- Camp management, operation, maintenance and catering.
- Sewage treatment plant operation.
- Water treatment plant operation.
- Incinerator operation.

21.1.2.8 Commissioning (refer to Appendix A21-9)

The EPCM will be responsible for managing the commissioning program. The responsibilities for completion of each stage of commission is defined below;

Number	Package Name	Commissioning Stage				
		1	2	3	4	5
CM001	Ore Processing	C	C	C	C	BIM
PE001	Power Distribution E-Houses	C	E	E	BIM	BIM
PE002	Power Generation (not final)	C	E	E	BIM	BIM
PM007	Jaw Crusher Upgrade (not final)	C	C	C	C	BIM
PM100	Mobile Equipment - Mine	C	C	C	C	BIM
PR001	Locomotives	C	C	C	BIM Note 1	BIM Note 1
PR002	Wagons	C	C	C	BIM Note 1	BIM Note 1
TM001	Fuel Storage	C	E	E	BIM	BIM
TR001	Rail System (not final)	C	E	E	BIM	BIM
TX001	Construction Accommodation Camp and Services	C	C	C	C	BIM
TX002	Permanent Accommodation Camp	C	C	C	C	BIM

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Number	Package Name	Commissioning Stage				
		1	2	3	4	5
CG001	Ore Dock	C	C	C	C	BIM

Note 1: BIM has plans to utilize a rail operator (ZR001) who will have Stage 4 commissioning responsibility as the operator. (and ongoing operations thereafter)

Table 21-4: Commissioning Responsibilities/

The stages of commissioning being defined are in the table below.

Function	Construction	Commissioning			
Project Phase	Execution			Start-up	Ramp-up
Stage	Stage 1: Construction Testing	Stage 2: Pre-Operational Equipment Testing	Stage 3: Pre-Operational Systems Testing	Stage 4: Process Commissioning	Stage 5: Ramp-Up
Activity	Equipment inspection and testing	Equipment inspection and testing	Systems testing	Process start up and testing	Ramp-up
Conditions	Not energized	Energized	Inert material (water, air)	Process materials	Process materials
Example Tasks	Wiring point to point Vessel leak checks Pressure pipe tests	Motor bump test Vibration checks Align conveyor	Interlock check Sequence check Pump flow check	Run systems with process materials Run the complete plant	Increase throughput to design rate and quality

Table 21-5: Commissioning Stages

- Where modules or pre-assembled components (CM001 elements, E houses, generators, locomotives etc) are procured, such items will be pre-commissioned to the a minimum commissioning Stage2, and where practical, particularly for CM001 modules, commissioned to Stage3, before shipping to site.
- To facilitate commissioning of critical equipment (CM001 and PR002) package engineers engaged at the start of the implementation phase will remain engaged with package management through design, fabrication, offsite pre-commissioning and on site commissioning to drive commissioning effort off site.

21.1.2.9 Project Controls (refer to Appendix A21-10)

- The project controls function will be managed and lead from the EPCM Home office. Field Coordinators will be engaged on site to capture schedule, cost and progress data from contractors. Processing of field collected data will be undertaken in the Home Office.

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- The EPCM will use its own cost control system in an un-customised roll out to manage progress and cost control for the project.
- Progress Measurement
  - EPCM Related work:
    - The EPCM will report progress for EPCM related Level of Effort work as Level of Effort activities where progress is based on actual hours relative to approved budget and expected forecast at completion.
    - Progress for EPCM engineering work will be based upon rule based rules of credit applied to the completion of Engineering Work Packages defined in the Engineering Functional Execution Plan contained in Appendix A21-6.
    - Cost performance will be assessed against approved budget using earned progress defined above.
  - Contractor and Vendor work
    - Contractors and vendors will be required to provide cost, schedule and performance reports in accordance with standards defined by the EPCM and as contained in their contracts.
    - The EPCM will verify field construction work by way of interactions with the field coordinators and input from the site based third party quantity surveyor.
  - Project Progress Measurement;
    - EPCM Services; measured as defined above and included in proportion to its cost contribution to the approved TIC.
    - Procurement: measured as above and included in proportion to its cost contribution to the approved TIC.
    - Contracts/Construction: measured as above and included in proportion to its contribution to the approved TIC.
    - Other; included in proportion to its contribution to the approved TIC.
    - EPCM standard procedures for progress measurement aggregation will be applied.
- Cost Controls will be applied in accordance with EPCM procedures and include for:
  - Capture of budgets, budget transfers and change approvals.
  - Capture of actual costs according to receipt of actual accruals and expenditure.
  - Cost trending to develop cost forecasts to enable mitigating strategies to be developed before cost is incurred.

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- Project reporting will be included issue of a formal monthly report summarising the status of the project and providing forward projections for project performance and measures to be applied to vary the execution method to mitigate adverse trends. The expected formal reporting regime is shown in:

Report	Frequency
Project coding structure	Implemented and revised as required
Cost Baseline	6 to 8 weeks from FEL3 approval
Schedule baseline	6 to 8 weeks from FEL3 approval
Progress baseline	6 to 8 weeks from FEL3 approval
Package Cost Analysis Sheet (commitment control)	As required
Cost Forecast Report (includes contingency and Forex reporting)	Monthly
Trend and change report	Interim Period to be determined, issued monthly in the MPR
Level 1, 2 and 3 schedule updates	Monthly
4 week manhour report	Weekly
Engineering progress (no review of hours)	Bi-weekly
Engineering and EPCM hours update	Monthly
Overall consolidated progress	Monthly
Monthly project report	Monthly
Hatch invoices	Monthly
Third party payment certificates (Contractors and Suppliers managed by Hatch)	As required
Accruals on Hatch managed packages	Monthly

Table 21-6: Standard Reporting

21.1.2.10 Document Management (refer to Appendix A21-11)

- The EPCM will provide the primary document management system for the project and

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- Store all and issue to contractors design deliverables created by the EPCM
- Receive document lists and track document submittals for all contractor and vendor packages.
- Store all documents created by the EPCM and contractors/vendors managed by the EPCM.

- The EPCM will require all vendors and contractors to submit document lists to be loaded into the document management system and against which project document numbers will be issued; contractors and vendors will be required to submit their documents according to their document list and numbered per EPCM issued document number.
- The document control function will be managed from the EPCM home office.

21.1.2.11 Project Systems Management (refer to Appendix A21-13)

In view of the lean EPCM approach, systems will only be deployed if core to a function on the project and where that function can setup and maintain that system:

- The standard engineering suite of tools will be used for Hatch generated design.
- The standard iPAS DM tool will be used for document management
- iPAS MP will be used to track materials at a container/module level, both in the home office and at site.
- iPAS PC will be used to manage contracts and project controls.
- iPAS EP/iPAS TF will be used to manage time reporting and engineering progress

Site IT systems and support costs have been minimized for the project and no allowance has been made for a Hatch IT site resource. Consequently, only those systems that can operate through a VPN connection, will be utilized at site.

21.1.2.12 PEP Part C - Control Baselines (refer to Appendix A21-14)

The PEP Part C contains the project baseline data against which project performance will be monitored, reported and as a basis to assess change. This section contains:

- The Project WBS structure which captures the Facilities Break Down Structure the FBS.
- Procurement Package Register
- Procurement Package Status Report – normalized for start of implementation
- Project Schedules
  - Milestones
  - Level 1, level 2 and level 3 project schedule
  - Critical path schedule level 1, level 2 and level 3

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- Construction Manpower histograms
- EPCM Staffing manpower histogram
- Progress Curve baselines
- Cash flow Curve and Cash flow data, commitments and expenditure
- Facilities description

21.2 Systems and Procedures

The EPCM will deploy its standard suite of procedures, templates, forms and systems in discharge of its obligations. No provision has been made for customisation of any system, procedure, template or form during the execution phase.

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21.3 Organisation

21.3.1 Owner's Team

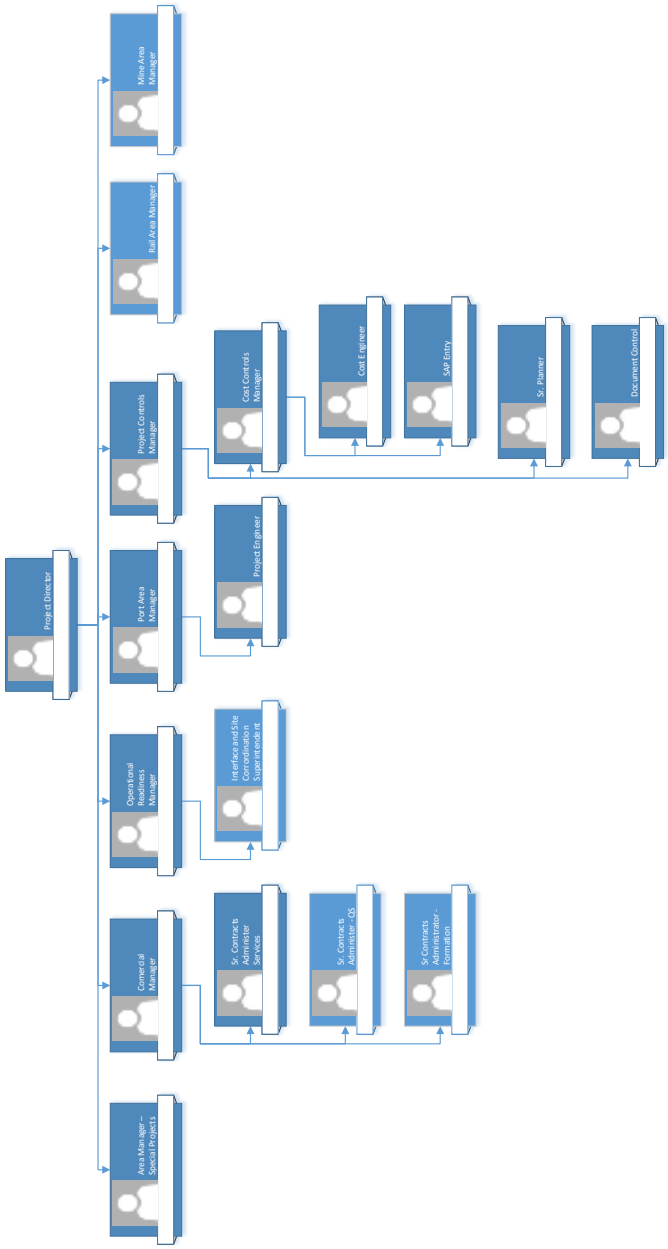

Figure 21-1:BIM Owner's Team Organisation

21.3.2 EPCM

The EPCM team structure recognizes;

- In 2017 to 2018 the team is focused upon:

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- Completion of EPCM supplied engineering
- Award of all contracts and purchase orders
- Contract administration for awarded contracts
- Completion of Early Work to allow efficient ramp of 2017 construction work following the 2017 sealift
- Earthworks to progress site development at Milne Port, the mine site and Railway, in particular preparation of foundations for key elements of the CM001 package ready for delivery in 2018.
- Offsite fabrication and pre commissioning of modular and per-assembled plant and equipment
- Dock design and contractor mobilisation
- Delivery modular units for CM001

- In 2018 to 2019 the team is focused upon:
  - Completion of fabrication and shipping to site all plant and equipment required for construction completion.
  - Completing earthworks and rail line installation
  - Installation and commissioning of the bulk materials handling facilities.
  - Start up of the rail line and train unloader
  - Crushing, screening and lump stacking plant commissioning and ramp up.
  - Installation and commissioning of the shiploaders.
  - Performance testing of one shiploader onto a Panamax vessel.
  - Achieving mechanical completion for all plant and completion of dry commissioning for all plant.
- In 2020 BIM will manage any outstanding activities for the project, such as:
  - Performance testing associated with the lump reclaim and shiploading circuit supplied contractor CM001
  - Retrograde shipping in the 2020 sea lift of remaining contractor equipment and personnel.
  - Any outstanding financial close out on contracts and purchase orders (eg final payments, retention releases, release of bonds, etc)

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The EPCM team structure has been aligned to the changes in work focus from year to year and also to the need to deport a lean management approach to the management of the site wherein major contractors are expected to self-manage against contracted schedules and cost projections.

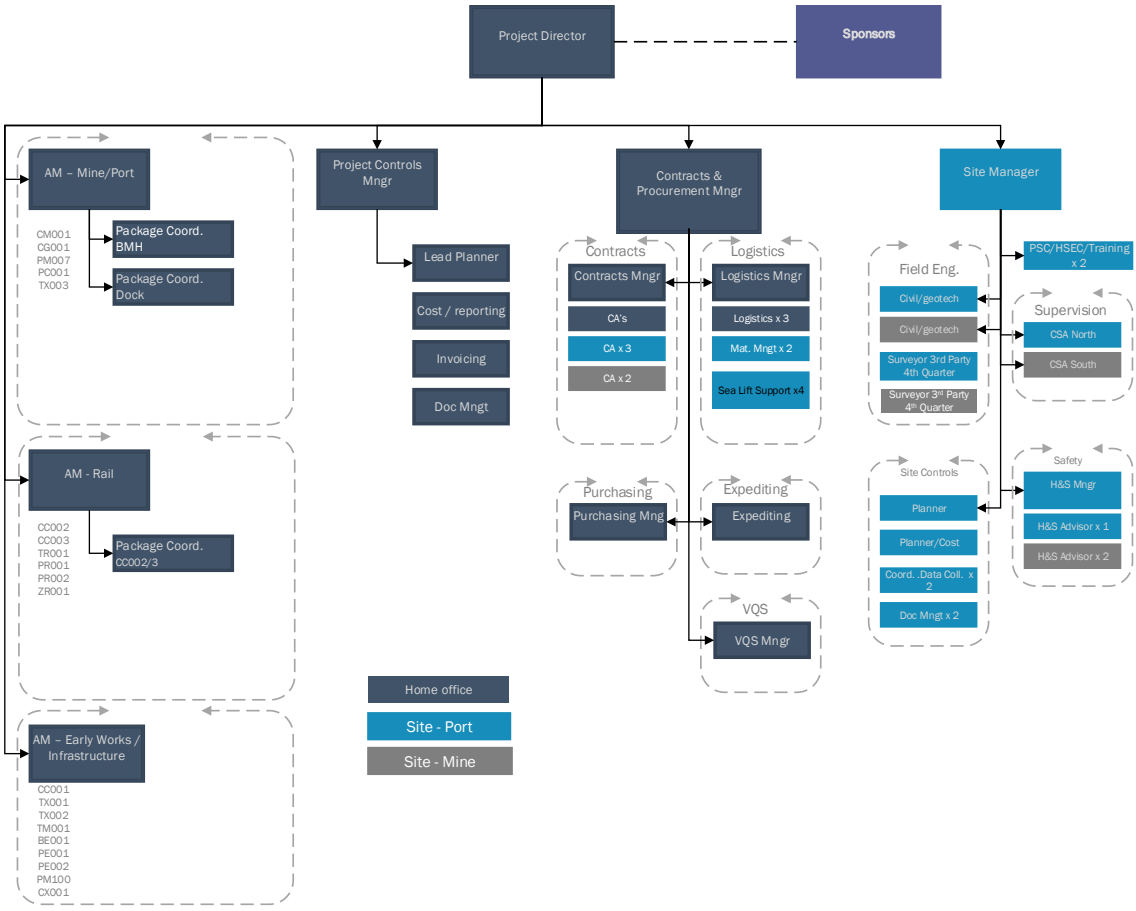

Table 21-7: EPCM Organisation 2017 - 2018

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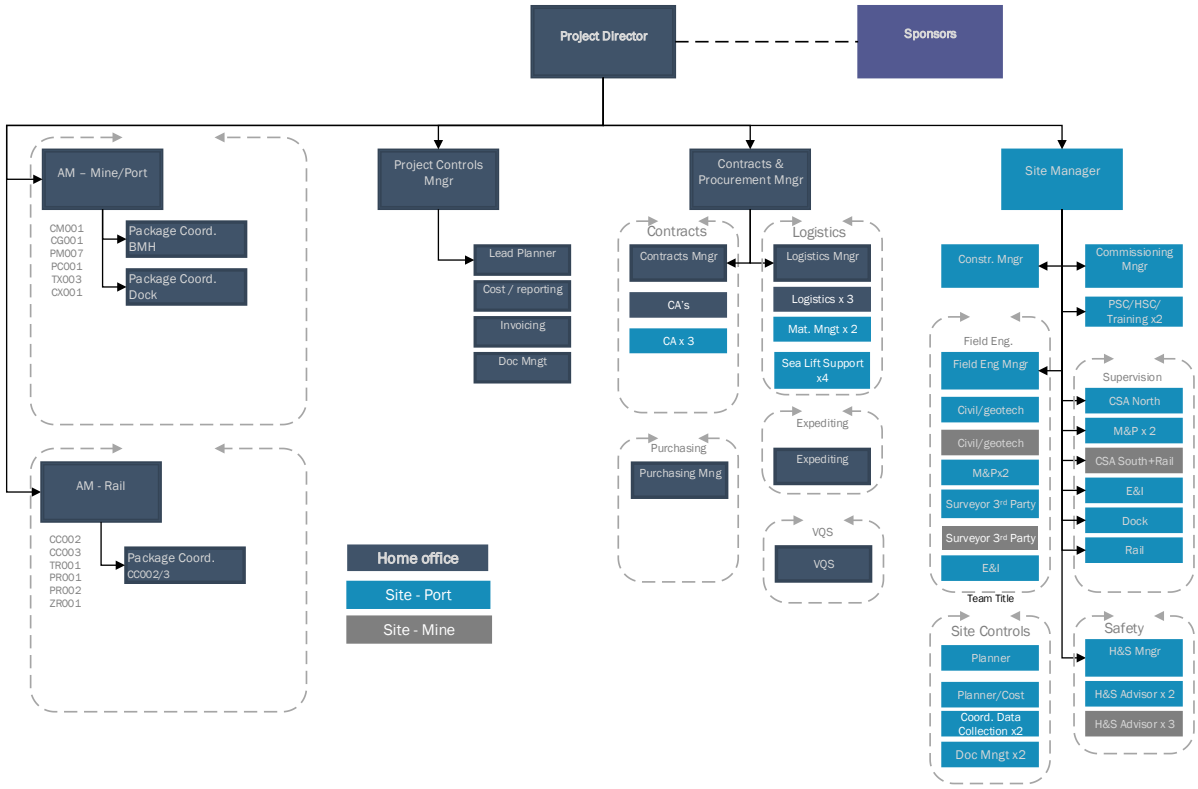

Table 21-8: **EPCM Organisation 2018 – 2019**

In all scenarios the EPCM will mobilize a small team to the Consolidation Hub at Velley Field in Quebec to prepare for and manage the sealifts for 2017, 2018 and 2019.

21.3.3 Roles and Responsibilities

Roles and responsibilities for the BIM Owner Team, the EPCM and Contractor/Vendor organisations have been developed and included within Appendix A21-1 PEP Part A.

21.3.4 Delegation of Authorities

21.3.4.1 Owner

The Owner delegations of authority have been developed and included within Appendix A21-1 PEP Part A.

21.3.4.2 EPCM

The EPCM delegations of authority have been developed and included within Appendix A21-1 PEP Part A.

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21.3.5 Execution Offices

21.3.5.1 Home Offices

The BIM Owner's team will operate from the corporate offices of BIM located at 2265 Upper Middle Road, Oakville Ontario.

It is expected that the home office for the EPCM will be located close to the Home Office for the BIM Owner's Team.

21.3.5.2 Site Offices

BIM will provide serviced office accommodation for both the Owner and EPCM at both the port at Milne and also the mine at Mary River.

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21.4 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-103-120-0001	PEP Part A – Definition and Execution Strategy	B	04/21/2017	A21 - 1
H353004-00000-110-120-0001	PEP Part B1 – Health and Safety Management	B	04/21/2017	A21 - 2
H353004-00000-120-120-0001	PEP Part B2 – Environment, Sustainability and Community Interface Management	B	04/21/2017	A21 - 3
H353004-00000-130-120-0001	PEP Part B3 – Quality Management	A	04/21/2017	A21 - 4
H353004-00000-140-120-0001	PEP Part B4 – Risk Management	B	04/21/2017	A21 - 5
H353004-00000-200-120-0001	PEP Part B5 – Engineering Management	A	04/21/2017	A21 - 6
H353004-00000-300-120-0001	PEP Part B6 – Procurement and Materials Management	B	04/21/2017	A21 - 7
H353004-00000-400-120-0001	PEP Part B7 – Construction Management	B	04/21/2017	A21 - 8
H353004-00000-500-120-0001	Pep Part B8 – Commissioning Management	B	04/21/2017	A21 - 9
H353004-00000-600-120-0001	PEP Part B9 Project Controls Management	B	04/21/2017	A21 - 10
H353004-00000-720-120-0001	PEP Part B10 – Document Management	B	04/21/2017	A21 - 11
H353004-00000-730-120-0001	PEP Part B11 – Project Systems Management	B	04/21/2017	A21 - 12
H353004-00000-103-120-0001	PEP Part B12 – Owner's Team Execution Plan	A	04/21/2017	A21 - 13
H353004-00000-103-120-0002	PEP Part C Control Baselines	B	04/21/2017	A21 - 14

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 22 – Operations Readiness

2017-05-01	0	Approved for Use	R. Barrette	É. Denommée-Gravel	C. Horan	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
HATCH						

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Baffinland Iron Mines LP
Mary River Expansion Stage 3

Definitive Study Report

Section 22 – Operations Readiness

2017-05-01	0	Approved for Use	R. Barrette	É. Denommée-Gravel	C. Horan	BIM
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

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22. Operations Readiness

22.1 Executive Summary

The Operational Readiness (OR) Plan has been developed with the aim of ensuring the safe and expeditious ramp-up of the Mary River Expansion Operations to achieve the forecasted production rate and operational costs.

The OR work conducted to date has identified no fatal flaws from an operational readiness perspective. The OR plan contains a fit for purpose execution strategy for the remaining project lifecycle. Key dimensions of this OR plan included development of the:

- Operating Strategy.
- Maintenance Framework.
- Organisational Charts.
- BIM Headcount and Assumptions.
- OR Work Plan.
- OR Estimate.

Central to the OR Plan is the OR Work Plan (OR Work Packages) which was developed in accordance with the Operations Strategy and Maintenance Framework. These work packages were derived from the known requirements to ensure there is a plan and budget for the execution phase for the Maintenance, Operations, Training (Maintenance and Operations) and Supply Chain and Logistics functions.

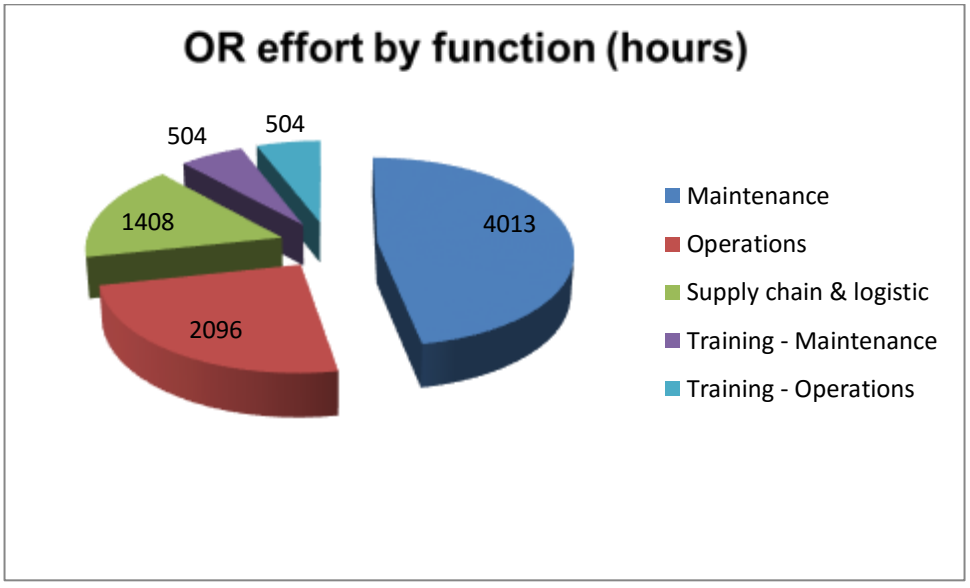

Figure 22-1: OR Effort Estimate

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An OR estimate has been developed from base principles to +/- 25% accuracy. The OR estimate has been estimated based on similar project experience, with consideration for the execution strategy and challenges expected with the successful execution for the Mary River Project. The total OR estimate is estimated at $1,407,000.

Comparisons of the OR needs to the Project and the Commissioning budgets have been conducted to ensure there are no gaps, overlaps or double entries.

A detailed OR Execution Plan will be developed at the commencement of the Execution phase with the continued involvement of the site Management Team, the chosen OEM's, BIM Contractual, O&M Contractors and other relevant Stakeholders.

22.2 Approach to Developing Operational Capabilities

The Mary River mine, Railway and Milne Port sites is a brownfield project with an existing operation, however the OR plan contains requirements of developing a new organisation. This organization will ensure a safe, planned and rapid start-up of these sites, the integration and setup of required systems and infrastructure, the engagement and development of the team, as well as the associated equipment, is capable and operationally ready so that safety, production, cost and quality meet the projects ramp-up operations forecasts. The OR Plan (A22-5)considers the needs of the following functional areas in Figure 22-2 below.

Figure 22-2: OR Plan Functional Considerations

The operating strategy developed by BIM for the expanded operation is shown in Appendix A22-1.

22.2.1 Vision for the BIM Operation

BIM vision is to safely and efficiently identify and develop resources within Baffin Island, unlocking their wealth-generating potential to the benefit of all stakeholders.

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BIM is committed to building and operating the Mary River mine and Milne Port in an environmentally and socially responsible manner that will benefit all stakeholders. Particular consideration will be given to the Inuit of the North Baffin region as the project is successfully developed. Our approach is one of caring, hard work, innovation, reliability and teamwork.

The Operations Strategy document describes how this will be achieved in great detail, it can be found in Appendix A23-1.

22.2.2 Operational Readiness Needs

In order to achieve the above vision, the OR plan is focused on providing the following:

- The safe, planned and rapid start-up of the mine and equipment so that production, cost and quality meet the project ramp-up operations forecasts.
- Equipment that is 'Reliable" and able to safely perform at expected availability to meet the needs of the Production Schedules and Project Plans. The Maintenance Framework document describes how this will be achieved in great detail and can be found in Appendix A22-2.
- People who are "Capable" with high levels of engagement, empowerment, skills and knowledge to safely meet the needs of the start-up and on-going production. *The organisational charts depict the functional spread of responsibility for the intended* BIM organisation while the headcount and assumptions show the number of people in each function. The organisational charts and headcount can be respectively found in Appendix A22-3 and A22-4
- Systems and processes are "Efficient", operationally ready and in place, deployed to the workforce and ready to ensure that the production requirements of the schedules and plans are met safely, consistently and in full compliance with operating licenses and the values, mission and vision.

Key elements of the OR plan include:

- Operating strategy.
- Organizational philosophy and structure.
- Management of change process.
- Shutdown management and strategy.
- Work management and maintenance system (CMMS).
- Material management.
- Contractor management.
- Maintenance daily management and performance monitoring.
- Drawings and document management.

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The OR Team will function as an integrated team within the project. Figure 22-3 below shows the OR Delivery Model to transition the Project into sustainable operations.

Figure 22-3: Integration of Project Commissioning, Operations Readiness and Ramp Up

OR specific work packages and implementation activities are focused on the following areas to prepare BIM in achieving the production increase:

- Management operating systems, business systems, business processes and operating procedures are identified, developed as 'fit for purpose', implemented, understood and used effectively.
- Robust asset management practices are in place, aligned with the Maintenance Framework.
- Appropriate training is provided to Operations and Maintenance, including training material development, implementation, planning and scheduling.
- Supply Chain and Logistics processes such as outbound material logistics, material management strategy and spares cataloguing.
- Commissioning is defined in the Project Execution Plan (PEP).
- Ramp Up is planned as part of the Production Planning.

22.3 Operational Readiness Progress at the End of Definitive Study

During the Definitive Study (DS), the following key activities were completed:

- Operating Strategy.
- Maintenance Framework.
- Organisational Charts.
- BIM Headcount and Assumptions.
- OR Work Plan.

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- OR Estimate.

The OR activities progress budget, risk and schedule implementation tracking will be set up at the beginning of the execution phase and continue for the duration of the project until ramp up targets are achieved.

22.4 Operational Readiness Risks Consideration

The OR work conducted to date has identified no fatal flaws from an operational readiness perspective.

22.5 Operational Readiness Work Plan

The OR Work Plan in Appendix A22-5 consist in a work package list that is required to complete the OR component of the Project in execution for the Operations, Maintenance, Training (production and maintenance) and Supply Chain and Logistics functions.

The main OR work packages are outlined below:

- Operations:
  - Management of change.
  - Operating plans/task lists.
  - Upload data into CMMS.
  - Operating WI's and procedures (SOPs).
- Maintenance:
  - Equipment registers and functional locations.
  - Criticality assessment of new equipment and processes.
  - Equipment maintenance strategies, plans, tasks lists and BOMs.
  - Maintenance procedures and WI's.
  - Data uploaded into CMMS.
  - Maintenance metrics and reports for new equipment.
  - Spare part philosophy.
  - Spare part and tooling assessment.
- Training:
  - Training planning and scheduling.
  - Training material development and implementation.

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- Supply Chain and Logistics:
  - Material management strategy.
  - Outbound material logistics.
  - Spare parts cataloguing.

At the outset of the DS, an OR core team will be mobilized to the Project Team under the direction of the Mary River Project Manager and a part time OR Manager. To ensure suitable focus and ownership of OR activities during the Execution Phase, the OR Team will comprise of OR contractors supported by a range of part time specialists from BIM Operations and Support Departments. This mix allows the OR Team to flex as required to meet the needs of the OR Work Plan.

22.6 OR Schedule

To be developed in Execution.

22.7 OR Estimate

An OR budget has been estimated, at the work package level, for the OR costs during the Project Life. The work has been validated by both the project and BIM OR manager. This approach has identified approximately 2,13 person years of work to complete the OR execution from Detailed Engineering to the end of pre-commissioning, estimated at 2 years. A blended all-inclusive hourly rate of CAD$ 165 per/hour rate for OR contractors. The resulting OR Budget by functional area is listed in Table 22-1 below.

Table 22-1: OR Estimate by Functional Area

Function	Hours (OR Contractor)
Maintenance	4013
Operations	2096
Supply chain & logistic	1408
Training - Maintenance	504
Training - Operations	504
Total effort (h)	**8525**
Cost per hour	165
Total cost ($)	**$ 1 407 000**
Services and Supplies	**$ -**
Contingency (included in overall Project)	**$ -**
Grand Total	**$ 1 407 000**

22.7.1 Estimate Basis and Assumptions

The following assumption have been made in the OR estimate.

- OR estimate is zero based, reflecting the identified an agreed work packages from the DS.

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- OR estimate is based on DS information available.
- OR estimate does not include OR capital cost items.
- Vendor labour for commissioning, ramp-up support and training is included in the Project Budget.
- Maintenance and Operations labour for commissioning is included in the Commissioning Budget.
- Construction trade labour and supervision for commissioning and ramp-up activities is included in the Commissioning Budget.
- Start-up and ramp-up management and execution costs is excluded from the OR budget. This cost would be covered under OPEX.
- Operations, Maintenance and other people hired by BIM, not directly involved in the development of OR work, are budgeted for in the OPEX Budget, not the OR Budget.
- People who are working on the development and implementation of OR activities that are included in the OR Work Plan are budgeted for in the OR estimate.
- Operations and maintenance planning and development of procedures and work instructions for the Railway system will be developed by the Rail operation and maintenance contractor. Cost is included in the Project Budget.
- Maintenance planning and the development of procedures and work instructions for the heavy mining equipment (HME) will be developed by the HME maintenance contractor. Cost is included in the Project Budget.
- There is no cost included in the OR estimate for the training material development and implementation for the site services and accommodations since the Project will expand with identical equipment (same as existing).
- Training material development and implementation for the Mine bulk material handling system modifications is included in the OR estimate.
- Training material development and implementation for the Port bulk material handling system (from car unloading to ship loader) is included in the Project Budget.
- Training material development and implementation for the Railway system operation and maintenance and the HME maintenance is included in the Project Budget.
- Operations labour, accommodation and travel expenses for attendance at training and or between hire and start of operations are included in OPEX.
- Capital purchases of systems, tools and equipment required for the BIM to operate are included in the Project Budget. Labour for spare parts cataloging is included in the OR estimate.

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- All first fills are covered under the Project budget.

22.7.2 Estimate Summary Tables

Table 22-2: OR Estimate – Area Level (L3)

Level 2 OR Functions	Level 3 Area	Effort (h)
Maintenance	General	410
Maintenance	Mine	401
Maintenance	Port	2975
Maintenance	Rail	228
Operations	General	160
Operations	Mine	296
Operations	Port	1560
Operations	Rail	80
Supply chain & logistic	General	320
Supply chain & logistic	Mine	32
Supply chain & logistic	Port	1056
Supply chain & logistic	Rail	0
Training - Maintenance	Mine	264
Training - Maintenance	Port	160
Training - Maintenance	Rail	80
Training - Operations	Mine	264
Training - Operations	Port	160
Training - Operations	Rail	80

Table 22-3: OR Estimate – Sub Area Level (L4)

Level 2 OR Functions	Level 3 Area	Level 4 Sub area	Effort (h)
Maintenance	General	General	410
Maintenance	Mine	Camp accommodations extension	35
Maintenance	Mine	HME fleet and workshop	123
Maintenance	Mine	Primary crushing and stacking	243
Maintenance	Port	Camp accommodations extension	80
Maintenance	Port	Car dumper system	193
Maintenance	Port	Dock no. 2	42
Maintenance	Port	Reclaimer and shiploader	1194
Maintenance	Port	Secondary crushing and screening	829
Maintenance	Port	Site services	215
Maintenance	Port	Stacking	422
Maintenance	Rail	Railway, rolling stocks and workshop	228
Operations	General	General	160
Operations	Mine	Bulk material handling system	200
Operations	Mine	HME fleet and workshop	96
Operations	Port	Car dumper system	280
Operations	Port	Reclaimer and shiploader	400

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Level 2 OR Functions	Level 3 Area	Level 4 Sub area	Effort (h)
Operations	Port	Secondary crushing and screening	520
Operations	Port	Site services	80
Operations	Port	Stacking	280
Operations	Rail	Railway, rolling stocks and workshop	80
Supply chain & logistic	General	General	320
Supply chain & logistic	Mine	Bulk material handling system	32
Supply chain & logistic	Mine	HME fleet and workshop	0
Supply chain & logistic	Port	Car dumper system	144
Supply chain & logistic	Port	Reclaimer and shiploader	400
Supply chain & logistic	Port	Secondary crushing and screening	336
Supply chain & logistic	Port	Site services	0
Supply chain & logistic	Port	Stacking	176
Supply chain & logistic	Rail	Railway, rolling stocks and workshop	0
Training - Maintenance	Mine	Bulk material handling system	104
Training - Maintenance	Mine	General	160
Training - Maintenance	Mine	HME fleet and workshop	0
Training - Maintenance	Port	Bulk material handling system	0
Training - Maintenance	Port	General	160
Training - Maintenance	Port	Site services	0
Training - Maintenance	Rail	General	80
Training - Maintenance	Rail	Railway, rolling stocks and workshop	0
Training - Operations	Mine	Bulk material handling system	104
Training - Operations	Mine	General	160
Training - Operations	Mine	HME fleet	0
Training - Operations	Port	Bulk material handling system	0
Training - Operations	Port	General	160
Training - Operations	Port	Site services	0
Training - Operations	Rail	General	80
Training - Operations	Rail	Railway, rolling stocks and workshop	0

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22.8 Reference Documents

Document Number	Title	Revision	Date	Appendix Number
H353004-00000-800-084-0003	Operating Strategy	0	11/4/2017	A22 - 1
H353004-00000-800-084-0002	Maintenance Framework	0	11/4/2017	A22 - 2
H353004-00000-100-146-0001 AP0C	Organisational Chart	N/A	12/4/2017	A22 - 3
H353004-00000-800-066-0001	Head Count and Assumptions	0	11/4/2017	A22 - 4
H353004-00000-100-146-0001 AP0E	OR Work Plan	N/A	10/4/2017	A22 - 5

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