

Notice of Alteration – Smelter & Refinery Closure



Project Name:	Smelter & Refinery Closure	Project Number:	X000180
Development:	Vale Manitoba Operations	Project Site Application:	Thompson, Manitoba
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[2017, 03, 17]

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SECTION 1: INTRODUCTION

1.1 Context

On November 17, 2010 Vale announced plans to permanently close its Smelting and Refining Operations in Thompson Manitoba at the end of 2014. As a result of this announcement, the effort to develop a comprehensive closure plan for these facilities as well as a transition plan for the Manitoba Operations began in early 2011.

Recognizing the need to extend the operating life of the Thompson facilities to better align with the overall strategic plan for Vale's Base Metals Business, a variance to the 22.8kT /annum SO₂ cap prescribed by the Base Level Industrial Emissions Regulations (BLIERS) was requested.

Subsequent negotiations with the Federal Government resulted in the agreement signed in 2015 to extend the life of the Smelter and Refinery operations to the end of 2018 with an SO₂ performance target of 330 kt over the remaining three years.

This extension would provide the necessary time to complete the ramp up of Vale's Long Harbour Processing Plant in Newfoundland as well as construct a new Concentrate Load Out Facility in Manitoba facilitating the shipment of nickel concentrate following the closure of the Smelter and Refinery. Vale is now submitting this Notice of Alteration as required by section 14 of The Environment Act in respect of the closure of the Smelter and Refinery Operations in 2018.

1.2 Executive Summary

Existing as a fully integrated nickel operation since the 1960's, Vale's Manitoba Operations has provided economic growth and stability to the community of Thompson and Northern Manitoba for generations. The closure of the Smelter and Refinery and transition to a Mine/Mill operation is a critical step in securing its future success.

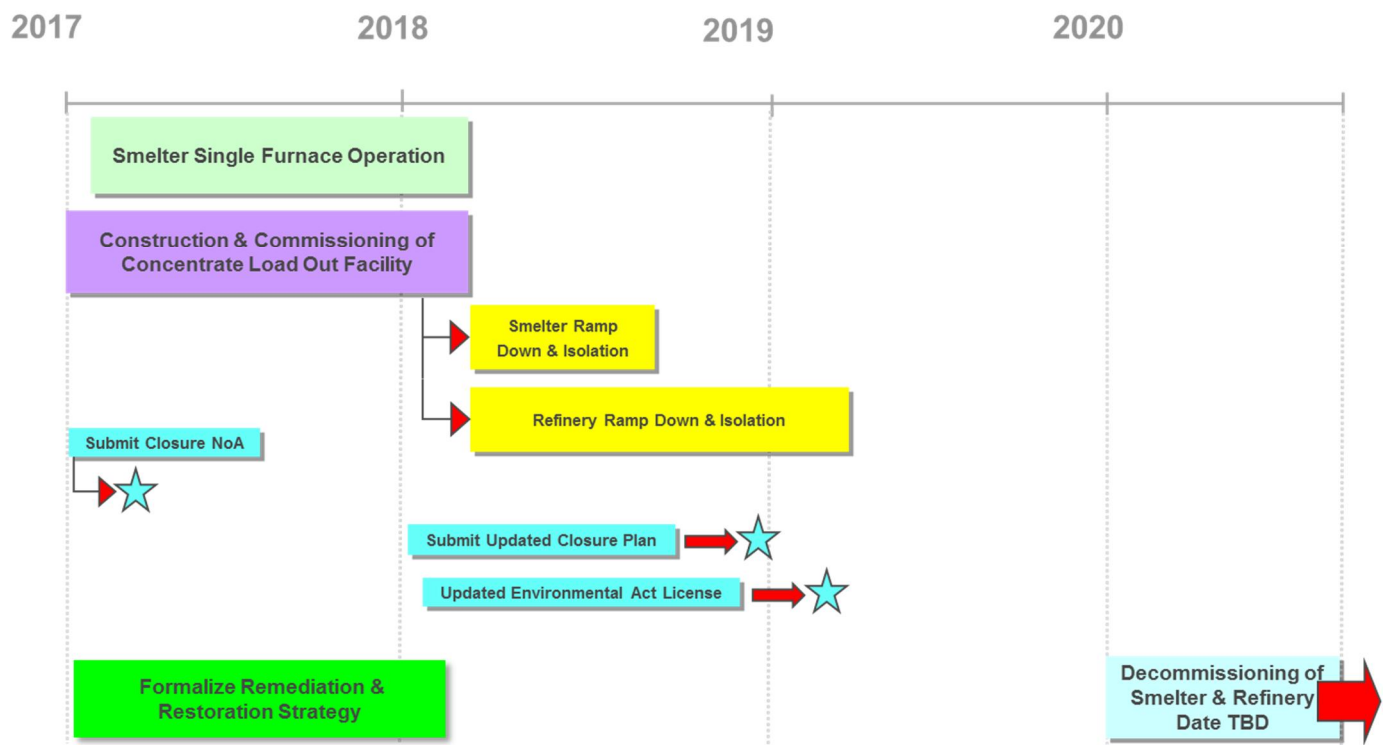
Approved on November 14, 2016 by Manitoba Sustainable Development Environmental Approvals Branch, the Concentrate Load Out project is currently in its construction phase. Facility commissioning is expected to begin in May of 2018 at which time the ramp down of the Smelter and Refinery will commence. Process shutdown of the Smelter and Refinery is expected to be completed by the end of August 2018 at which time final processing of intermediates and cleaning of the facilities will take place.

It is recognized that the environmental impact of the closure of the Smelter & Refinery will be significantly positive. The elimination of SO₂ and particulate emissions from the Smelter Stack, an estimated 47% reduction in raw water usage, the elimination of approximately 68 million lbs. of annual bulk chemicals consumed, and the estimated 42% site reduction in annual waste generation all serve to re-shape the operation and its environmental impact following the closure of the Smelter and Refinery.

Vale has developed detailed plans regarding the closure and decommissioning of the Smelter and Refinery that include: Plant Shutdown Procedures, Waste Management, Environmental Protection,

Landscaping/Restoration, Storage, Transportation & Logistics, and Utilities Isolation. These plans are discussed further in the sections below and have been appended for your reference. As is evidenced by these plans, the potential environmental effects resulting from this alteration *i.e.* the closure of the Smelter & Refinery Operations are positive and/or insignificant, as the closure will result in, among other positive impacts, a decrease in the release of environmental contaminants to the air, a decrease in the amount of waste generated, and a decrease in the amount of hazardous chemicals used at Vale’s Manitoba Operations.

1.3 Schedule

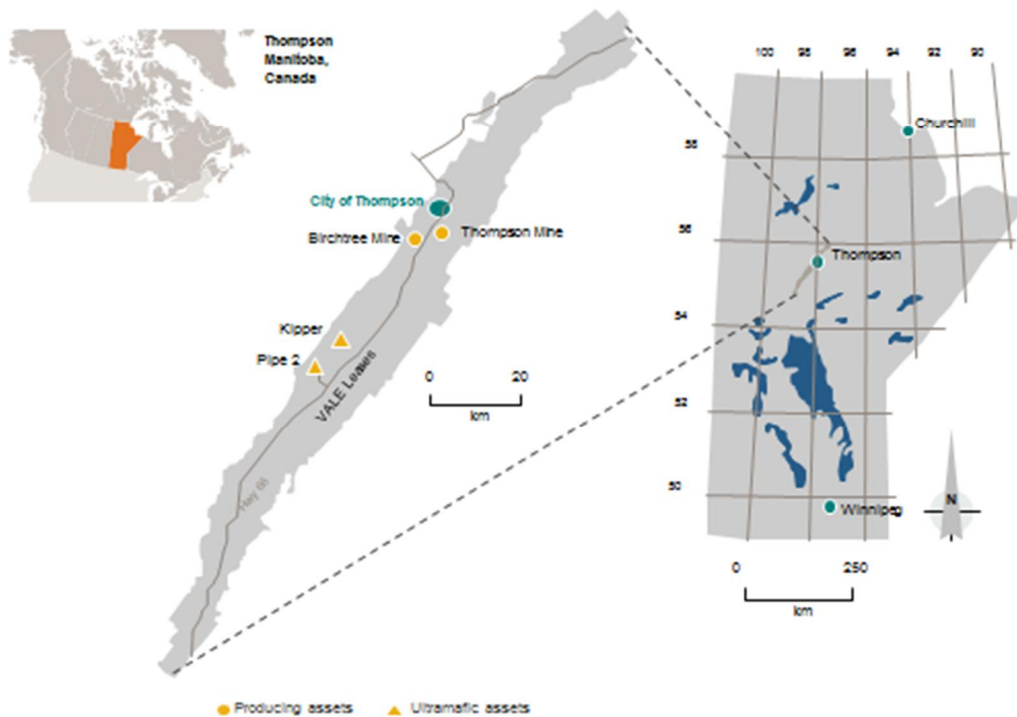


1.4 Facilities & Process

1.4.1 Site

The Thompson Mine is situated in Thompson, Manitoba, at latitude 55° 48' N and longitude 97° 52' W. Thompson Mine is located approximately 5 km (3 miles) south of the City of Thompson, and approximately 645 km (400 miles) north of Winnipeg, Manitoba.

Thompson Nickel Operations overview

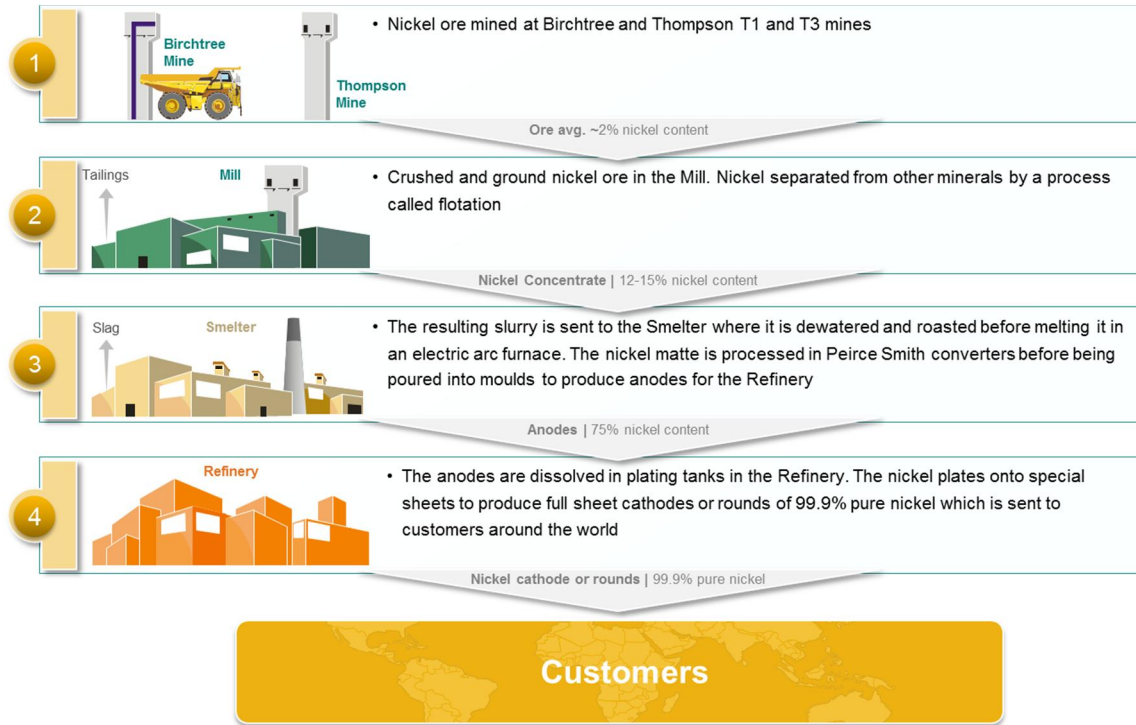


1.4.2 Current Process

Vale Manitoba Operations is an integrated Mine-Mill-Smelting-Refining operation which produces on average 100 Million pounds of refined nickel annually.

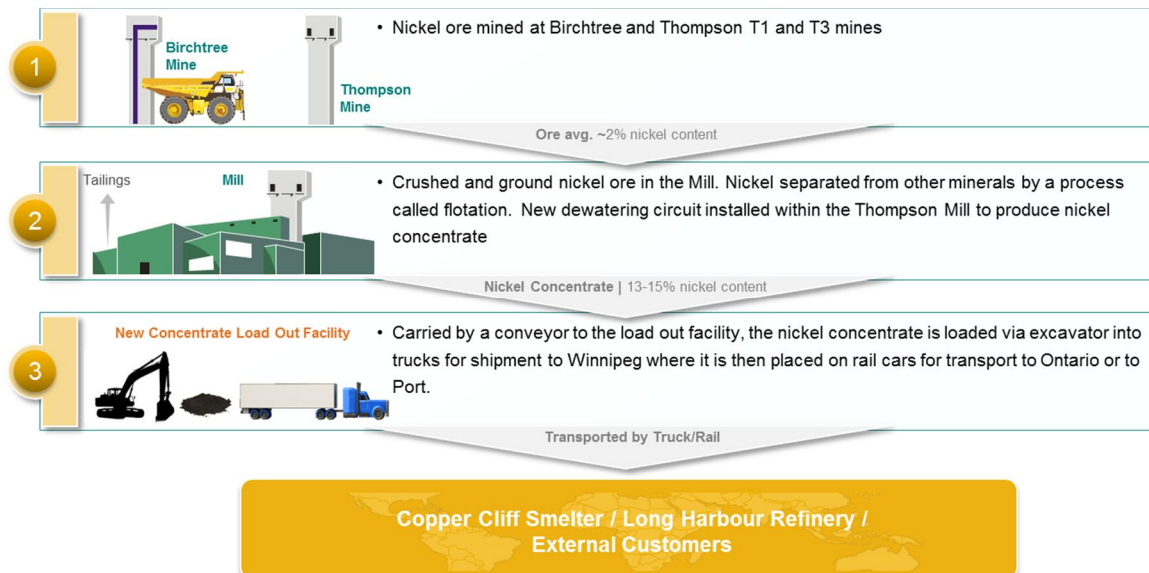
Operating 24 hours 7 days/week the site employs a workforce of approximately 1400 direct employees with an additional 400-500 indirect contractors.

Nickel Ore is extracted from three operating Mines and transferred to the Mill where it is crushed; ground and separated producing a nickel concentrate slurry. Received by the Smelter, this slurry is thickened and dewatered prior to entering the molten process. Molten material is then tapped from the electric furnace and converted in order to cast anodes for the Refinery. The final refining process produces three primary products which include Nickel Cathode or Slab, R – Rounds and S – Rounds. Finished product is then shipped from the Manitoba Operations to customers across the globe.



1.4.3 Future Process

Following the closure of the Smelter and Refinery, nickel concentrate will be produced at the Thompson Mill within a new dewatering circuit that is currently under construction. This 13% - 15% nickel concentrate will be transferred via conveyor to a new Load Out Facility, loaded onto trucks and shipped for further processing at Vale Operations in Sudbury and Newfoundland.



1.4.4 Mines

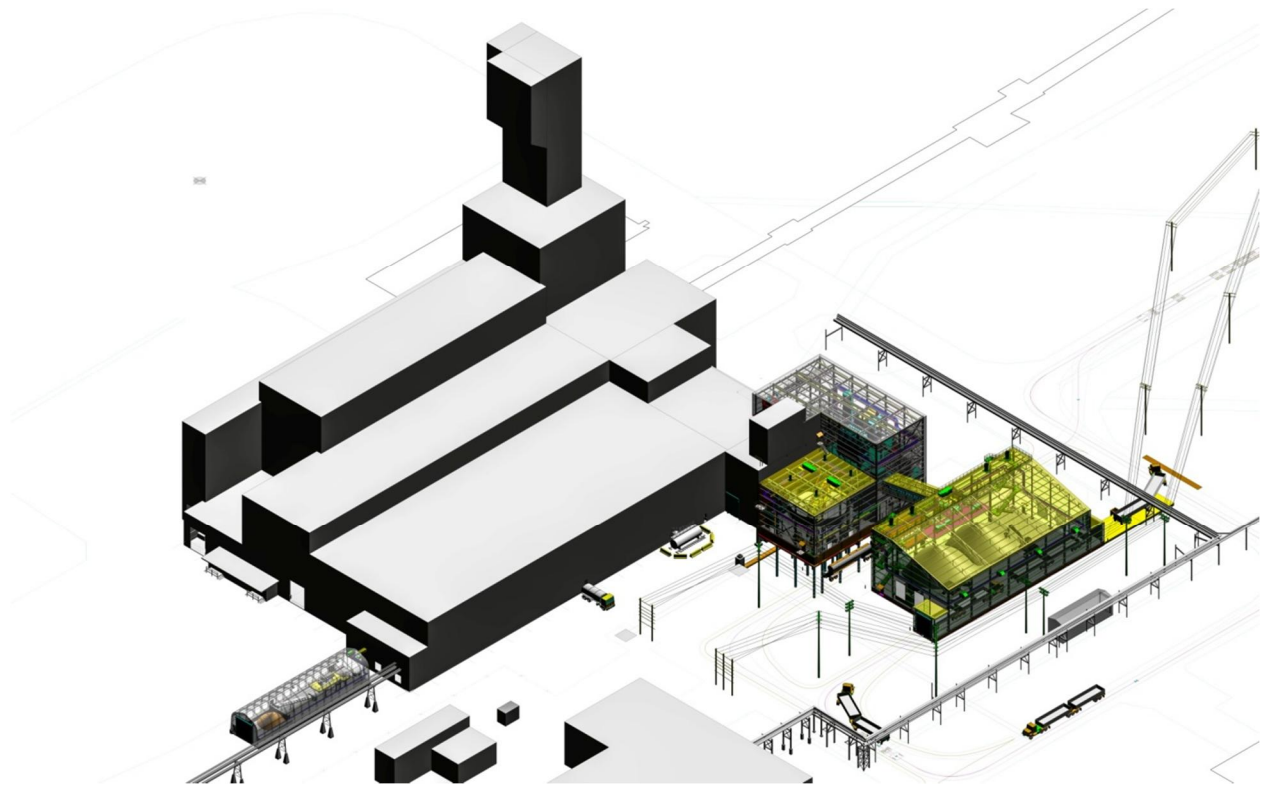
The Mines will not undergo any changes as a result of the Smelter and Refinery Closure. Details of the Mines and their processes can be referenced in the report entitled Comprehensive Report of Vale Canada Limited Manitoba Operations submitted on August 6th, 2015.

Appendix 6.1 - Comprehensive Report of Vale Canada Limited Manitoba Operations

1.4.5 Mill

As outlined and approved in the 2016 Notice of Alteration, the Concentrate Load Out facility will be constructed in order to facilitate the closure of the Smelter and Refinery. The new dewatering circuit will be primarily contained within the existing Mill building with the exception of the newly constructed thickener area. The new load out facility, connected by an enclosed conveyor galley way will serve to load on average 26 trucks per/day of nickel concentrate for shipment.

Diagram of New Dewatering & Concentrate Load Out Facilities



SECTION 2: ENVIRONMENTAL IMPACTS

2.1 Atmospheric

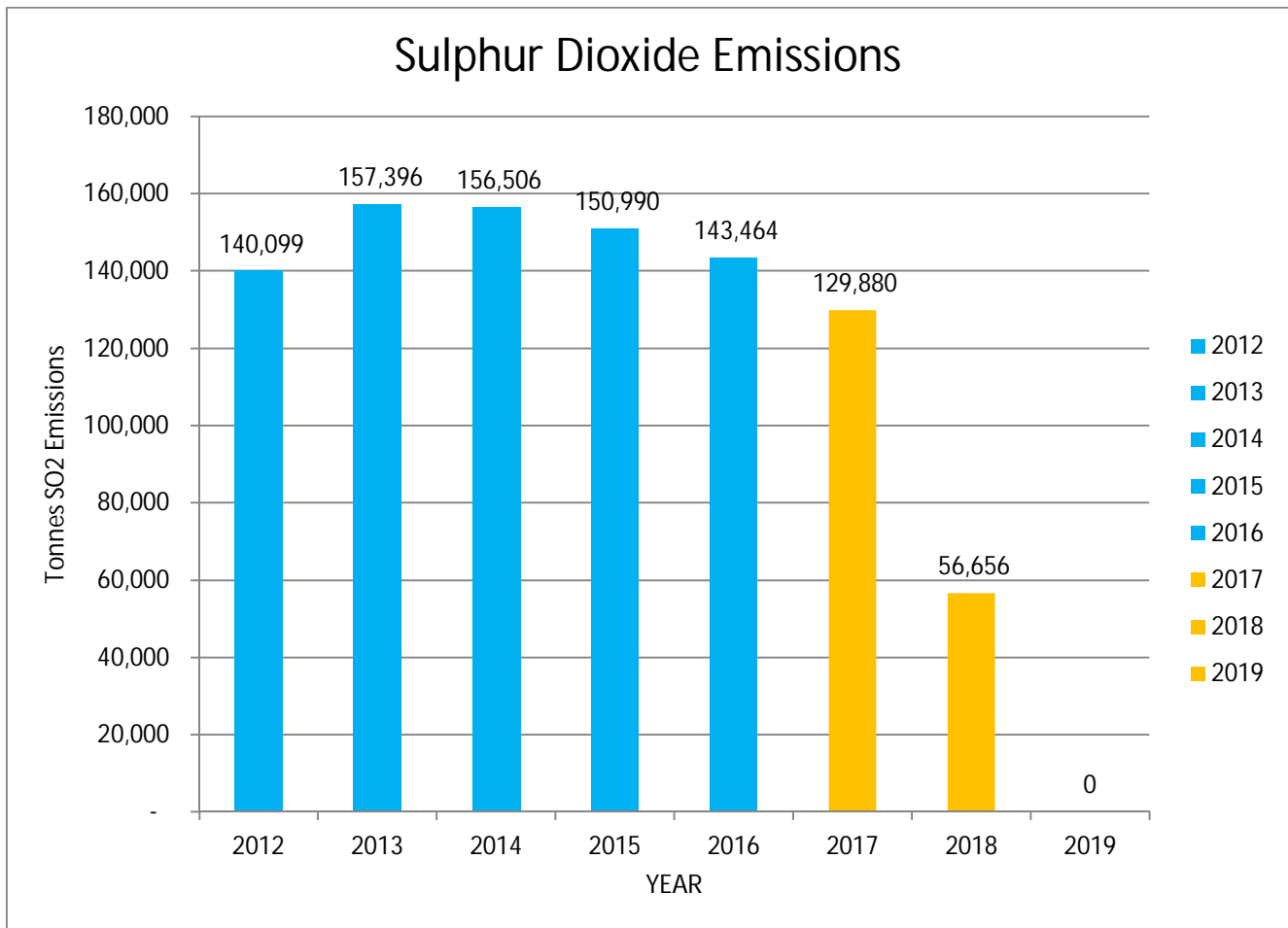
In compliance with Manitoba Regulation 165/88 Inco Limited and Hudson Bay Mining Co. Limited Smelter Complex Regulation (C.C.S.M. c. E125) and the 2004 Memorandum of Understanding between Manitoba Conservation and Inco Limited – Manitoba Operations, Vale Manitoba Operations has continued to test, monitor and report SO₂ and particulate emissions to the Province. It is Vale's current assumption that with the closure of the Thompson Smelter & Refinery, this regulation and Memorandum of Understanding would no longer apply to its operations within Manitoba. It is also assumed that the Community Air Quality Protection Program (CAPP), Voluntary Emissions Reduction Program (VERP), community particulate monitoring program (partisol particulate sampler), and 4 ambient SO₂ monitoring stations located within the community of Thompson would no longer be maintained by Vale.

Appendix 6.2 - Memorandum of Understanding between Manitoba Conservation and Inco Limited – Manitoba Operations

2.1.1 SO₂ Emissions

The Sulphur mass balance calculates total Sulphur emitted, as Sulphur in inputs minus Sulphur fixed in product and waste streams. All Sulphur that is not fixed in product or wastes is assumed emitted as SO₂. Thus, the calculated emission includes both process and fugitive SO₂. The Sulphur mass balance program utilizes material balances determined by truck and railcar shipping weights, and determination of Sulphur by the LECO analytical method, performed by the Vale Manitoba Operations laboratory which is ISO-IEC 17025 certified by the American Association for Laboratory Accreditation.

In conformance with the Federal SO₂ performance target, the following chart represents the estimated annual emissions of SO₂ based upon the commissioning schedule of the Concentrate Load Out Facility and annual production plan estimates. As is evident in the chart, the closure of the Smelter & Refinery will result in a significant reduction in SO₂ emissions.



2.1.2 Particulate Emissions

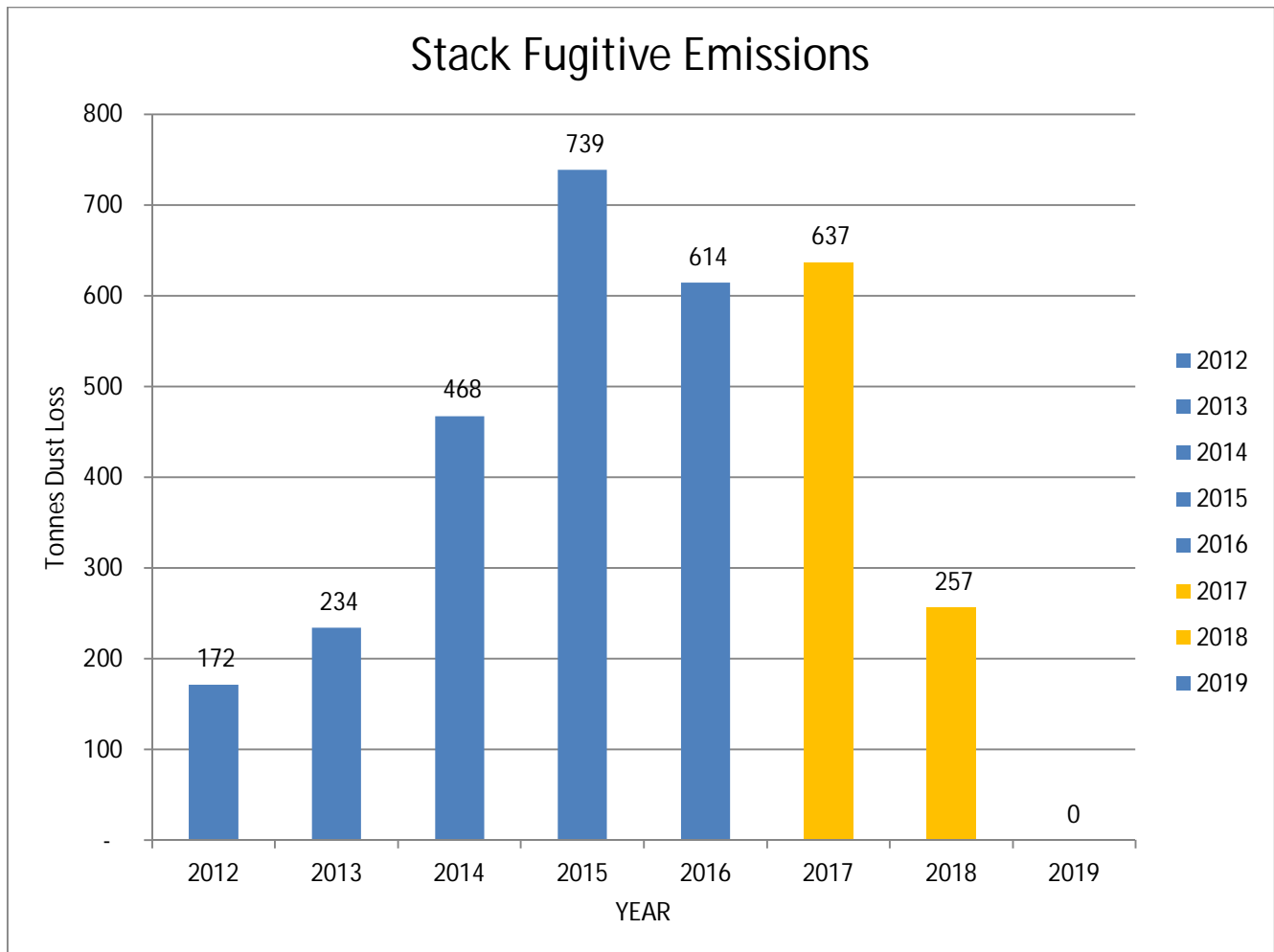
Also pursuant to Manitoba Regulation 165/88, and in accordance with proposed Performance Agreements between Vale Canada Limited and the Government of Canada, emissions of PM from the smelter stack are monitored continuously. Emissions of substances in Particulate Matter (PM) from the Smelter Stack are tested at least every 3 years in accordance with Stack Sampling Protocols.

To ensure compliance with reporting requirements under the Canadian Environmental Protection Act, 1999, and to assess performance of Vale's Environmental Programs (Pollution Prevention Plan, Implementation of the BMS Environmental Code of Practice, CCME Canada-Wide Standards) substances in PM routinely tested for include Criteria Air Contaminants, Metals, Mercury, Dioxins and Furans, and the determination of PM size distribution (PM_{2.5} & PM₁₀).

Emissions from the Thompson Nickel Refinery are source tested, at minimum, every 5 years. Site specific emission factors have been developed for the 13 Nickel Refinery point sources to determine annual emissions of Chlorine, SO₂, PM and Metals in PM.

Site specific emission factors are also applied to the determination of annual emissions of PM_{2.5} & PM₁₀ size distribution from the Thompson Mill and the Thompson T1, T3 and Birchtree Mine Ventilation systems. Fugitive emissions originating from unpaved road dust are estimated in accordance with sector specific guidance from Environment Canada for reporting to the National Pollutant Release Inventory (a requirement under CEPA, 1999).

PM emissions from the Thompson Mill are currently estimated by applying data from a 1999 bag house efficiency test. Recognizing that the Mill will be the primary stationary source of emissions following the closure of the Smelter & Refinery, the Manitoba Operations is in the process updating its bag house inventory and establishing locations/ports for source testing which will then be used in calculating the overall emissions for the facility. As is evident in the chart below, the closure of the Smelter & Refinery will result in a significant reduction in stack fugitive emissions.



2.1.3 Diesel Particulate & Vehicle Emissions

Diesel Consumption

The closure of the Smelter & Refinery will result in an estimated 38% annual reduction in the overall site diesel consumption as illustrated in the table below.

S&R - Diesel Consumption (2012 - 2016)						
						5Yr Avg (2012-16)
	2012	2013	2014	2015	2016	
<u>SMELTER</u>						
Litres	3,592,072	1,719,894	1,216,785	1,775,356	1,788,581	2,018,538
<u>REFINERY</u>						
Litres	5,091	6,600	6,429	12,046	12,975	8,628
<u>Manitoba Operations</u>						
Litres	6,872,559	3,553,359	3,650,340	6,369,903	6,428,024	5,374,837

Petroleum Coke

Necessary for the smelting process, the use of petroleum coke will be eliminated upon closure.

S&R - Petroleum Coke Consumption (2012 - 2016)						
						5Yr Avg (2012-16)
	2012	2013	2014	2015	2016	
<u>SMELTER</u>						
Tons	6,763	7,122	5,859	9,276	6,545	7,113
<u>Manitoba Operations</u>						
Tons	6,763	7,122	5,859	9,275	6,545	7,113

Vehicle Emissions

Once transitioned to a Mine/Mill Operation, the overall emissions generated from the transport of nickel concentrate from site will be offset by the elimination of reagent and supply shipments as well as the receipt of Voisey's Bay Nickel Concentrate. The net effect to haulage on provincial roadways is expected to be negligible.

2.2 Water Quality & Consumption

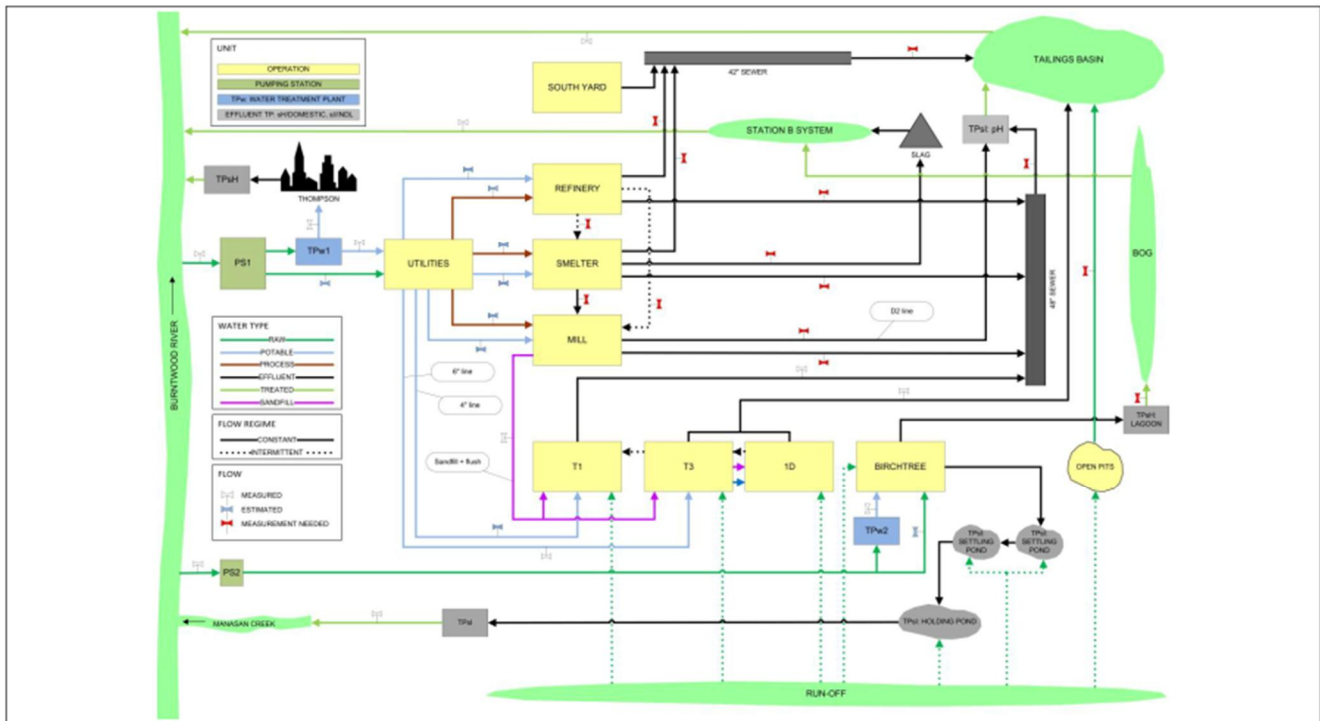
In 2011, Crono Engenharia Ltda. supported by CH2M Hill conducted a water balance study on behalf of the Manitoba Operations. The objectives of this study were to: develop a diagram of Vale's Manitoba Operations Industrial water flow, calculate the Global Reporting Initiative – (GRI)

environmental performance indicators (EN8, EN10 and EN21), identify water reuse and recycling opportunities and finally to estimate the impact that the closure of the Smelter & Refinery would have on the site water balance.

A simulation of the Manitoba Operations post Smelter & Refinery Closure indicated that we can expect to realize an estimated 47% reduction in total water consumption. It also estimated a reduction in potable water consumption of 13% in relation to the total potable water including the City of Thompson drinking water and the potable water distributed by the Utilities to the Operation. If considered on its own, the potable water reduction by the Manitoba Operations was estimated to be 35%.

Further details can be found in Appendix 6.3 – Manitoba Operations Water Flow - Technical Report

Manitoba Operations Water Flow



2.2.1 Control & Monitoring

The Manitoba Operations monitors and reports results from 3 licenced discharge points which include Station B, Area 5 Weir and Birchtree Effluent. Following closure, these discharge points will continue to be managed and reported however it is expected that the impact on the Area 5 Weir and Station B will be significantly reduced with the Smelter and Refinery processes no longer contributing.

Station B Effluent System Map



Tailings Management Area – Monitoring Locations



2.2.2 Effluent

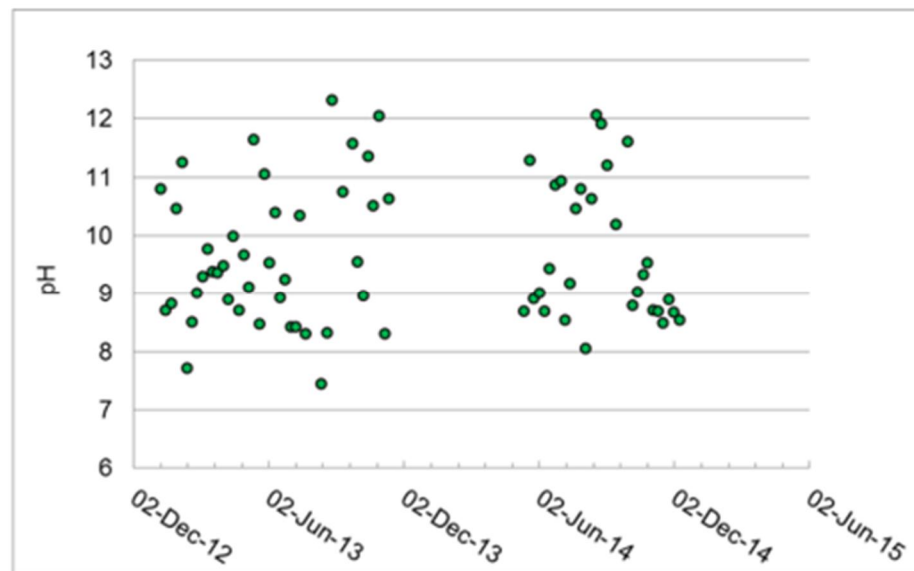
In 2015 as a result of the ongoing project to expand the Tailings Management Area and to develop a detailed lime demand model for the treatment of the TMA, EcoMetrix was hired to study and develop a strategy for water quality management in the TMA during operations and for closure planning. The following two paragraphs taken from this report help to illustrate the positive impact that the closure of the Smelter & Refinery will have on the effluent stream and more specifically, the reduction of nickel and acidity loading that the Refinery currently contributes to the 48" Process Sewer.

"The 48" sewer represents the largest process flow rates into the basin and is known to be a source of nickel and acidity to Areas 1 to 3. Previous modelling investigations completed in the mid 2000s relied on measured flows and monitored concentrations from the sewer to

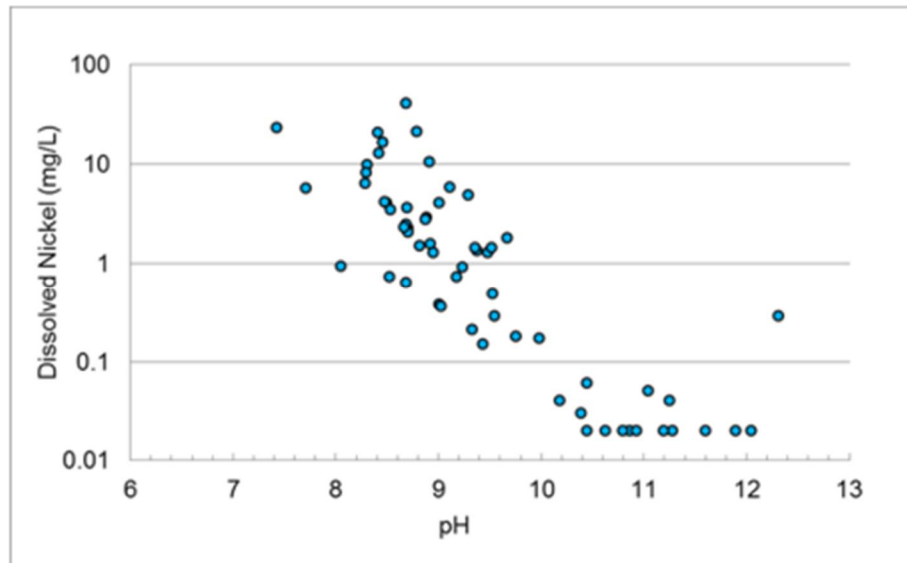
estimate nickel loadings. While concentrations of nickel and many other constituents are measured weekly in the sewer outfall, there are no measurements of acidity. Also, there are no recent measurements of flow from the sewer and the absence of these data represent a major source of uncertainty in the total acidity loadings from the sewer and therefore, a major source of uncertainty in the lime demand required to treat the acidity from the sewer."

"It is our understanding that the majority of potential acid and nickel loadings from the sewer are associated with the refinery that will be closed in the future. Following the closure of the refinery, the loadings associated with the sewer are expected to decline although other discharges may remain due to on-site drainage. The lime demand is therefore expected to decline by 10 tonnes per week after the refinery is closed and there are no longer any important sources of acidity and nickel in the sewer discharge. This decrease would be expected to start as soon as the loadings to the sewer were mitigated."

Measured pH Values in the Outlet from the 48" Sewer



Concentrations of Dissolved Nickel with pH in the Outlet of the 48" Sewer



Appendix 6.4 – Lime Demand Estimates for the Management of Water Quality in the Thompson Tailings Basin during Operations and for Closure Planning

Sanitary Sewer

The Sanitary Sewer reporting to Area 1 of the Tailings Management Area is expected to realize a significant reduction in biological waste as a result of the overall change in workforce. This reduction will be representative of the 35% adjustment from the current workforce once the final employee transition has been completed.

2.3 Waste Management

Waste management at Vale's Manitoba Operations has progressively evolved over the past 5 years with the construction and commissioning of a new waste management facility in 2012 and the implementation of a comprehensive waste collection and disposal program known as "Slam Dunk". Through this program, all employees and contractors are educated on proper waste segregation and collection, segregation performance is tracked at all locations and all waste is measured prior to final disposal or reuse/recycle.

In 2016 the Manitoba Operations generated 8.4 Million lbs. of waste of which approximately 42% originated from the Smelter & Refinery. Upon closure, the Smelter and Refinery will no longer contribute to the annual waste generation on site with the exception of waste generated in the final ramp down and decommissioning. Therefore, the closure of the Smelter & Refinery will result in a significant reduction in the amount of waste generated from the Manitoba Operations. The detail of the closure waste management strategy is outlined in section 2.3.2.

Appendix 6.5 – Slam Dunk Program

Appendix 6.6 – Slam Dunk Proper Handling of Common Hazardous Waste

Waste Management Facility

The Manitoba Operation's Waste Management Facility (WMF) is located on a parcel of land, approximately 895 by 1,535 feet in size that is owned by Vale. Within this area, the landfill cell #1 footprint covers an area of 265 by 630 feet at the south end of the WMF. The main building and storage shed are located on the southwest side of the WMF. The burn area and leachate holding pond are located on the north end of the site.

The nearest residence is roughly 1.5 miles away; thus the site is sufficiently separated so that no objectionable odours or noise are apparent to the neighbours.

The annual precipitation is 20 inches with the annual rainfall being 13 inches. It is expected that there will not be excess surface water as the total annual evaporation rate is 22 inches.

**Components of the WMF**

The primary components of the WMF include:

- gated access road to provide controlled access into the WMF;
- waste disposal areas in defined landfill cells;
- main waste handling building;
- cold storage shed;

- outdoor storage pad;
- storage area for clean wood (burn area);
- leachate holding pond;
- expansion areas set up for future cell construction; and
- storage areas for cover soil;
- Groundwater table monitor wells for monitoring of the elevation and quality of groundwater within the WMF boundary.

Prohibited Waste

The following wastes are prohibited from final disposal in the landfill cell at the WMF:

- hazardous wastes;
- radioactive materials;
- burning wastes (materials that are still at elevated temperatures);
- contaminated soil;
- liquids (as defined in Section 1 of the Waste Disposal Grounds Regulation 150/91);
- dead animals; and
- Explosives or ammunition.

Temporary Storage of Waste

The WMF is also used to temporarily store waste generated from Vale Manitoba Operations, including the following:

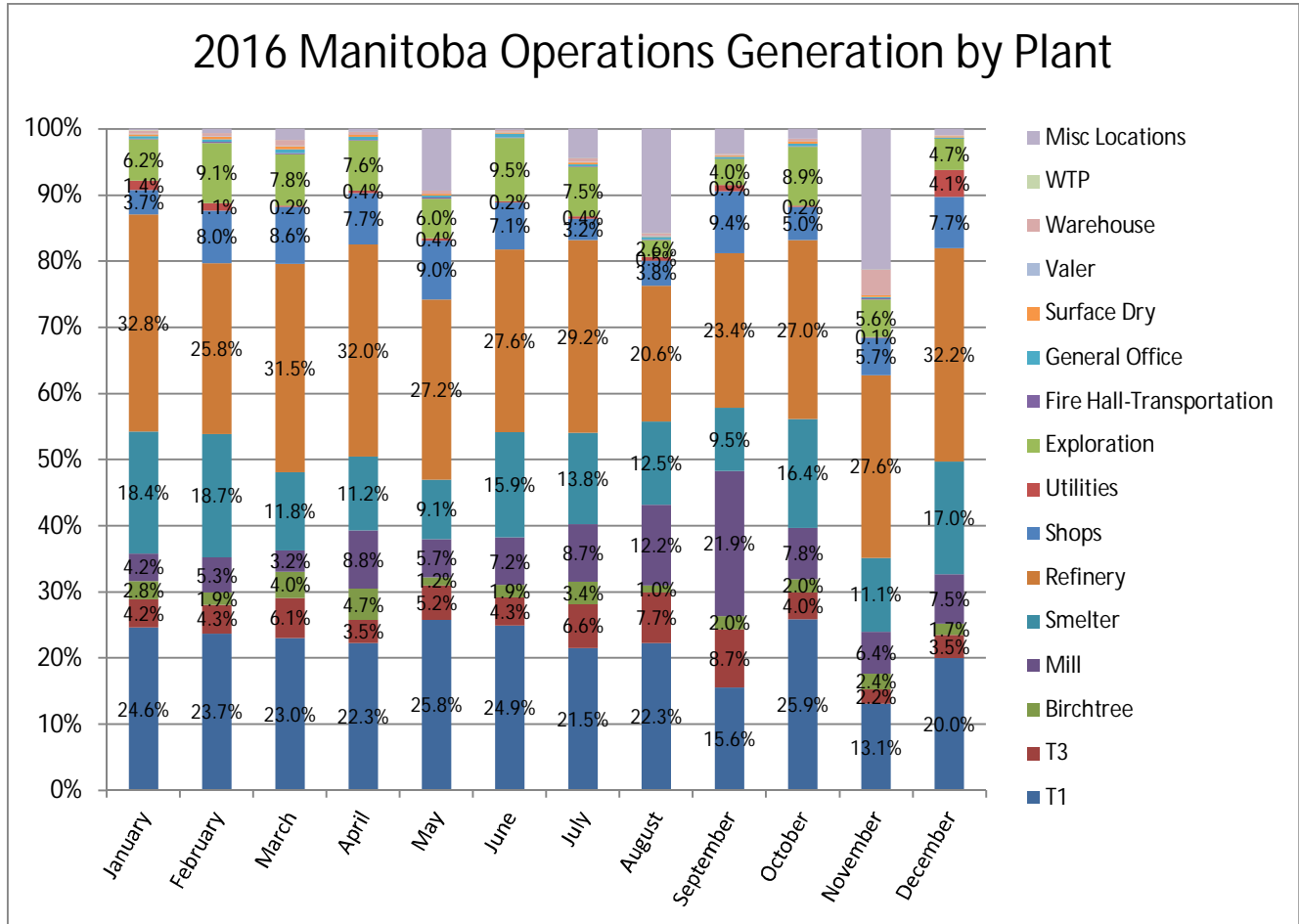
- non-industrial recyclables (non-industrial plastics, recyclables, cardboard and office paper) – baled and, stored in the storage shed, and transported off site for recycling;
- industrial plastics – stored in the storage shed, and transported off site for disposal;
- wood – stored within the WMF and burned for disposal with a portion of the wood recovered for re-use;
- Contaminated – the waste oil will be pumped into the AST adjacent to the main building. Other contaminated material will be stored within the WMF. The contaminated waste will be transported off site for disposal; and
- hazardous - stored within the WMF, and transported off site for disposal

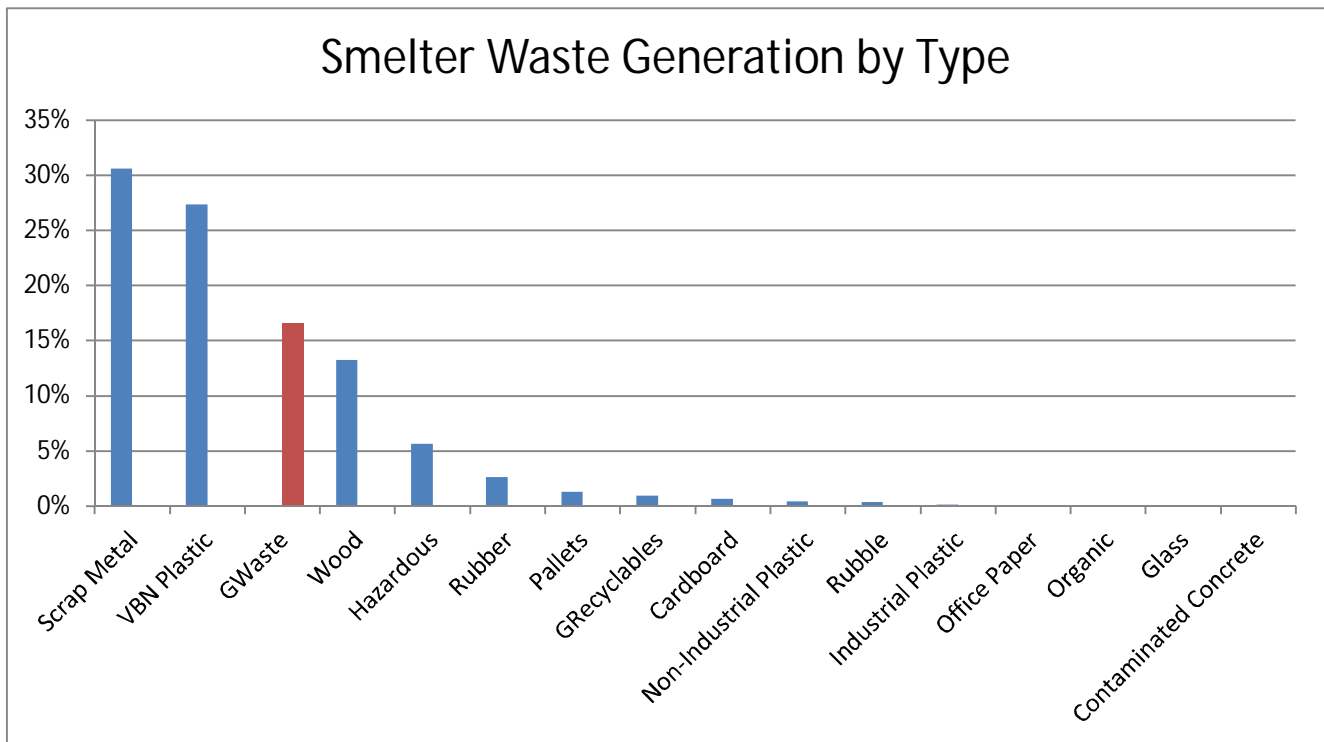
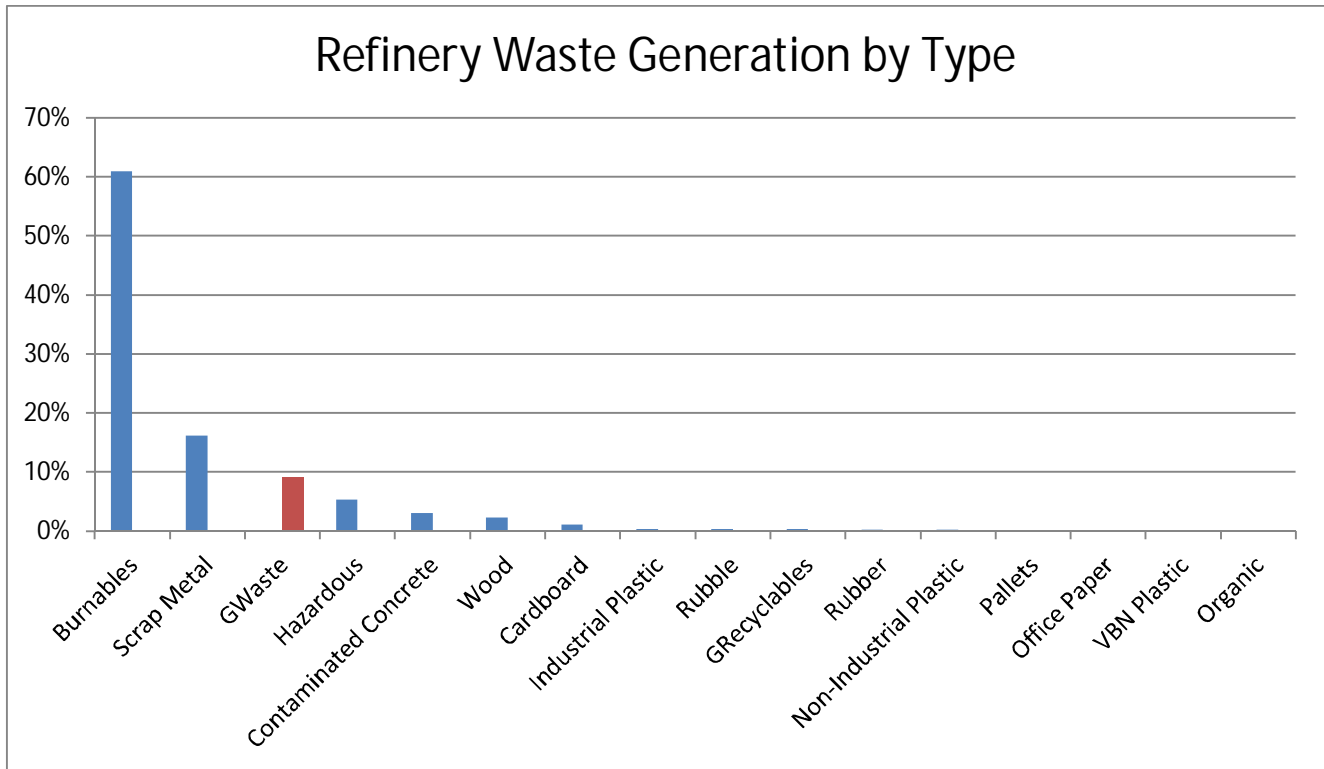
Appendix 6.7 – Vale Waste Management Facility Operations Manual

2.3.2 Waste Generation

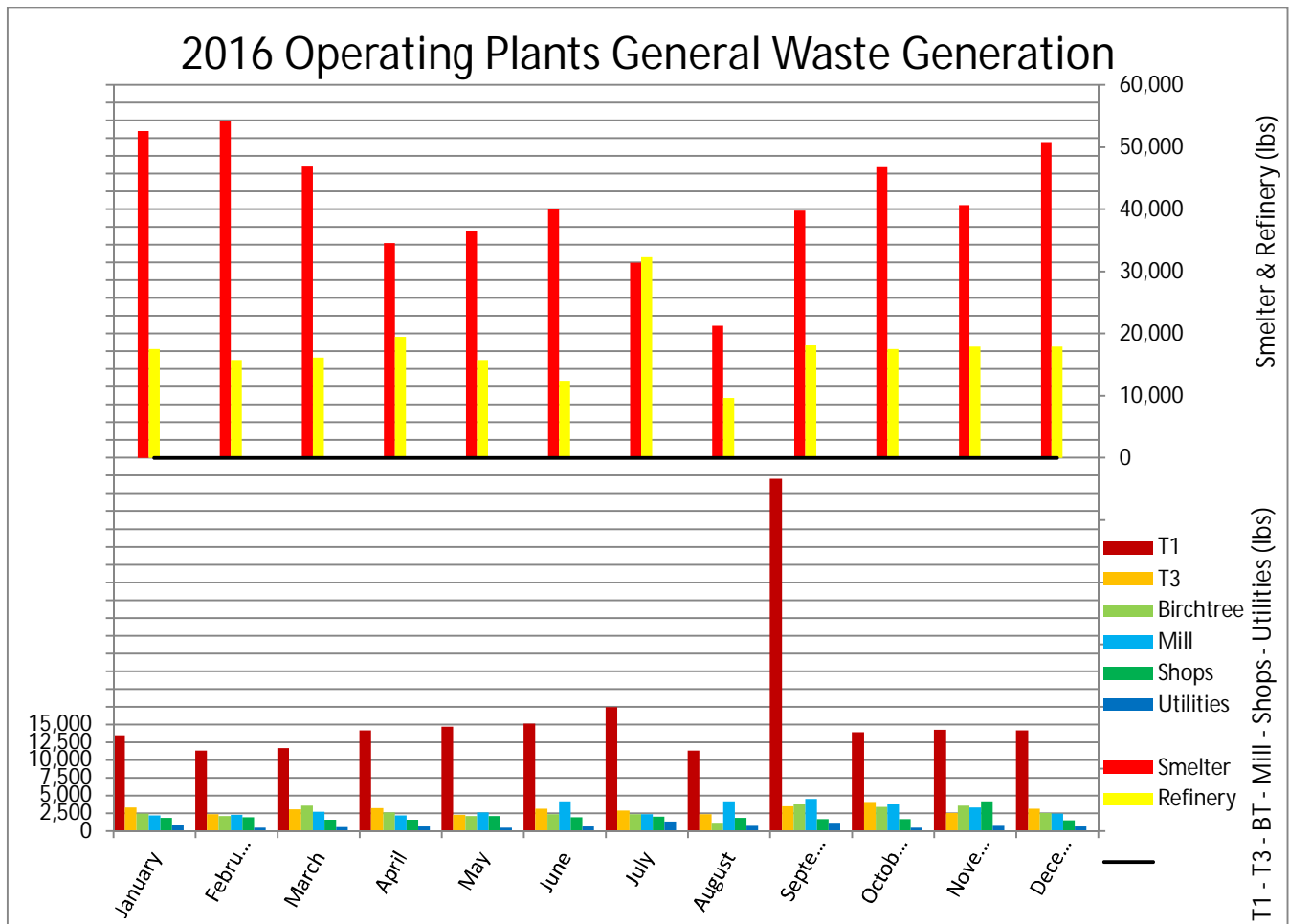
Operating as a fully integrated nickel operation, the combined waste generated from the Smelter & Refinery operations in 2016 accounted (on average) for 42% of the total monthly waste generated on site. The significance of the input from the Smelter and Refinery operations into the overall waste management requirements of the Manitoba Operations for 2016 can be seen in the chart below. This is also representative of 2015 where the average monthly waste generation by the

Smelter & Refinery was 43% of the total.





The chart below has been provided to illustrate the impact that the Smelter & Refinery have on the active landfill cell today in comparison to the rest of the operation. In 2016, the Manitoba Operations generated 1.15 million lbs. of general waste that was placed into landfill. Of this total, the Smelter & Refinery accounted for 61%. Upon closure these operating waste streams will be eliminated and the impacts on the environment will consequently be significantly reduced.



Appendix 6.8 – Data Collection - Analysis

2.3.3 Demolition/Decommissioning Waste Management Strategy

Developed in 2012 by Conestoga Rovers & Associates and Vale the Waste Management Plan (WMP) describes policies, procedures and protocols for the handling of waste materials generated by Vale and contractors during the decommissioning and demolition of the Smelter and Refinery. Types of wastes that may be generated from the decommissioning and demolition activities include the following:

- Hazardous and regulated waste as defined by the Dangerous Goods Handling and

Transportation Act (Act) (C.C.S.M. c. D12) and the Transportation of Dangerous Good Act, 1992 as amended

- Naturally Occurring Radioactive Materials (NORM) as defined in the Canadian Guidelines for the Management of NORM, October 2000
- Asbestos waste (includes insulation, transite, and floor tile)
- Bulk solid wastes (includes potential product/residue in pipelines/tanks, hydrocarbon product, refractory brick, bricks from inside tanks/thickeners, and hazardous dust, and concrete/cinder blocks)
- Recyclable materials (includes cinder blocks/concrete, lighting ballasts (non polychlorinated biphenyl [PCB]), ozone depleting substances [ODS], mercury containing devices, liquid mercury, batteries, glycol, and ferrous and non-ferrous metals)
- Demolition debris/non-hazardous materials (includes untreated wood, non-asbestos containing material [ACM] insulation, roofing materials, plastic, creosote wood [rail ties and cribbing], used filter cloth [washed], and non PCB light ballasts)
- Rinse water – generated from cleaning the surfaces and equipment in the Smelter and Refinery during decommissioning
- Petroleum and polycyclic aromatic hydrocarbon (PAH) impacted soil – identified during a soil investigation within the Smelter and Refinery area

The procedures and protocols outlined in the WMP include administrative roles and responsibilities, management, characterization, testing/sampling, containerization, storage, transportation, and/or disposal of wastes generated during project activities. The site specific WMP may be revised/expanded, as appropriate, while the project work progresses to include information, methodologies, and procedures associated with any changes in work scope, site conditions and/or regulations.

The WMP has been written in accordance with the Federal Transportation of Dangerous Goods Act (TDG Act) and the Manitoba Dangerous Goods Handling and Transportation Act (Manitoba Act); however, while developing this plan Manitoba Conservation (renamed Manitoba Sustainable Development) was in the process of developing new regulations for the management of hazardous materials. Manitoba Conservation did not have an expected date of promulgation.

Appendix 6.9 – Waste Management Plan Smelter & Refinery Decommissioning/Demolition

2.4 Hazardous Chemicals

The operation of the Refinery currently accounts for the majority of all chemical use within the Manitoba Operations. At closure, many of these chemicals and reagents will no longer be required on site. It is important to note that the quantities of bulk chemicals and reagents used are easily calculated however, there will be further reductions in chemical use as controlled products consumed daily in the form of cleaning and maintenance supplies will no longer be required by the

Smelter and Refinery.

2.4.1 Bulk Chemical Inventory

The following tables represent the overall reduction in bulk hazardous chemicals that will occur with the cessation of the Smelter and Refinery operations. Although some chemicals such as flocculant, soda ash, lime and copper sulphate will continue to be used in the milling process, an overall elimination in excess of 68 million lbs. of hazardous chemicals annually will be realized from the closure of the Smelter and Refinery.

Annual consumption of propane will decrease only by 1% as a result of the closure. The primary use of propane on site is the heating of the Mine fresh air raises.

S&R - Reagents Consumptions (2012 - 2016)							
							5Yr Avg
	UoM	2012	2013	2014	2015	2016	(2012-16)
SMELTER							
Flocculant	Lbs	27,778	27,778	25,794	23,810	25,794	26,191
Alunite Mould Wash	Lbs	196,520	181,440	199,160	196,480	206,640	196,048
REFINERY							
Chlorine	Lbs	6,706,454	8,060,091	6,926,916	8,817,479	8,249,688	7,752,126
Soda Ash	Lbs	30,631,371	32,881,058	28,984,876	35,492,989	30,030,867	31,604,232
Sulphuric Acid	Lbs	14,122,796	16,012,155	13,320,314	18,481,881	17,035,099	15,794,449
Boric Acid (50lb Bag)	Lbs	16,204	37,809	16,185	17,471	10,880	19,710
Borax (2205lb Sack)	Lbs	670,204	921,531	921,531	921,531	921,531	871,266
	Lbs	686,408	959,340	937,716	939,002	932,411	890,976
Hydrogen Sulphide	Lbs	1,828,688	1,981,851	2,204,691	2,349,569	2,055,454	2,084,051
Hydrochloric Acid (240 kg drum)	Lbs	171,428	103,704	160,846	222,222	180,952	167,831
Hydrochloric Acid (216 kg drum)	Lbs	22,771	22,771	36,054	32,382	24,762	27,748
	Lbs	194,200	126,475	196,901	254,604	205,715	195,579
Nitric Acid (272 kg drum)	Lbs	97,145	70,760	86,351	79,155	124,729	91,628
Lime	Lbs	5,315,714	5,563,314	5,183,062	4,913,624	7,330,767	5,661,296
Sulphur Dioxide	Lbs	3,329,550	3,874,185	3,199,455	3,898,440	3,574,305	3,575,187
Copper Sulfate	Lbs	68,200	33,000	39,600	26,400	39,600	41,360
ECH	Lbs	109,728	52,000	122,702	79,218	141,675	101,065
Sodium Sulphide	Lbs	71,200	144,000	164,900	112,000	96,000	117,620
Sodium Sulphite	Lbs	63,700	83,150	96,855	63,800	69,900	75,481
Sodium Chloride (20kg Bag)	Lbs	113,576	88,185	135,577	118,514	125,921	116,354
Average Annual lbs Reducution of Bulk Reagents							68,323,641

S&R - Propane Consumption (2012 - 2016)						
						5Yr Avg
SMELTER	2012	2013	2014	2015	2016	(2012-16)
Bulk (Litres)	85,578	78,346	70,961	68,088	52,740	71,142
Cylinders (Kgs)	1,215	702	1,001	793	603	863
REFINERY						
Bulk (Litres)	42,373	39,306	39,544	38,945	41,276	40,289
Cylinders (Kgs)	15,713	17,456	16,605	19,694	17,345	17,363
Manitoba Operations						
Bulk (Litres)	11,457,593	15,724,808	14,270,013	13,686,550	7,878,823	12,603,557

2.5 Hydro Electric Power

As one of the largest single consumers of Hydro Electric Power within the Province the closure of the Smelter & Refinery will result in a 50% reduction in the overall annual consumption by Vale Manitoba Operations. This estimate is solely based upon plant usage and does not include any further reductions realized as steam, water and other ancillary service demands adjust to meet the needs of the new process.

Smelter & Refinery Hydro Consumption (2012 – 2016)

S&R - Hydro Consumption (2012 - 2016)						
						5Yr Avg
SMELTER	2012	2013	2014	2015	2016	(2012-16)
Furnaces - MWH's	221,101	230,928	210,679	221,603	228,643	222,591
Building - MWH's	36,020	36,115	35,794	35,834	36,356	36,024
Total MWH's	257,121	267,043	246,472	257,437	264,999	258,614
REFINERY						
Total MWH's	218,255	236,057	224,490	224,366	221,376	224,909
Manitoba Operations						
Total MWH's	941,907	981,979	965,509	986,955	987,210	972,712

2.6 Steam Generation

Upon closure, steam to the Smelter & Refinery will be maintained in localized areas in order to complete the final processing of materials. Following this activity, the steam systems will be

isolated at the utilities building resulting in an estimated 64% reduction in annual consumption.

Smelter & Refinery Steam Consumption (2012 – 2016)

S&R - Steam Consumption (2012 - 2016)						
						5Yr Avg (2012-16)
	2012	2013	2014	2015	2016	
SMELTER (1,000 Lbs)	53,370	54,806	55,568	38,831	38,781	48,271
REFINERY (1,000 Lbs)	212,260	251,499	277,780	232,380	243,995	243,583
Manitoba Operations	418,793	496,058	531,080	433,071	413,480	458,496

2.7 Human Health Effects

Vale Manitoba Operations maintains a comprehensive Occupational Exposure Monitoring Program designed to identify occupational exposures in the workplace, assess, and develop controls to reduce the risks to employees. A review of the program is completed annually by the Health Safety & Environment department, Management and Worker Safety representatives at each department. In addition, health screening is completed annually for all employees to identify potential occupational health effects.

The closure of the Smelter and Refinery will not alter the current program that is in place. Vale has and will continue to improve the program, monitor, and where possible eliminate exposure risks.

2.8 Noise Emissions

Vale Manitoba Operations has conducted noise testing within the community with the most recent study completed in 2014. The closure of the Smelter and Refinery will not alter or affect noise levels on site or within the outlying community.

2.9 Smelter & Refinery Process Legacies

2.9.1 Soil & Groundwater Contamination

Operating as a fully integrated nickel business, the overall site contamination reflects a mature operation that has existed since the 1960's. Soil and groundwater contamination is largely concentrated surrounding the Smelter and Refinery complexes and was the focus of a 2012 study conducted by AMEC Foster Wheeler following the closure announcement.

Vale recognizes the need to further develop the strategy for soil and groundwater remediation at the Manitoba Operations. As such, Vale is proposing to conduct a site-specific Risk Assessment in

order to establish the levels of Nickel above which the soil will be remediated. In order to treat the existing impacted water plume under the Refinery, the proposed approach will be to pump the groundwater to the Mill as supplemental process water and eventual discharge to the Tailings Management Area.

It is Vale's intent to begin formal discussions with the Province regarding this remediation strategy with the goal of establishing its criteria in the near future. In addition, Vale understands that all required remedial closure obligations would not be expected to be initiated prior to the complete closure of the Manitoba Operations.

Picture of the South Yard – Area of Contamination



Appendix 6.10 – Soil and Groundwater Remediation Study

2.9.2 Slag Pile

The Slag pile is located immediately west of the Smelter Complex and in 2008 was estimated to be approximately 1,100,000 square metres or 11,840,000 square feet in area. The conceptual plan to

re-grade, cap and install a vegetative cover is included in the overall plan for decommissioning. In order to develop the detailed design to cap the Slag Pile, a topographic survey, geotechnical investigation, and chemical stability evaluation of the Slag Pile will be conducted. A detailed Cap design, Final Grading Plan and Erosion and Sediment Control Plan will be developed in support of the final Slag Pile restoration. The aerial Lidar survey of the Slag Pile and review of clay borrow sources are scheduled to be completed in 2017.



2.9.3 Copper Arsenic Ponds

As a by-product of normal operations, the Refinery produces an impure sulphide precipitate termed copper residue. This residue contains approximately 40% copper, 8% nickel, 2-4% arsenic, 30% sulphur and residual amounts of PGMs.

While copper residue produced from our operations is currently sold to the market, an estimated 50,000 tons of copper residue has been stockpiled in ponds over our history of operation. They contain approximately 35Mlbs of copper, 8.5Mlbs of nickel, and associated PGMs.

The levels of these ponds are monitored and excess liquid is hauled to the Mill where it is treated

with lime and pumped into the Mill's floatation circuit. Volume and haulage frequency is based upon seasonal precipitation.

Vale continues to source new markets for this material however; at this time has no plans to re-process copper arsenic material on site.



2.9.4 Manasan Quarry

Mining activity first started at the Manasan quarry site in the early 1960's. The quarry has been intermittently used by both Manitoba Hydro and by Vale as a source of quarried rock, primarily quartz. The quarried material is used by Vale as a flux material in the Thompson smelter.

The Manasan Quarry is located approximately 6 km (3.8 mi) south of the Thompson Mine on Provincial Hwy 391. Currently the Manasan Quarry has a maximum depth of 38 m (125 ft.). It is an elongated "L shaped" pit which trends from north to south and from northeast to southwest to follow the quartz rock vein.

Closure requirements for the Quarry are detailed in the Manitoba Operations Closure Plan however; it is recognized that this quarry may hold significant value to 3rd Parties within the region and a transfer of ownership may be beneficial.



SECTION 3: FACILITIES RAMPDOWN

3.1 Strategy

Developed in 2012 by Conestoga - Rovers & Associates and Vale, the Plant Shutdown Procedure contains the necessary detail and procedures required to safely and effectively ramp down the Smelter & Refinery processes. The overall goals and objectives are to cease operations in an orderly and efficient manner, realize the maximum economic value for all products & process intermediates, minimize shutdown efforts/costs, and prepare the Smelter & Refinery complexes for eventual decommissioning.

Contained within the Plant Shutdown Procedure are detailed descriptions of each sub process along with the sequence and method of shutdown. Additional study is currently underway to enhance this ramp down with an electrowinning test completed in February 2017. The results of this test may serve to improve the current ramp down of the Refinery by allowing Vale to process nickel effluent solutions following the initial shutdown generating saleable nickel cathode.

Over the 4 years following plan development, the Manitoba Operations has worked diligently to reduce its liability at closure. Through the establishment of a Centre for Material Disposal (CMD) and based upon the principles and policies of our Waste Management Program, much of the materials and hazardous chemicals outlined in the Plant Shutdown Procedure document have been removed. In addition, 10,000 tons of nickel bearing soil has been gathered and processed through the Smelter in two separate campaigns.

A Smelter Reclamation Crew was formed in February 2017 to prepare the building for final closure. Their objectives leading into 2018 are to clean the facility; directing contained metals back into the process during the remaining operational life, gather and relocate equipment and materials, and execute various elements of the ramp down plan.

Throughout 2017, the Plant Shutdown Procedure will be reviewed and updated as required.

Appendix 6.11 - Plant Shutdown Procedure Smelter & Refinery Decommissioning/Demolition

3.2 Isolation

Conestoga – Rovers & Associates was retained by Vale to provide detailed design associated with the above and below grade utilities required for the Smelter and Refinery Closure and decommissioning. The report entitled 100% Design Brief Utilities Decommissioning details the utility requirements and includes the following information:

- Brief background description of the existing utility systems as they relate to the smelter and refinery facilities
- Description of the below grade, above grade, and electrical utilities packages that will form part of the smelter and refinery decommissioning

-
- Required approvals and studies
 - Constructability review
 - Listing of design drawings and specifications

The utility systems servicing the smelter and refinery are primarily sourced through the site's Utility (compressor) building. The systems include the following:

- Compressed Air/Air Drier (Instrument Air)
- Vacuum
- Potable Water
- Process (Raw) Water
- Sanitary, Storm, and Process Sewers
- Steam and Condensate
- Electrical System (High Voltage)
- Converter and Roaster Air (Smelter)

Since the development of these utility isolation plans, the Manitoba Operations has advanced the work to reroute power to the South Buildings. The need to replace the existing power line feeding the Orica Facility presented an early opportunity to isolate the infrastructure identified as required which resides adjacent or attached to the Smelter & Refinery. Final rerouting is expected to be completed by the end of 2017 providing a new power source to the South Yard outbuildings and isolating areas of the Smelter such as the Thickener, VBN off-loading and Thawshed.

Based upon this new configuration and to update the Care & Maintenance strategy, the detailed plan for utilities isolation is in the process of being revised and will be completed by April 2017.

Appendix 6.12 - 100% Design Brief Utilities Decommissioning

SECTION 4: CARE & MAINTENANCE

4.1 Strategy

Following the final ramp down of the Smelter & Refinery the equipment will be powered down and locked out as per Vale's switch lock tag & check policy. Where feasible, transformers, switch rooms or MCC's will be powered down and isolated. Power will remain available for lighting for the purposes of the demolition bidding process, potential equipment removals and final hazardous materials sweep.

Once the activities described in the Plant Shutdown Procedure have been completed, access to the buildings will be restricted. All doors and access points will be locked to prevent unauthorized entry. The tag in/tag out procedure for the Smelter & Refinery will be modified to require tag in at the Utilities Building for authorized personnel to enter.

The Smelter Stack will be inspected, stack bottom cleaned, and covered with an engineered cap. The stack will then be inspected by a third party stack maintenance company every two years until such time as the final demolition occurs.

In accordance with Vale's obligation, the timeline for final decommissioning of the Smelter and Refinery facilities will be updated in the 2018 closure plan update and submitted to the Province. At this time a date for final decommissioning has not been established however, Vale is continuing to explore opportunities to advance this work. In order to progress all necessary activities outlined in the Smelter and Refinery closure plan it is understood that additional consultation will be required with both Manitoba Sustainable Development Environmental Approvals Branch and Manitoba Mineral Resources Branch.

The following appendices have also been provided to illustrate the maturity of the existing Smelter and Refinery closure plan.

Appendix 6.13 - Environmental Protection Plan - Smelter & Refinery Decommissioning/Demolition

Appendix 6.14 - Landscaping/Restoration Plan - Smelter & Refinery Decommissioning/Demolition

Appendix 6.15 - Transportation and Logistics Plan - Smelter & Refinery Decommissioning/Demolition

Appendix 6.16 - Storage Plan - Smelter & Refinery Decommissioning/Demolition

4.2 Inspection of Facilities

Security

The Smelter & Refinery reside within the boundaries of its main operating site. All access points to the property are gated and Vale employs a private security contractor on site 24hours/day 7days/week. Building perimeter checks will be incorporated into their regular routines in order to detect any unauthorized entry.

Facility Inspections

An annual inspection program for the Smelter & Refinery will be developed by Vale Manitoba Operation's Central Engineering Department prior to final closure. This inspection program will detail the assessment criteria and inspection requirements for the following:

- Structural Integrity
- Building Perimeter Assessments
- Roof Integrity
- Stairways and Access Platforms
- Condition of Asbestos Containing Materials (ACM)
- Sump maintenance & pumping requirements

Once established, these inspections will continue until the final decommissioning has occurred. Limited maintenance of the facilities will be performed with the exception of that which is required to address health, safety and environmental concerns or in preservation for final demolition.

SECTION 5: PUBLIC ENGAGEMENT

5.1 Context

Beginning with the November 2010 public announcement of the transition to mining and milling, which would result in the closure of the Smelter and Refinery, Vale has been delivering ongoing updates for the public, our employees and their families, communities of interest and our stakeholders. While the original announcement set the closure for the end of 2015 and the date was eventually pushed to 2018, Vale has never ceased to provide the aforementioned groups with regular, detailed updates on the transition and plan and any potential impacts relative to workforce adjustment, environmental impacts and related projects. This communication has taken place annually both formally and informally, through: print materials, formal presentations in Thompson and the region, requested meetings and updates, and at events such as our annual open house and community town hall events. It is also worth noting that during this time Vale Manitoba Operations has maintained a AAA rating for engagement within the Mining Association of Canada's Towards Sustainable Mining program. This has been externally verified twice, most recently in 2016, and has won a performance award for the quality of the outreach.

5.2 Outreach, Reporting, Feedback, and Communications

Community Liaison Committee: This group meets three times a year, and consists of our regional stakeholders and communities of interest, including Nisichawayasihk Cree Nation, Tataskweyak Cree Nation, Northern Association of Community Councils, Pikwitonei, Thicket Portage, Manitoba Metis Federation, UCN, School District of Mystery Lake, USW 6166, Province of Manitoba (Sustainability), City of Thomson, Northern Health Authority. Input, feedback and concerns are regularly solicited, reviewed with the executive leadership team and auctioned appropriately. The terms of reference allow for anyone to identify themselves or an organization as a "community of interest". Standing subjects include the Northern Employment Strategy, Community Investment, Health and Environment Monitoring, Exploration and Development, Tailings Management and Business/Transition Updates. The group has input into the annual community report and can request community presentations for business updates or on specific subjects. In 2017, Vale will be visiting the CLC communities to give a business update presentation and a detailed overview of closure and transition plans and impacts.

Annual Open House: Advertised broadly and hosted annually in Thompson, this event is an opportunity for the public to review in detail all aspects of our Manitoba Operations. There are samples, models, posters, activities and displays with environmental, exploration, project and operations subject matter, and several subject matter experts on hand to answer questions and collect feedback. Attendees can share feedback in-person or anonymously.

Annual Corporate Social Responsibility Report: This report is normally released concurrently with our annual open house with a link to the report, contact information for our Manitoba Operations and a feedback survey are mailed to every address in Thompson on a postcard. In

addition, a copy of the report and a link to an online survey is e-mailed to hundreds of indigenous, public, community and government stakeholders. The report includes regular updates on closure planning, environmental impacts and monitoring, safety, employment, exploration and development. Since 2010, we have averaged between 100-250 returned feedback cards annually and there have not been concerns raised specific to the environmental impacts of the transition. The focus has been, quite understandably, related to economic and employment impacts. This year's report and open house will once again feature detailed information about the closure and transition.

Manitoba Operations Update – Beginning in 2010, we launched a campaign by which we used town halls, employee update presentations and a Manitoba Operations Update bulletin to regularly update our employees and their families on the transition and the closure plan. This will intensify again as we draw nearer to August 2018.

Thompson Chamber of Commerce (televised) – Vale normally presents a business and operations update to the local Chamber of Commerce twice a year and in addition to being very well-attended in person, the presentation is televised on Shaw Cable locally and covered extensively in the local paper. This has included progress on impacts and projects relative to the 2018 closure and transition. Additionally, our Vice President was the keynote speaker for Manitoba Business week alongside Chief Moody (NCN), MLA Bindle, and Mayor Fenske in co-launching Thompson 2020--the closure impact mitigation task force. At that event, further details of the closure plan were shared.

Other Presentations: As requested, we offer presentations that include details about closure and transition plans and impact for communities, political and indigenous organizations and associations that have included: City of Thompson, School District of Mystery Lake, UCN, Rotary Club, Keewatin Tribal Council, Manitoba Keewatinowi, Okimakinak (MKO), Manitoba Metis Federation, Northern Association of Community Councils, Manitoba Chambers of Commerce and more. At times these have taken place before hundreds of delegates at annual general meetings and assemblies.

Thompson Aboriginal Accord – As a partner to the Thompson Aboriginal Accord, we offer quarterly updates and invite feedback, questions, suggestions and concerns for the many stakeholders at the Accord table.

Manitoba Mining and Minerals Convention: For the past several years, Vale has delivered a business update presentation and a separate presentation on indigenous engagement and community outreach. These presentations included detailed updates on the closure and transition, some detail about environmental impact and emissions, and they are always attended by several members of Nisichawayasihk Cree Nations leadership and Resource Management Board.

Environmental Hotline: – Vale broadly promotes (radio, newspaper, community report, fridge magnets, etc.) and reports on its environmental Hotline which receives and actions phone calls from the public regarding environmental or other concerns. To date, we have not received any enquiries relative to the closure or related, potential environmental impacts.

5.3 Impact Mitigation

Since Vale announced the transition to mining and milling in November 2010, there have been two significant initiatives launched towards economically diversifying Thompson and the region and mitigating the social and economic impacts of the closure.

Thompson Economic Diversification Working Group: Co-launched by Vale and the City of Thompson in 2011, this unprecedented, two-year process brought together key stakeholders around a consensus-based model, to address social and economic barriers, diversify the regional economy, and leverage opportunities in order to offset the loss of employment. The initiative resulted in several ready-to-implement action plans that are in varying stages of implementation, and consisted of over 20,000 hours of regional community engagement. The foundation was built in the spirit and intent of the treaty relationship and the Thompson Aboriginal Accord, and the impact of the relationships built and the plans themselves continue to have lasting effect. Vale completely funded the initiative, directly investing nearly \$2.5 million in the process.

Thompson 2020: Proposed by Vale in May 2016 to three levels of government and regional economic development entities, this has now been launched in order to further implement the TEDWG plans and mitigate economic risks posed by the closure of the smelter and refinery and the loss of some 500 direct jobs in 2018. Similar to TEDWG, the process is collaborative and inclusive, but with specific emphasis on three areas: workforce utilization; retiree retention; and, business (re)development and tourism. Vale sits on the Project Management Team, that includes the City of Thompson, the Province of Manitoba, the Federal Government, Community Futures North Central Development and the Community Economic Development Fund.

SECTION 6: APPENDICES

- 6.1 Comprehensive Report of the Vale Canada Limited Manitoba Operations
- 6.2 Memorandum of Understanding between Manitoba Conservation and Inco Limited – Manitoba Operations
- 6.3 Manitoba Operations Water Flow – Technical Report
- 6.4 Lime Demand Estimates for the Management of Water Quality in the Thompson Tailings Basin During Operations and for Closure Planning
- 6.5 Slam Dunk Program
- 6.6 Slam Dunk Proper Handling of Common Hazardous Waste
- 6.7 Vale Waste Management Facility Operations Manual
- 6.8 Collection Data - Analysis
- 6.9 Waste Management Plan - Smelter & Refinery Decommissioning/Demolition
- 6.10 Soil and Groundwater Remediation Study
- 6.11 Plant Shutdown Procedure Smelter & Refinery Decommissioning/Demolition
- 6.12 100% Design Brief Utilities Decommissioning
- 6.13 Environmental Protection Plan - Smelter & Refinery Decommissioning/Demolition
- 6.14 Landscaping/Restoration Plan - Smelter & Refinery Decommissioning/Demolition
- 6.15 Transportation and Logistics Plan - Smelter & Refinery Decommissioning/Demolition
- 6.16 Storage Plan - Smelter & Refinery Decommissioning/Demolition