Long Harbour
Processing Plant

VALE INCO

Environmental Monitoring Plan for Construction, 2010-2013

Vale Inco Newfoundland & Labrador Limited

June 2010

This page is intentionally blank.

Table of Contents

List of Figures

List of Tables

1.0 INTRODUCTION

1.1 Overview

The Environmental Monitoring Plan is an important element of Vale Inco Newfoundland & Labrador Limited's (Vale Inco NL) overall Project Environmental Management Plan that is being developed to meet the anticipated environment, health and safety, as well as sustainability, needs of the Project.

The Environmental Management Plan priority work is to develop the plans required to address immediate schedule-driven needs, such as the Fish Habitat Compensation Plans, Fisheries and Aquaculture Compensation Plan, Emergency Response Plan and updates to the Environmental Protection Plan.

1.2 Comprehensive Environmental Monitoring Approach

Vale Inco NL is planning and implementing a comprehensive approach to environmental monitoring comprising compliance monitoring, surveillance monitoring and environmental effects monitoring.

1.2.1 Environmental Compliance Monitoring

An important aspect of the overall Environmental Management Plan is the compliance monitoring-associated conditions and clauses of permits, authorizations and approvals. Data obtained as a result of compliance monitoring will be used, where appropriate, in other environmental monitoring initiatives.

1.2.2 Surveillance Monitoring

Surveillance monitoring comprises any monitoring and data gathering initiatives that, although important to Vale Inco NL's overall environmental performance and data gathering needs, does not fit truly into compliance monitoring or environmental effects monitoring.

1.2.3 Environmental Effects Monitoring

Vale Inco NL will consider and, as appropriate, propose candidate studies to follow up on key residual environmental effects predictions made in the April 2008 EIS. Environmental Effects Monitoring (EEM) studies require a wide range of inputs and perspectives in their set up and design. Vale Inco NL has identified candidate EEM study topics and has developed programs for construction phase which are described in this report for review and consideration. Vale Inco NL anticipates that by the start of marine construction the available information and input from not only the regulatory review of the approach, but input from the Community Liaison Committee, Fisheries and Aquaculture Liaison Committee and other interested parties will be in place to meet the EEM program needs for construction.

1.3 Implementation

Vale Inco NL will maintain this Environmental Monitoring Plan as a life-of-project "living" document to meet the needs of the Project at any point in time. Thus the current emphasis for Project monitoring is the construction works and in particular marine and freshwater monitoring.

As the project schedule and construction sequencing evolve, the Environmental Monitoring Plan, as well as the overall Environmental Management Plan, will be reviewed and updated as needed. Also, the Environmental Monitoring Plan will be reviewed and revised as necessary based on the results of sampling and data analysis. For example, depending on the results there may need to be adjustments in scope, sampling locations and perhaps even analytical methods (this Project has a construction and operational life of almost 20 years). As appropriate and through the regular review of progress activities and monitoring data, the relevance of candidate EEM studies will be assessed.

Construction of the project began in April 2009 with port site demolition and remediation, and clearing of the plant site and access roads, followed in June by start of plant site earthworks. First marine works is scheduled for the first quarter of 2010. Construction is scheduled to be complete in early 2013 at which time commissioning and start up will begin.

The Environmental Monitoring Plan will undergo a major overhaul approximately 12 months before the commencement of Operations to specifically address the anticipated monitoring needs of that phase of the project.

1.4 Roles and Responsibilities

This section outlines the roles and responsibilities of all Project personnel, including Vale Inco NL company personnel and contractor personnel, with respect to monitoring of this Project.

Vale Inco NL is responsible for:

- all monitoring and shall report all findings to the appropriate regulatory authorities, liaison committees and the public.
- providing direction to the Engineering, Procurement, and Contract Management (EPCM) contractor on any changes or additional requirements for monitoring.
- managing the air quality monitoring contractor including; reporting of data collected to the appropriate regulatory body, conditional monitoring of air quality monitoring station and liaison with contractor to resolve any equipment issues that may arise.
- completing monthly reports as required by Certificates of Approval with input from the EPCM contractor and other environmental monitoring consultants.

The EPCM Contractor is responsible for:

- assisting Vale Inco NL in the management and execution of the monitoring program.
- coordination of sample collection and undertaking site condition analyses, as required.
- assisting with the analysis, storing and reporting of all data, as required by Vale Inco NL.
- supporting Vale Inco NL in Quality Assurance/Quality Control (QA/QC) of all monitoring data, including arranging where needed for third party analyses.

All Contractors working on site are responsible for:

- collecting all environmental information needed for their internal operations for compliance with permits held by the contractor.
- providing copies of all such data to Vale Inco NL's Representative.

1.5 Other Relevant Aspects of the Environmental Management Plan

The other elements of the overall project Environmental Management Plan are provided in the EIS. Once the majority of critical path Plans and Programs are in place, Vale Inco NL will address the overall coordination and administration of the Environmental Management Plan.

1.6 Reporting

Reports will be prepared as required by regulatory agencies and as stipulated in Certificates of Approval (see also Section 2.7).

Results and progress of the Environmental Monitoring Plan will be reported regularly to governments, the Community Liaison Committee and the Fisheries and Aquaculture Liaison Committee or, if results dictate, on an ad hoc basis should the need arise. Such situations include, for instance, if the monitoring studies identify a potential undesirable adverse environmental effect that was not anticipated in the 2008 EIS and further program review, adjustments or environmental effects analysis is warranted.

1.7 Auditing and Continual Improvement

The Environmental Monitoring Plan is subject to Vale Inco NL's auditing and continuous improvement efforts over the life of the project. Auditing and continuous improvement will be described in the overall Environmental Management Plan.

2.0 ENVIRONMENTAL COMPLIANCE MONITORING

2.1 Objectives

Compliance monitoring addresses Vale Inco NL requirements to meet the conditions and clauses of its permits, authorizations and approvals. This section outlines a suggested program of sampling, analysis and monitoring frequency only. Actual sampling, analysis and monitoring frequency will be conducted as per the requirements of the various Certificates of Approval issued for the Construction phase.

Compliance monitoring will provide data on the quantity and quality of various discharges to the environment, including:

- Airborne contaminants and noise
- Sewage treatment plant discharge and runoff from active construction sites
- Water quality and quantity

While the focus is on Construction, in some cases the data will be useful as a supplement to the environmental programs used to support monitoring during Operations.

2.2 Air Quality / Meteorological

2.2.1 Construction

During Construction phase, the primary sources of air contamination are particulates from earthmoving, blasting and quarrying operations, and exhaust fumes from the equipment on site, and from vessel traffic. From a health viewpoint, the finer particulate fraction is of greatest concern; whereas total suspended particulate (TSP) is a good indicator of the nuisance impact, particularly from earthmoving operations.

2.2.2 Scope

The objective of the air quality monitoring program is to establish the ambient air quality conditions during the Construction phase of the Project. Air quality monitoring is focussed on measuring the air quality changes arising from construction and comparing the data to the established parameters set by permits and to data collected during periods of inactivity.

Specific monitoring requirements will be as per the Certificate(s) of Approval for Construction issued for the project from the provincial Department of Environment and Conservation (DOEC).

2.2.3 Monitoring Locations, Frequency and Parameters

There will be three (3) fixed air quality monitoring stations:

- AM-1 – Located in Long Harbour North across the harbour from the Port area (on Main Road opposite church). This station was installed in June / July 2009. This site represents the closest permanently populated area to the construction site.
- AM-2 – Located in Long Harbour generally North East (NE) of the port site (on Main Road opposite road accessing ballfield). Installation of this station will be completed in February 2010. This site represents the area of the town more typically downwind of the construction activity.
- AM-3 - Located on the NE side of the site, close to the site boundary (adjacent to the permanent Security Building). This station will be installed in 2010 after the permanent security structure is constructed and site power lines are established. This site represents the closest site boundary along the prevailing wind direction from the plant site.

Monitoring station locations are shown on Figure 2-1.

The location of these monitoring stations was selected based on the following criteria:

- Security against interference.
- Limiting the impact of local sources of particulate, particularly from sources of combustion, including wood fires, oil furnaces, and truck parking areas.
- Nearby vehicle access for servicing.
- Clear air pathway.
- Power availability and the need for real-time data communication.

Locations have been chosen with direct input from the Department of Environment and Conservation, Pollution Prevention Division.

The two parameters monitored are $PM_{2.5}$ and NOx. Both parameters are measures of combustion sources, and $PM_{2.5}$ is also generated as dust from earthmoving.

The monitors are Beta Attenuation Monitors (BAM), which measure particulate matter continuously. The monitors provide hourly measurements, and can be used if required to measure either one of total suspended particulate, or a selected fine fraction ($PM_{2.5}$ or PM_{10}).

Vale Inco NL has a contract with Enviromed Detection Services for the collection and reporting of this data throughout the duration of construction. Data is downloaded weekly and submitted in report format to Vale Inco NL monthly. The information is also available for download at the project site and is checked daily to confirm system operation. Results can be reviewed at the project site, if required, and evaluated to identify conditions that are outside the recommended range, or to identify a need for equipment servicing. Pollution Prevention Division also has direct access to the data at any time.

Meteorological data are being collected at AM-1. Data collected includes precipitation, wind speed and direction, temperature, relative humidity and barometric pressure. A noise monitor has also been installed at AM-1 (see Section 2.3).

Meteorological stations will also be located on site as required to accommodate the needs of construction as determined by the EPCM contractor.

Prior to Operations, stations will be installed on site, one in the Port area and one near the plant site, to provide real time data, including wind velocity, direction and temperature. These data will be transmitted to the same location as the air quality data.

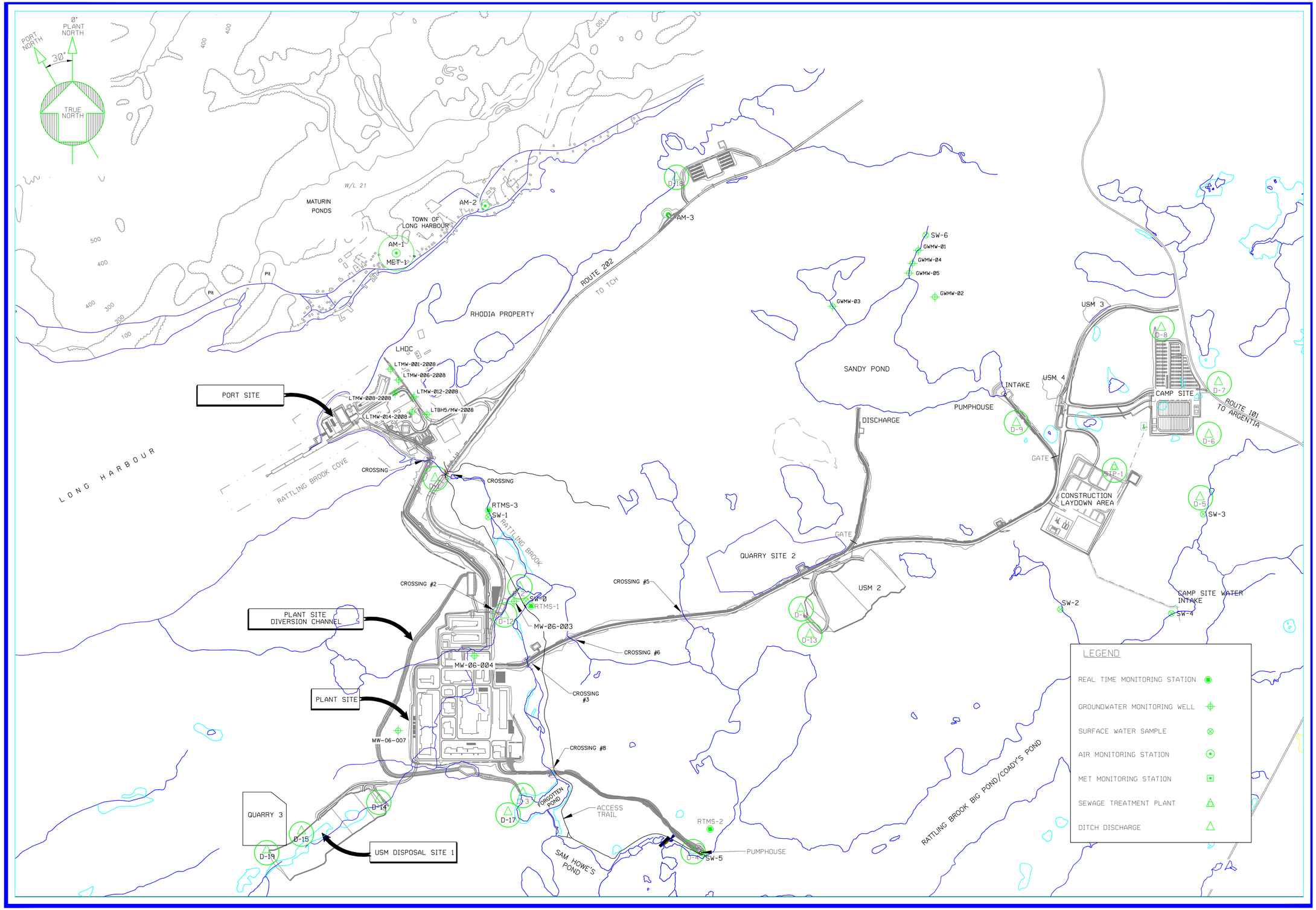

Figure 2–1.
Compliance Monitoring Locations

2.2.4 Analysis, Calibration and Verification

All analysis, calibration and verification of this equipment will be provided by the supplier. Vale Inco NL site staff will monitor equipment and report any concerns to Enviromed.

Typically the calibration for particulate is checked each hour automatically and where the results indicate a problem a signal will be sent to the data receiving location. All of the supplier's recommendations for servicing will be followed, and, at a minimum, each site will be visited regularly to determine that the equipment is operating correctly, and that there have been no changes in the surrounding environment that could adversely affect the results.

Equipment at the three ambient air monitoring stations will be subjected to a quarterly system and performance audit by the Department of Environment and Conservation, Pollution Prevention Division.

2.2.5 Operations

An air quality monitoring plan for Operations will be developed in consultation with the appropriate regulatory agencies at least one year prior to start of Operations.

2.3 Noise

2.3.1 Construction

Given the proximity of the Port Site to a residential area, it is desirable to obtain quantitative information on the noise levels in the nearby community, as a number of noise generating sources will be operating some of the time at the Port Site. The information collected will assist in identifying what if any measures should be taken to manage the effect of construction noise in the Town of Long Harbour & Mount Arlington Heights.

During Construction phase the primary sources of noise are earthmoving equipment, blasting, pile driving, and general construction activity. Construction activity at the Port area, the roadways leading from the Port area up to the Plant site and at the construction office site, are expected to be the greatest noise sources that could be detected by the nearby community.

As part of the environmental management, equipment brought on site for construction purposes is checked to determine whether it meets noise generation guidelines. Spot checking is conducted to confirm that noise abatement equipment is effective, and being properly maintained.

Concern has recently been raised about potential for underwater noise from blasting. Therefore underwater noise monitoring is also proposed.

2.3.2 Scope

A single, fixed noise monitoring station has been set up in Long Harbour opposite the Port Site at AM-1 (Figure 2-1). This station is operated on a continuous basis (excluding downtime for maintenance).

Where noise levels exceed the provincial guidelines, the timing of these exceedances will be matched against the site activities underway at the time. Where possible measures will be taken to manage the noise generation in a way that will reduce nuisance events.

Underwater noise will be measured using hydrophones. An experienced technician will be engaged to take measurements at a number of locations and water depths within Long Harbour during blasting operations. A local fisher will provide transportation and will advise on appropriate locations and depths.

2.3.3 Monitoring Locations, Frequency and Parameters

The monitoring station is located in the Town of Long Harbour & Mount Arlington Heights at Air Quality Monitoring Station AM-1.

Although the noise monitoring equipment operates 24 hours a day, useful data collection can be reduced because of interference by adverse weather conditions, wind and wave noise, maintenance needs, and possible intermittent local noise sources including traffic and ATV activity. Wind data will be monitored and recorded at the Port Site, and a log of the construction activity in the Port area will be maintained, which will provide support in separating construction noise from other sources.

Monitoring requirements are subject to change with the issuance of Certificate(s) of Approval for construction and other permits.

Underwater noise monitoring locations are yet to be determined. The timing will be coordinated with blasting activity.

2.3.4 Analysis, Calibration and Verification

Calibration and servicing of the instrument will be conducted as per the manufacturer's requirements. All noise survey data will be collected, and retained electronically for the duration of the plant construction. All data will be backed up at least monthly.

Operation and maintenance of hydrophones used for underwater noise monitoring will be the responsibility of the consultant hired to conduct this work. An appropriate QA/QC program will be required.

2.3.5 Operations

Noise sources during Operations will be evaluated and appropriate locations for noise monitoring will be selected in consultation with the appropriate regulatory bodies. It is

anticipated that the noise monitoring station at AM-1 will continue to be used to monitor noise during Operations, considering the ongoing activities at the Port during that phase.

2.4 Discharges

Monitoring will be conducted during Construction to confirm that discharge from the sewage treatment plant and runoff from exposed areas meet the requirements of the *Environmental Control Water and Sewage Regulations*.

2.4.1 Construction

During Construction phase there will be one sewage treatment plant located on the northeast side of the laydown area near the accommodations complex (Figure 2.1). At the various construction sites, diversions and settling ponds will be used to manage the runoff flowing to, and flowing from, the various sites.

2.4.2 Scope

Parameters of concern for the sewage treatment plant (STP) include Biochemical Oxygen Demand (BOD), nitrates, ammoniacal nitrogen, and phosphates (PO_4); for the site runoff, the primary concern is Total Suspended Solids (TSS). Ammoniacal nitrogen is a parameter of interest at sites where blasting is extensive, and hydrocarbons and/or BTEX is monitored in the discharge from all construction sites. As construction proceeds, all contractors are required to advise the Vale Inco NL representative of any hazardous materials that are to be brought on site. Depending on these materials the discharge monitoring program may need to be expanded, to detect any loss of material. Where higher levels of particular contaminants are observed, the monitoring parameters will be adjusted accordingly. Where parameter concentrations are continually low, and not expected to change, the program may also be modified (subject to approval by the regulatory bodies).

2.4.3 Monitoring Locations, Frequency and Parameters

Monitoring is undertaken at all discharge locations. Based on the present construction plan these locations are as shown on Table 2.1. If the construction plan is changed the locations will be adjusted, such that all discharges are captured in the monitoring program.

Table 2-1: Discharge Monitoring Overall Breakdown

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
Drainage from active/exposed earthworks locations	pH, TSS, nitrate, nitrite, ammonia, metals scan, mercury, silicon, tellurium	• Weekly for first four weeks • After four compliant sample sets have been obtained, monthly until an exceedance is recorded, at which time weekly sampling is required to recommence until four compliant sample sets are obtained. • Additional sampling following high precipitation*.	Sampling locations will be at the outlet of all settling basins.
Drainage from areas during construction of buildings/facilities.	pH, TSS, nitrate, nitrite, ammonia, metals scan, mercury, silicon, tellurium	• Weekly for first four weeks • After four compliant sample sets have been obtained, monthly until an exceedance is recorded, at which time weekly sampling is required to recommence until four compliant sample sets are obtained. • Additional sampling following high precipitation*.	Monitoring locations will be at the outlet of all settling basins.
STP discharge STP-1	Nitrates, ammoniacal nitrogen, Phosphates, TSS, Heavy Metals, TPH, BOD_5, pH, FOG	• Weekly during initial operation and after any process upset or failure to meet standards. • Monthly, if discharge meets all standards over previous four weeks.	
Disposal Areas Discharge Streams	pH, TSS, nitrate, nitrite, ammonia, metals scan, mercury, silicon, tellurium	• Weekly for first four weeks • After four compliant sample sets have been obtained, monthly until an exceedance is recorded, at which time weekly sampling is required to recommence until four compliant sample sets are obtained. • Additional sampling following high precipitation*	Additional parameters may be included, if the materials being disposed of show potential for generating such material.

* Substantial precipitation means in excess of 25 mm in a 24 hour period. Sample as closely as possible to peak discharge.

2.4.4 Analysis, Calibration and Verification

Measurements of pH, DO, temperature and turbidity will be made on site using portable equipment.

Sample collection, storage and analysis will follow guidelines given in the following documents;

- "Guidance document for the Sampling and Analysis for Metal Mining Effluents" – EPS 2/MM/5 – April 2001.
- "MISA Protocol for the Sampling and Analysis of Industrial/ Municipal Wastewaters" or any other set of appropriate procedures, requested by the regulatory authorities.
- Chapter 6 of the Metal Mining EEM Guidance document, Effluent & Water, June 2002.

Grab samples will be used, unless otherwise specified in permit conditions. Samples will be collected in prepared sample containers, to be provided by the analytical laboratory. Samples will be stored on site at 4^{o} C and transported within 24 hours for laboratory analysis.

During sample collection any observations relevant to water quality will be recorded, such as surface sheen, floating or stranded debris, or streambed or bank deposition/erosion downstream of the discharge point.

Calibration and verification of equipment used for field measurement of water quality parameters will be completed using laboratory prepared standards, at least once a day, and records kept to monitor equipment stability.

In the event that quality control data indicates unacceptable results, additional measures including additional sampling/analyses will be conducted to define and correct the problem.

2.4.5 Operations

There will be one combined effluent outfall during Operations which will be subject to monitoring as prescribed by the *Metal Mining Effluent Regulations*. All compliance monitoring applicable to Operations will be addressed in a subsequent revision of this Environmental Monitoring Plan which addresses the environmental monitoring needs of that project phase.

2.5 Surface Water Quality

2.5.1 Construction

The plant site and much of the construction activity is in the catchment of Rattling Brook. In some cases construction is taking place on or close to the boundary of the catchment and some drainage will take place to adjacent catchments. Exceptions are the Construction Site Offices and the development of the Port Site where the runoff will all be directly to the waters of Long Harbour. At a later date in the Construction phase, during the construction of the residue disposal facility, there will be a need to monitor the Sandy Pond catchment.

2.5.2 Scope

The surface water monitoring program is designed to determine any direct effects from construction activity on surface water quality. This program supplements the discharge monitoring by providing information on the effects of those discharges on the quality of the receiving waters. The program provides data to determine the effectiveness of the Environmental Protection Plan (EPP) and whether the measures are adequate or should be modified.

2.5.3 Monitoring Locations, Frequency and Parameters

Monitoring locations, frequencies and parameters are presented in Table 2-2. The monitoring station locations are shown in Figure 2-1. Final locations may be adjusted upstream or downstream, in the field, based on ease of access and ability to obtain representative samples.

The stations include four continuous (real time) monitoring stations as shown in Figure 2-1. Three sites already exist in Rattling Brook:

- Rattling Brook below bridge (operating since 2006)
- Rattling Brook below plant discharge (started operation in October 2009)
- Rattling Brook Big Pond (water level since 2006, water quality added in October 2009)

A fourth station will be added on the stream draining Sandy Pond at a still undetermined location. All site locations for real-time water quality stations are made in conjunction with the provincial Water Resources Management Division and Environment Canada.

Monitoring requirements will be modified if required, with the issuance of the Certificate(s) of Approval for construction as well as other permits.

Table 2-2: Surface Water Monitoring

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
SW-0 - Real Time Water Quality Monitoring Station – Rattling Brook below bridge (RTMS-1)	Turbidity, pH, DO, Temperature, Specific Conductance, % Saturation, TDS	Continuously	Station also includes continuous hydrometric measurements.
	TPH, nitrate, nitrite, ammonia, metals scan, TSS, Total Coliform	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	
SW-1 - Real Time Water Quality Monitoring Station – Rattling Brook below plant discharge (RTMS-3)	Turbidity, pH, DO, Temperature, Specific Conductance, % Saturation, TDS	Continuously	Station also includes continuous hydrometric measurements.
	TPH, nitrate, nitrite, ammonia, metals scan, TSS	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	
SW-2 and SW-3 - Streams flowing into Rattling Brook Big Pond	TPH, nitrate, nitrite, ammonia, metals scan, TSS	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	
SW-4 - Rattling Brook Big Pond at Temporary Water Intake	TPH, nitrate, nitrite, ammonia, metals scan, TSS	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
SW-5 - Real Time Water Quality Monitoring Station - Rattling Brook Big Pond (RTMS-2)	Turbidity, pH, DO, Temperature, Specific Conductance, % Saturation, TDS	Continuously	Station also measures water level on Rattling Brook Big Pond.
	TPH, nitrate, nitrite, ammonia, metals scan, TSS, Total Coliform	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	
SW-6 – Real Time Water Quality Monitoring Station – Sandy Pond Catchment (site to be determined)	Turbidity, pH, DO, Temperature, Specific Conductance, % Saturation, TDS	Continuously	To be installed in 2010 or 2011. Station also includes continuous hydrometric measurements. Measurements to start at least two months before construction starts on the Sandy Pond residue storage area.
	TPH, nitrate, nitrite, ammonia, metals scan, TSS, Total Coliform	Monthly and High Precipitation	
	Water Chemistry Analysis*	Quarterly	

- *Water Chemistry Analysis (27 parameters) and Metals Scan (28 parameters).
- Other locations may be monitored, as specified in Certificates of Approval or at the discretion of site environmental inspectors in order to monitor the performance of silt control measures.

2.5.4 Analysis, Calibration and Verification

Measurements of pH, DO, temperature and turbidity will be made on site, using portable equipment. Equipment used for field measurement of water chemistry will be calibrated at least once a day using laboratory prepared standards, and records kept to monitor equipment stability.

All continuous water quality monitoring equipment will be maintained and calibrated on a monthly basis by provincial Water Resources Management Division staff using established protocols and procedures. Additionally, appropriate quality assurance/quality control protocols will be followed.

Sample collection, storage and analysis will follow guidelines given in the following documents;

- "Guidance document for the Sampling and Analysis for Metal Mining Effluents" – EPS 2/MM/5 – April 2001.
- "MISA Protocol for the Sampling and Analysis of Industrial/ Municipal Wastewaters" or any other set of appropriate procedures, requested by the regulatory authorities.
- Chapter 6 of the Metal Mining EEM Guidance document, Effluent & Water, June 2002.

Grab samples will be used, unless otherwise specified in permit conditions. Samples will be collected in prepared sample containers, to be provided by the analytical laboratory. Samples will be stored in a refrigerator at $4^{o}C$ on site and transported within 24 hours for laboratory analysis. During sample collection any observations relevant to water quality will be recorded, such as surface sheen, floating or stranded debris, or streambed or bank deposition.

In the event that quality control data indicates unacceptable results, additional measures including additional sampling/analysis will be conducted to identify and correct the problem.

2.5.5 Operations

It is anticipated that the real time water quality monitoring network established during Construction will continue to operate during Operations. Any other compliance monitoring needs will be addressed in a subsequent revision of this Environmental Monitoring Plan which addresses the environmental monitoring needs of that project phase.

2.6 Groundwater Quality

2.6.1 Construction

Groundwater monitoring is conducted to identify any contamination of the groundwater arising from hydrocarbon spills or mobilization of heavy metals during the earthworks and remediation activities.

There are existing groundwater monitoring wells at the Port and Plant sites and at Sandy Pond which were installed in the collection of baseline data for the EIS. These wells remain and are being utilized during Construction.

In the case of incidents where existing wells impede project construction, they will be maintained for as long as possible and will then be decommissioned. If needed, new wells will be installed as close as possible to the original location.

2.6.2 Scope

Three existing wells located in the vicinity of the Plant Site and shown on Figure 2-1 have been included in the program. These include one well located upslope from the plant (MW-06-007) and two new wells to be located in or down slope from the Plant Site to replace two wells (MW-06-004 and MW-06-003) which were destroyed during early construction.

At the Port Site a number of monitoring wells have recently been installed and were used to monitor groundwater during site remediation and will continue throughout the duration of port site construction. The six port site monitoring wells (LTMW-001-2008, LTMW-006-2008, LTMW-012-2008, LTBH5/MW-2008, LTMW-008-2008 and LTMW-014-2008) are shown on Figure 2.1.

At Sandy Pond, five new wells will be installed downstream of proposed dams (GWMW-01 through – 05) as shown on Figure 2-1. These wells will be installed a minimum of one year in advance of construction at these locations to allow for the establishment of baseline data and sampling protocol.

The number and location of real-time groundwater monitoring stations and the parameter list will be determined in consultation with Water Resources Management Division.

A shallow and a deep groundwater monitoring well will be installed near the topographic low point southeast of Sandy Pond. These wells will be located in consultation with Water Resources Management Division.

Since the locations of the groundwater wells to be discussed with Water Resources Management Division are not yet determined, they are not shown on Figure 2-1.

The monitoring program will be adjusted, if necessary, prior to Operations to comply with the requirements of the Certificate(s) of Approval for construction as well as other permits.

2.6.3 Monitoring Locations, Frequency and Parameters

Monitoring locations, frequency and parameters are presented in Table 2-3.

Table 2-3: Groundwater Monitoring Overall Breakdown

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
Monitoring Wells at Plant Site – (3 wells as shown on Figure 2.1)	Water Chemistry Analysis*	Quarterly	Water levels in the wells will also be recorded at the time of sampling.
Monitoring Wells at Port Site- (6 wells as shown on Figure 2.1)	pH, TPH, Metals Scan, Water Chemistry Analysis*	• During port site remediation and port site earthworks construction activity: o Monthly sampling of pH, Total Petroleum Hydrocarbon, Metals Scan. o Quarterly Water Chemistry Analysis. • Frequency may be reduced during periods when there is no active construction at the Port Site.	Water levels in the wells will also be recorded at the time of sampling.
Monitoring Wells at Sandy Pond – (5 wells as shown on Figure 2.1)	Water Chemistry Analysis *	Quarterly to begin at least one year prior to construction at Sandy Pond	Water levels in the wells will also be recorded at the time of sampling.
Real Time Groundwater Monitoring Wells at Sandy Pond	To be determined	Real time to begin at least one year prior to residue disposal	To be discussed and mutually agreed between Vale Inco and Water Resources Management Division
Shallow and Deep Groundwater Wells SE of Sandy Pond	Water level	To be determined in consultation with Water Resources Management Division	To be discussed and mutually agreed between Vale Inco and Water Resources Management Division

*Water Chemistry Analysis (27 parameters) and Metals Scan (28 parameters).

2.6.4 Analysis, Calibration and Verification

Measurements of pH will be made on site, using portable equipment. Equipment used for field measurement of water chemistry will be calibrated at least once a day using laboratory prepared standards, and records kept to monitor equipment stability.

Sample collection, storage and analysis will follow guidelines given in the following documents;

- "Guidance document for the Sampling and Analysis for Metal Mining Effluents" – EPS 2/MM/5 – April 2001.
- "MISA Protocol for the Sampling and Analysis of Industrial/ Municipal Wastewaters" or any other set of appropriate procedures, requested by the regulatory authorities.
- Chapter 6 of the Metal Mining EEM Guidance document, Effluent & Water, June 2002.

Grab samples will be used, unless otherwise specified in permit conditions. Samples will be collected in prepared sample containers, to be provided by the analytical laboratory. Samples will be stored in a refrigerator on site and transported within 24 hours for laboratory analysis.

2.6.5 Operations

All groundwater compliance monitoring applicable to Operations will be addressed in a subsequent revision of this Environmental Monitoring Plan document which addresses the environmental monitoring needs of that project phase. The emphasis will be on the residue storage facility at Sandy Pond.

2.7 Reporting

Monthly reports containing the environmental compliance monitoring and sampling information required by Certificates of Approval, and any additional monitoring data gathered during the reporting period, will be compiled and submitted to the Director of Pollution Prevention Division, Department of Environment and Conservation. Reports will be submitted within 30 days of the reporting month.

Any laboratory reports related to the report information will be appended to the monthly report.

In addition to all environmental compliance monitoring data, reporting to Department of Environment and Conservation will include:

- a summary of any incidents of Emergency Response implementation;
- non-conformances to any conditions of approval of C of As;
- reports of any spillage or leakage of a regulated substance;
- incidents of suspected or actual exceedance of discharge criteria; and,
- any written or verbal complaints of an environmental incident from the public related to the Project.

Water quantity and quality information from all real-time stations is reported and available to the general public on the Department of Environment and Conservation web page in near real-time.

3.0 SURVEILLANCE MONITORING

3.1 Objectives

Vale Inco NL will be conducting a variety of data collection and monitoring initiatives as part of its overall approach to improving its knowledge base in the region and to address information sharing expectations with stakeholders. Surveillance monitoring during Construction includes general monitoring and reporting of encounters with wildlife, with emphasis on otter and Red Crossbill. Monitoring of socio-economic VECs is also included in this section.

3.2 General Wildlife Presence

General wildlife presence will be noted throughout Construction. Specific monitoring will be conducted to determine the presence of otter and Red Crossbills adjacent to construction activity. Any sightings and/or nests of any rare/endangered species will be reported to Provincial Wildlife Division.

3.2.1 Otter

Otter haul out areas have been identified along the shore of Long Harbour. The otter population in the area tend to prefer the marine environment rather than freshwater. Potential adverse environmental effects may result from the sound of blasting. Prior to blasting the vicinity of the blast area will be examined for otter presence. For blasting adjacent to or in water a small initial charge will be detonated ahead of the main charge. Any otters observed during the pre-blast activity or immediately following the initial charge will be recorded. Blasting operations will be delayed if otters are within a designated safety zone.

3.2.2 Red Crossbill

Red Crossbills may potentially be in the Project Area nesting. The presence of potentially nesting crossbills is best determined by listening for calls, including singing, and watching for the presence of the species. The density of breeding pairs on the Avalon Peninsula is very low, and the chance of Red Crossbills nesting in the Project Area during Construction is very low. Vale Inco contracted a biologist experienced with the calls, songs, field marks and habits of the Red Crossbill to visit forested areas scheduled for clearing within two weeks of tree cutting. If any Red Crossbills were detected, additional surveys would be undertaken to determine whether they were nesting in the path of the clearing. If nesting Red Crossbills were found, then tree cutting would be delayed until the crossbills had fledged and left the area.

During the June and July 2009 Red Crossbill surveys, no Red Crossbills were detected, however a nesting pair of Rusty Blackbirds were located. A buffer zone was left in the area of the nest and follow-up surveys were conducted. During the final visit, the Rusty Blackbirds were gone, however it is not clear whether the young had fledged successfully or whether the nest may have failed.

3.3 Socio-Economic VECs

3.3.1 Economy, Employment and Business

The EIS predicted significant positive effects for this VEC during the Construction and Operations phases of the Project. Vale Inco NL currently has a benefits-monitoring system in place which captures and compiles employment and contract award data and reports results to the provincial government. This monitoring will be extended to cover all phases of the Project.

Since 2003, the company has been providing monthly reports outlining the employment and industrial benefits that accrue to the Province from the mine/mill in Labrador and the Demonstration Plant in Argentia. This reporting system has been extended to include the Construction of the Long Harbour Processing Plant (and subsequently into Operations). During Construction these data will be reported monthly. Employment data will be reported by residence, work location, gender and category of employment. Expenditure data will be reported for labour, supplies and equipment, transportation, taxes, subcontracts, and other items (including overhead charges, insurance, supplier mark-ups, carrying charges, restocking costs and other charges).

Information on contract and procurement awards and on any major contracts/procurement activity being planned will also be provided throughout the life of the Project. It is anticipated that the normal quarterly meetings with provincial officials to discuss any implications of this information will continue.

3.3.2 Services and Infrastructure

The EIS predicts that the residual effects of the Project on the components of the Services and Infrastructure VEC (health, education, income support and employment services, policing and safety, transportation, municipal government, industrial and commercial real estate, and housing) is either not significant (health, policing and safety) or positive (remaining components). No specific monitoring related to the Services and Infrastructure VEC is proposed. Monitoring of any effects on the components within this VEC is normally the responsibility of government generally, and the agency or organization with the mandate for the delivery of the service in particular. As committed to in the EIS, Vale Inco NL will assist this by providing relevant plans and information, by co-operating to address any important unanticipated effects, and in the review of any management strategies implemented to optimize Project outcomes.

3.3.3 Recreational Activities

Recreational activities include recreational natural resource use, recreational leisure activities, and natural, cultural, and historic tourism attractions. Following on the predictions in the EIS, no specific monitoring is considered necessary for this VEC. Existing organizations (e.g., tourism attractions, agencies which regulate hunting and fishing) maintain records of activity use. Any unanticipated effects of the Project would become evident through these monitoring processes.

4.0 ENVIRONMENTAL EFFECTS MONITORING (EEM)

4.1 Objectives

Vale Inco NL understands the role and importance of selective and focused EEM studies in providing meaningful information into improving overall environmental performance on a Project. Vale Inco NL has a long history of conducting successful EEM studies to provide feedback on cause and effect relationships with its construction and operations of its mine/mill project and associated shipping and marine port development facilities in Labrador. The results of such studies have enabled Vale Inco NL to become a responsible and reliable developer with a high level of environmental performance with functional processes for the continuous improvement of environmental performance.

Vale Inco NL intends to fully consider the need for scientifically sound EEM studies that have clear and achievable hypotheses for Valued Environmental Components (VECs) evaluated in the detailed environmental effects analysis in the EIS throughout the life of the Project. Vale Inco NL considers its proposed project at Long Harbour as an opportunity to consider EEM studies that complement its studies and findings in Labrador.

Vale Inco NL proposes that the criteria for determining the need and/or utility of an EEM study on any particular VEC include the following:

Residual adverse effects of the planned project on all VECs will be considered in the EEM program development. Vale Inco NL proposes that the criteria for determining the need and/or utility of an EEM study on any particular VEC should include the following:

- Responsive monitoring studies as part of follow-up after an accident, malfunction or unplanned event will be addressed on an *ad hoc* basis as the need arises;
- Where any significant residual adverse environmental effects are predicted;
- Whether it is considered that adequate monitoring information is already being gathered under another complementary program for either compliance monitoring or surveillance monitoring;
- Whether the study reflects a new area of cause and effect relationships or determining the adequate of previously questionable or inadequate mitigation measures;
- Where no significant residual adverse environmental effects are predicted: the magnitude of the potential adverse effect is high and there is a high degree of uncertainty;

- Where, in receiving environments where there are many contributors to cumulative environmental effects, EEM studies may be needed to quantify project-related effects from a due diligence perspective;

- Where the acceptability of residual adverse environmental effects is in part due to special mitigation in the form of compensation; and

- Where engineering and design aspects are such that there is not a long period of operator experience or regulator oversight.

4.2 EEM Program Development

Vale Inco NL will submit its draft Environmental Monitoring Plan to interested agencies and groups such as the provincial government, federal government, the Community Liaison Committee and the Fisheries and Aquaculture Liaison Committee. The EEM Program will be a key aspect for this information sharing process with the aim to bring specific scientific expertise otherwise unavailable to Vale Inco NL into the process. Vale Inco NL will evaluate relevant cause and effect relationships and the implications for mitigation designed into the Project as well as the need for any additional mitigation measures necessary to address adverse environmental effects not anticipated during the EIS.

4.3 The EIS as a Basis for Focused EEM Studies

Vale Inco NL successfully completed a detailed and comprehensive environmental assessment of its planned projects in 2008. The environmental assessment evaluated two main alternatives and as such the engineering and design team had the opportunity to consider and integrate a wide range of mitigation measures into the projects being assessed. Such efforts substantially contributed to a high level of knowledge about its projects and activities. This, coupled with extensive construction and operations experience in the Province, environmental baseline studies and supporting models, allowed for Vale Inco NL to be able to rely on readily available mitigation measures that have been proven to be reliable in a wide range of environments. As such, for many of the potential project-environment interactions analyzed and the resulting determination of significance for residual adverse environmental effects, there is a high degree of confidence in the environmental effects predictions. Most residual adverse environmental effects in the EIS were rated as not significant with a high degree of confidence. Again this is largely reflective of:

- the proven nature of mitigation measures integrated into the project design;

- the experience of Vale Inco NL as a constructor and operator in the province and Vale Inco limited as a constructor and developer in a variety of areas across the boreal forest region of Canada; and

- the long history of environmental monitoring by Vale Inco NL and key provincial and federal government regulatory and resource management agencies in the province on Vale Inco NL projects and a myriad of other mining and minerals processing, industrial development and resource

development projects in the province and in the Placentia Bay region in particular.

4.4 Candidate Topics for EEM During Construction

Vale Inco NL has reviewed the scope and scale of activities anticipated during Construction based on its current level of design and schedule and the key relevant environmental effects described in the EIS. The majority of activities are relatively routine in nature and there is a generally high degree of confidence in rating of the residual adverse environmental effects in the EIS. As such the majority of the potential cause and effect relationships during Construction do not warrant the need for considering EEM studies. The exception is dredging and the proposed EEM program focuses on that construction activity.

Furthermore, Vale Inco NL has committed to a high level of management of selected potential cause and effect relationships due to the fact that designing detailed follow-up or EEM studies to address the concern may not be practical. Such management initiative includes specific Plans for:

- Vessel Traffic Management;
- Emergency Response, as well as Contingency situations described in the Environmental Protection Plan;
- Greenhouse Gas Emissions;
- Rehabilitation and Closure;
- Women's Employment; and
- Occupational Health and Safety.

There are, however, some VECs that Vale Inco NL considers important to nominate for potential EEM studies. They include marine fish and fish habitat, commercial fisheries and aquaculture, and Species at Risk - boreal felt lichen.

4.4.1 Marine EEM

4.4.1.1 Concern

Marine construction activities in Long Harbour, principally dredging, will disturb contaminated sediments. This disturbance will result in a real or perceived decrease in the quality of the marine environment in the vicinity of the Project. The blue mussel is a focal marine species that is a suitable candidate for EEM studies during Construction, with winter flounder used in fish health studies. During Operations, winter flounder is a focal species that will be monitored in addition to blue mussel.

4.4.1.2 Purpose

Investigate the cause and effect relationships between marine construction activities resulting in the suspension of sediments that may contain contaminants and reduce the quality of blue mussels (a commercial aquaculture product) for market. Evaluate the effect of Project activities on the marketability of blue mussels from the aquaculture operation in Long Harbour.

4.4.1.3 Proposed Monitoring Program

Vale Inco NL intends to hire a consulting firm with experience and expertise in marine environmental effects monitoring to conduct this monitoring study (with the exception of turbidity profiling which will be conducted by site environmental staff). Methodology will follow acceptable industry standards for such monitoring, and where possible consistency will be maintained with the previously approved marine baseline study. Vale Inco will audit the sampling protocol and QA/QC procedures of the potential successful bidder prior to awarding the marine monitoring contract. This information can be supplied to the regulator upon request.

The major objective of the marine EEM is to delineate the spatial extent of potential contamination and effects from dredging. Given the relatively small monitoring area within Long Harbour it is proposed to conduct sampling along two separate transects oriented so as to incorporate stations previously sampled during the marine baseline studies. In addition, due to the proximity of the aquaculture operation a transect was established in that direction.

During the initial phase of developing an EEM program, there must be a clearly defined set of expectations and goals that address concerns of the public and the expectations of the regulators. The principal goals of the EEM program will include:

- To fulfill regulatory information requirements and address legitimate public concerns;
- To be scientifically defensible;
- To meet the project requirements;
- To be flexible to allow for design modification as conditions change or new information comes forward;
- To disseminate monitoring information to stakeholders;
- To be practical.

4.4.1.4 Sampling Stations, Frequency and Parameters

To optimize the use of existing data, the construction EEM will incorporate stations already sampled during the marine baseline studies conducted for the EIS. During initial EEM baseline sampling, locations will be established to sample sediment having similar physical characteristics.

The marine baseline study had three sampling stations established in Long Harbour inside of Crawley Island: Sandy Point Station, Maturin Point Station, and The Key Station, as well as a reference station in Little Seal Cove outside Long Harbour. The addition of two sampling stations along a transect extending from The Key Station toward Mount Arlington Heights would form the outer limit transect for the “far field” construction EEM (Figure 4.1).

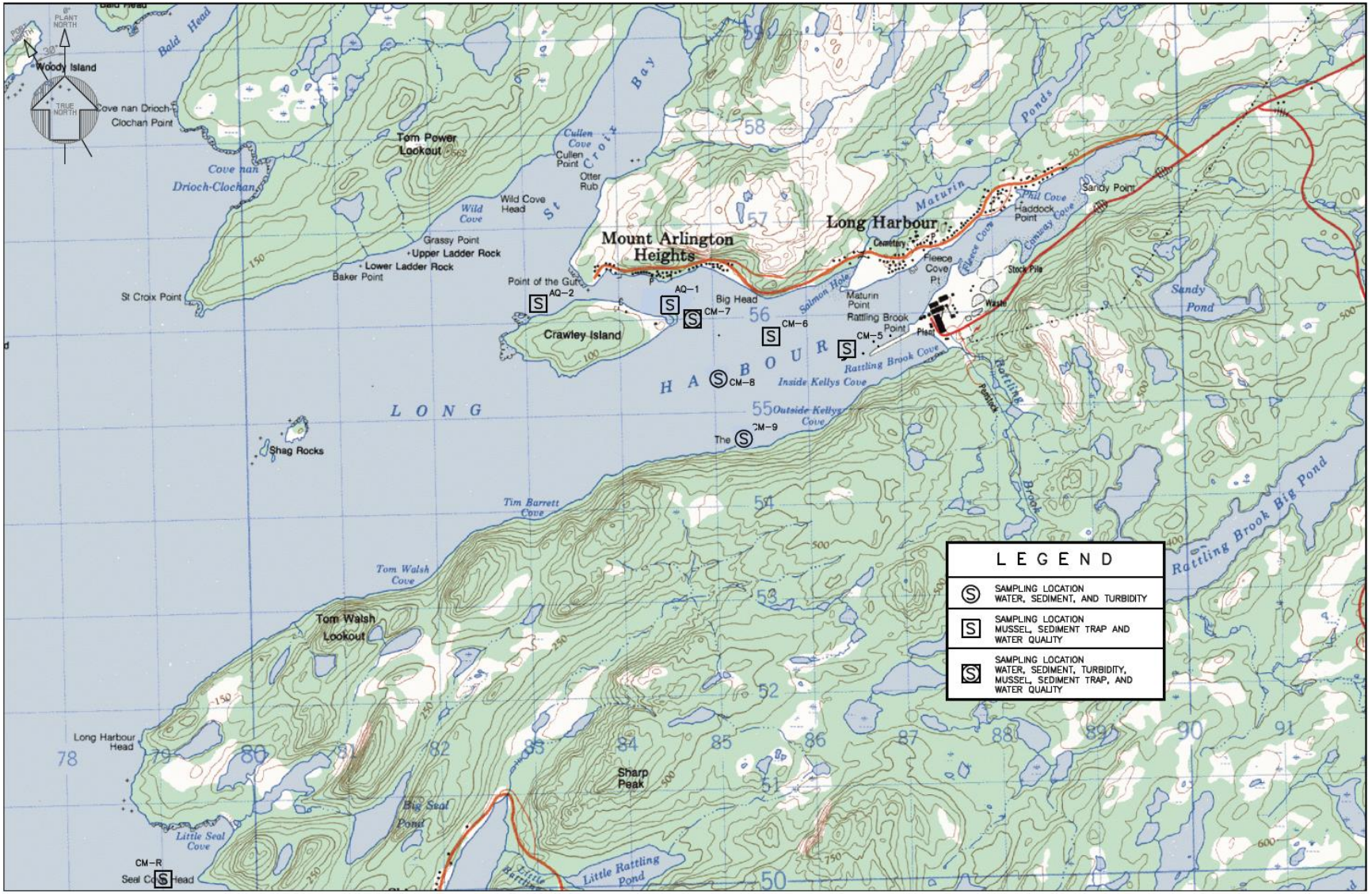

Figure 4.1: Marine Monitoring Far Field Sampling Stations

For the “near field” construction monitoring, sampling stations would be established around the perimeter of the silt curtain/ bubble curtain which will surround the proposed dredge area. The sampling stations will be spaced 100 m apart along the northwest side and the southwest end, which would mean establishing a total of four sampling stations for water, sediment and turbidity profiling within 100 meters of the perimeter of the dredge area (CM-1, CM-2, CM-3, CM-4) (Figure 4.2).

The Maturin Point location previously sampled during the marine baseline study will be incorporated into the near field sampling program and will be designated as one of the mussel and sediment trap deployment stations (CM-5). A second mussel and sediment trap deployment location will be established toward the west side of Long Harbour in line with the Maturin Point location and in the general vicinity of the mussel aquaculture site at the northeast end of Crawley Island (CM-7). Because of its location at the intersection of both the nearfield and farfield transects, and its proximity to the aquaculture site, sampling location CM-7 will be sampled for all proposed parameters. One other mussel/sediment trap location will be established mid-harbour (CM-6). In addition to these sites, the mussels at the existing aquaculture operation at Crawley Island (two locations on north side labeled AQ-1 and AQ-2) will be sampled in the same manner (Figure 4.1).

At least one week before the start of dredging all locations would be sampled to establish baseline sediment and water quality values and the caged mussels/ sediment traps would also be deployed during that time. Monitoring will continue at least weekly thereafter but may be conducted biweekly if conditions deteriorate.

One sampling location for sediment and water quality will be established within the dredge area inside the silt curtain (Dredge Reference, see Figure 4.2). This will be for comparison purposes.

As mentioned the sediment and water quality would be conducted at all stations prior to the start of dredging to establish a baseline. Turbidity profiles will be conducted at the “near field” stations around the dredge area to establish ambient conditions, with readings to be taken at 3 m intervals. After baseline sampling water column sampling will be conducted on a weekly/biweekly basis and the marine sediment sampling would be conducted again one to two days after dredging has been completed or when all suspended solids have settled out of the water column.

During dredging operations turbidity profiling would be conducted on the rising tide one hour before HHW and on the falling tide one hour before LLW. These sampling intervals should capture the maximum tidal flow as well as the “slack” tide at either end of the tidal cycle.

In summary, there will be 12* monitoring sites and 1 site for comparison for the construction EEM, as follow and as described in Table 4.1:

- 3 “far field” sampling locations along a transect incorporating “The Key Station” which was previously established (CM-7, CM-8, CM-9). This transect would extend toward Crawley Island and be sampled for water, sediment and turbidity only with the exception of CM-7 which will be sampled both as a near field and far field site.

- 6 stations for mussel/sediment trap deployment incorporating the previously established Maturin Point sampling site (CM-5), two stations at the aquaculture operation (AQ-1, AQ-2), one station approximately midway (CM-6), one station northeast end of Crawley Island (CM-7) and the previously sampled reference station at Little Seal Cove located outside Long Harbour, south of Long Harbour Head (CM-R). These will also be sampled for water and sediment during the baseline and after dredging is complete.

- 4 “near field” water, sediment and turbidity profiling stations within 100m of the silt/bubble curtain (CM-1, CM-2, CM-3, CM-4)

- 1 comparison sampling location for water quality (TSS) and turbidity profiling established between the dredge and the curtain (Dredge Reference).

* Since CM-7 is only counted once, total monitoring sites is 12.

Already established sites have been incorporated into the Construction EEM where possible since there are baseline data available from these locations. Moving forward, where appropriate, consideration will be given to incorporating some of the Construction EEM sites into the Operational EEM.

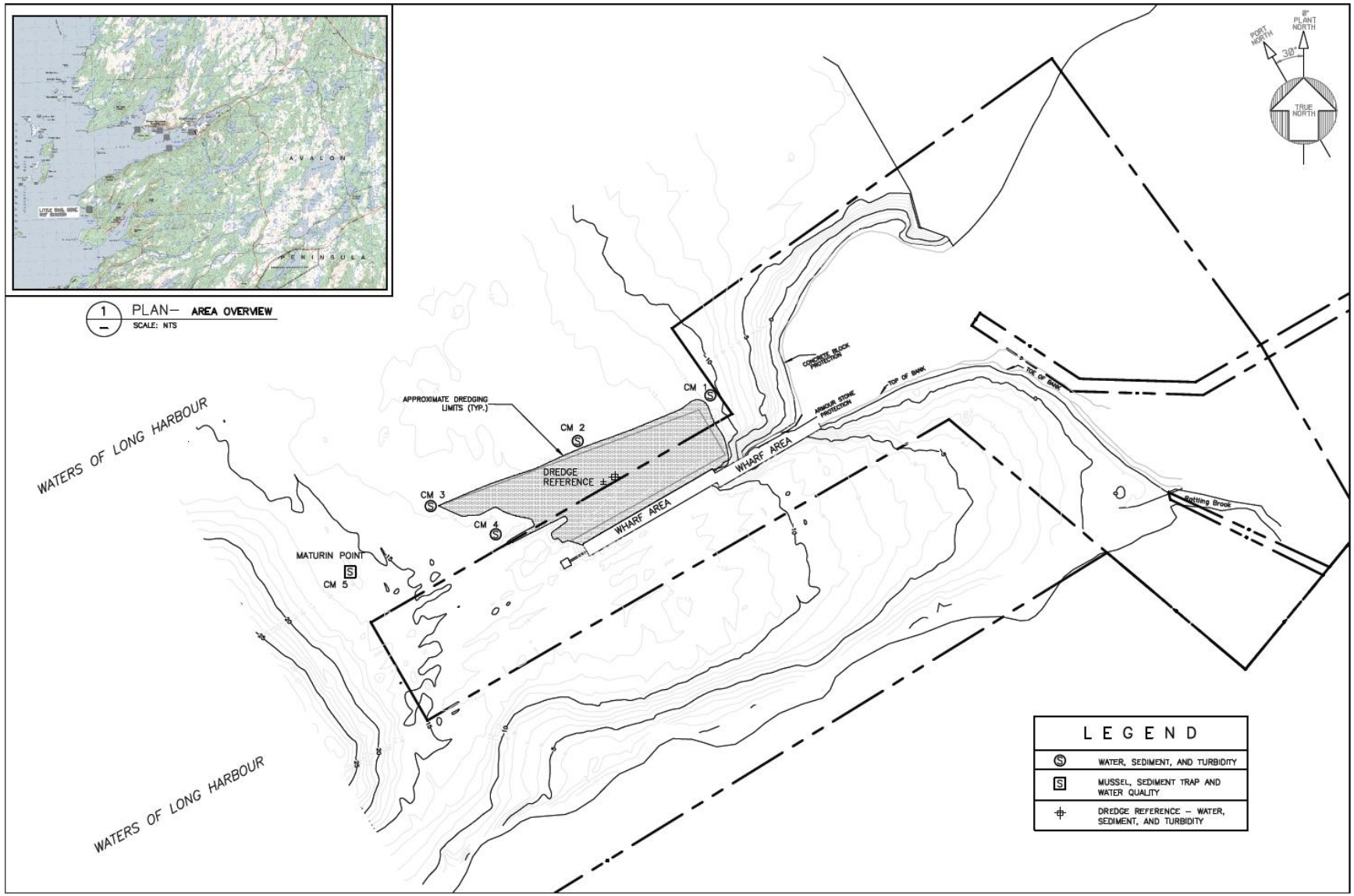

Figure 4.2: Marine Monitoring Near Field Sampling Stations

Table 4-1: Marine Monitoring Overall Breakdown

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
CM-1, CM-2, CM-3, CM-4 – approximately 20m outside silt curtain on north, east and west sides	Water - pH, TSS, temperature, dissolved oxygen, salinity, BTEX/TPH, Metals Scan, mercury, Turbidity Profiling Surficial Sediment - elemental phosphorus, particle size, mercury, TIC/TOC, extractable hydrocarbons (>C_{10}-C_{32}), sulphate, available metal scan	Weekly, starting one month before dredging commences. Sampling to stop 2 weeks after work is completed. Turbidity profiling at least once on each tidal cycle.	Sampling to be conducted on the falling tide If any visible turbidity plume, sample mid-plume Water samples taken below surface, mid water column and 1m above seabed
Dredge Reference - inside silt curtain approximately mid-way between wharf and silt curtain	pH, TSS, BTEX/TPH, Metals Scan, mercury, temperature, dissolved oxygen, salinity, Turbidity Profiling Surficial Sediment - elemental phosphorus, particle size, mercury, TIC/TOC, extractable hydrocarbons (>C_{10}-C_{32}), sulphate, available metal scan	Weekly, starting one month before dredging commences. Sampling to stop 2 weeks after work is completed. Turbidity profiling at least once on each tidal cycle.	Sampling to be conducted on the falling tide If any visible turbidity plume, sample mid-plume Water samples taken below surface, mid water column and 1m above seabed

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
Mussel and sediment trap monitoring sites CM-5, CM-6, CM-7, AQ-1, AQ-2, CM-R	Water – pH, TSS, BTEX/TPH, mercury, metals scan, temperature, dissolved oxygen, salinity Sediment (traps and surficial) – particle size, mercury, TIC/TOC, extractable hydrocarbons (>C_{10}-C_{32}), sulphate, available metal scan Mussels – metal scan, mercury, extractable hydrocarbons (>C_{10}-C_{32})	1 week prior to dredging and 1 week post-dredging	Water samples taken below surface, mid water column and 1m above seabed Sediment traps and surficial sediment Mussel sampling to be consistent with marine baseline study Mussel taint testing at AQ-1 and AQ-2 Mussel Health
Water, sediment and turbidity monitoring sites CM-7, CM-8, CM-9	Water – pH, TSS, BTEX/TPH, mercury, metals scan, temperature, dissolved oxygen, salinity Surficial Sediment – particle size, mercury, TIC/TOC, extractable hydrocarbons (>C_{10}-C_{32}), sulphate, available metal scan Turbidity profiling	Turbidity profiling daily on the falling tide Weekly, starting one month before dredging commences. Sampling to stop 2 weeks after work is completed.	Note that additional sampling of dredged material will be conducted to determine the appropriate disposal option for the material.

Monitoring Location	Monitoring Parameter	Monitoring Frequency	Comments
Fish health - near wharf water lot and reference site	Visible lesions Age Condition Relative gonad size Relative liver size Liver and gill histopathology Mixed function oxidases Bile metabolites	Pre and post dredging	
Mussel Health CM-5, CM-6, CM-7, CM-R, AQ-1, AQ-2 plus 2 wild mussel sites near CM-R and between AQ-1/AQ-2	Condition Histopathology of gill, mantle, gonad, digestive gland and corrective tissue	Pre and post dredging	

4.4.1.5 Mussel Taint Testing Trials

Mussels for taint testing will be collected from the approved aquaculture site waters in Long Harbour at AQ-2. The samples will consist of mussels from the local aquaculture operation and transferred farmed mussels placed at this location. Mussels for this purpose will be collected at the same time as the mussels are sampled as described above, both in advance of and after dredging.

The food technology kitchen at the Marine Institute will be hired to prepare the mussels, recruit persons from the faculty and student body to do blind taste testing of the mussels, and administer a questionnaire regarding visual appearance, smell, and taste. They will follow established protocols for conducting this type of study.

4.4.1.6 Fish Health

Considering the known elevated levels of some inorganic and organic chemicals in the surficial sediments occurring in the area immediately north of the wharf as a result of past industrial activity, Vale Inco considers it prudent to determine the baseline health of fish that inhabit that area prior to the start of dredging.

A fish health study was initiated in October 2009 consisting of collection and analysis of winter flounder samples to determine baseline fish health at two locations – immediately north of the wharf (dredge area) and at a reference site. Vale Inco engaged Oceans Limited to conduct this study. Data from both sites will be compared in order to determine whether the health of fish inhabiting the area immediately north of the wharf is significantly different from the health of fish inhabiting the reference area.

Sampling involves the collection of at least 25 adult winter flounder comprised of a mixture of male and female fish at each of the two locations. Parameters measured are liver and gill histopathology, mixed function oxidases (MFO) and bile metabolites. Also included is determination of condition indices and inspection of the fish for any observable tumours and lesions.

Following completion of the dredging in 2010, a second winter flounder study will be conducted following the same methodology used in fall 2009. Data will be compared to the pre-dredging data to determine whether the health of the fish differs significantly between years and between locations.

4.4.1.7 Mussel Health

The objective of the marine EEM program during construction of the Long Harbour processing plant is to delineate the nature and extent of potential contamination and effects from dredging activities. Dredging is commonly carried out in harbours in Newfoundland within any requirement for monitoring. However, due to the proximity of a mussel aquaculture operation, Vale Inco is giving particular attention to this bivalve. Oceans Limited has been retained to carry out histomorhology studies on blue mussels collected from field and caging sites.

Sampling Stations

Blue mussels (*Mytilus edulis*) will be collected ~1-2 weeks prior to dredging and ~1-2 weeks post-dredging from 6 stations for mussel/sediment trap deployment in the Long Harbour area, as follows: Maturin Point (CM-5), two stations at the aquaculture operation (AQ-1 and AQ-2), one station approximately midway (CM-6), one station at the northeast end of Crawley Island (CM-7) and a reference station at Little Seal Cove outside Long Harbour (CM-R) (Figure 4.1). As well, 2 wild mussel bed sites, one situated on the north side of Crawley Island and the other in the proximity of the reference site, will also be sampled. Mussel caging and collection will be carried out by another contractor who will transport the samples to Oceans Limited.

Mussel Collection

The gametogenesis/spawning period in Newfoundland is generally between April to July. In order to minimize its influence on body burden and tissue structure, mussels will be collected as late as possible before dredging starts (currently scheduled to start in late July/early August).

Forty five mussels (~ 5 to 6 cm length) will be collected at each station/site before and after dredging activities, for examination of condition index and histopathological analysis. Analysis will be carried out on 35 mussels (20 for mussel condition and 15 for histopathology), however an extra 10 mussels are being collected as a “back-up”. Forty five mussels will also be sampled prior to caging and placement into the waters of Long Harbour.

To reduce the occurrence of histological artifacts during sampling, all mussels collected will be placed in large plastic bags containing approximately 10L of ambient seawater from each respective site. Plastic bags will be placed in a chilled cooler box for transport back to the laboratory in St. John’s.

Sample Preparation, Mussel Condition and Histological Processing

Mussel condition will be assessed on 20 mussels per station/site and histopathological analysis will be carried out on 15 mussels per station/site.

The shell length, width and depth, wet weight, soft tissue wet weight and soft tissue dry weight will be measured to calculate the condition.

The shell length, width and depth will be measured before sample preparation. The adductor muscles will be cut with a sharp knife so that the valves remain open. The entire animal will be placed in Dietrich’s fixative for one week, then transferred to 70% ethyl alcohol. Prior to embedding, the byssal threads will be removed from the byssal

glands to avoid problems when sectioning the tissue and a 3-5 mm thick transverse cross-section including digestive gland and gills will be removed using a scalpel. Tissue sections will be placed in a tissue capsule, embedded in paraffin and then sectioned at 5µm. Tissue sections will be stained in H&E and mounted in Permount.

Microscopic Examination

Tissues examined will include gill, mantle, gonad, digestive gland and connective tissue. The histopathological analysis will begin by the determination of sex and stage of gonadal development.

Microscopical analysis will then focus on, but not necessarily be limited to, observations on the following pathologies:

- Abnormal gonad features
- Gonad inflammation
- Gonad intersex
- Gonad necrosis/atresia
- Digestive gland inflammation
- Digestive tubule atrophy
- Digestive tubule vacuolation
- Lipofuchsin formation
- Granulocytomas
- Tumors/cysts
- Haemocyte neoplasia
- Adipogranular tissue
- Ceroid bodies
- Kidney abnormalities
- Gill abnormalities
- Parasites

Guidance for this list principally comes from the Mussel Watch Program and the CEFAS Lab in the UK which has carried out extensive studies in mussel histology.

Reporting

An interpretative final report will be prepared and will include (a) general background literature, (b) all field and laboratory procedures with QA/QC documentation (QA/QC procedures will include independent expertise for screening 15% of the slides for confirmation of diagnosis), (c) statistical analysis, (d) summary figures and tables of results, (e) complete set of raw data, (f) representative histological photographs, (g) discussion of results and final conclusions in relation to relevant up-to-date primary and secondary literature dealing with field as well as laboratory studies with bivalves.

4.4.2 Operations

All marine monitoring applicable to Operations will be addressed in a subsequent revision of this Environmental Monitoring Plan which addresses the environmental monitoring needs of that project phase. The effluent outfall will be subject to the monitoring requirements specified in the *Metal Mining Effluent Regulations*.

4.4.3 Species at Risk – Boreal Felt Lichen (BFL)

4.4.3.1 Concern

Some trees containing BFL in the Project footprint could not be avoided and were transplanted. Growth and survival of transplanted lichens and those contained on trees located within a 20 m buffer zone could be in jeopardy.

4.4.3.2 Purpose

Investigate the cause and effect relationships between mitigation measures to help protect BFL through transplanting and establishment of buffer zones.

4.4.3.3 Proposed Monitoring Program

Vale Inco has contracted LGL Limited environmental research associates to implement the BFL environmental effects monitoring program. The Endangered Species and Biodiversity Group of provincial Wildlife Division has been engaged in the development of the monitoring program and information has been shared on findings.

Some degree of transplantation of thalli of the boreal felt lichen has taken place in the project 'footprint', and Vale Inco has attempted to achieve a minimum 20m buffer of undisturbed habitat for occurrences of BFL that are proximate to the development.

Other lichen species of conservation interest have been recorded, and the textured lungwort (*Lobaria scrobiculata*) has been included for monitoring, particularly because of the extensive scientific literature on this species. This species provides a valuable reference to any findings that emerge for the BFL.

The goal of the overall Environmental Effects Monitoring (EEM) program is to monitor demographics (growth and survival) of the BFL in the project area and in a control area, Lockyer's Waters, located in the Central Avalon Peninsula. Four major components of the life history of the lichens are being monitored - reproductive potential, growth, survival and recruitment. The data collection follows the established scientific protocol for BFL. Application of this scientific protocol in Long Harbour supports the direct comparison of demographics of this population to those being studied elsewhere on insular Newfoundland.

Site clearing and earthworks during 2009 has resulted in considerable disturbance to the natural environment in the immediate area of the plant site and supporting camp site and other project infrastructure. Where BFL-containing trees could not be avoided, transplantation of BFL thalli took place in fall of 2008 and for trees remaining in close proximity to the project footprint, buffer zones have been established. Vale Inco is attempting to achieve the 20m minimum buffer radius defined by the regulator.

Monitoring has been ongoing since fall of 2008 in an effort to identify any unforeseen issues, and apply adaptive management, as necessary, to the EPP as it relates to the lichens.

The moving of BFL thalli from the footprint to recipient areas represents the first operational transplant program attempting to mitigate negative impacts to BFL. As such, it is important that it be closely tracked. Therefore Vale Inco proposes to monitor transplants and lichens included in the EEM in the acquisition area on semi-annual basis up to the end of 2009. Depending on results, the EEM may adhere to a semi-annual protocol or revert to an annual protocol. This decision will be based on the level and types of construction disturbance completed and anticipated to continue into 2010-2011.

4.4.4 Operations

All monitoring of boreal felt lichen applicable to Operations will be addressed in a subsequent revision of this Environmental Monitoring Plan document which will address the environmental monitoring needs of that project phase.