

FINAL REPORT

Environmental Assessment
Registration, Panuke Quarry
Expansion Project

MUNICIPAL ENTERPRISES LIMITED

PROJECT NO. 1014939.

PROJECT NO. 1014939

REPORT TO

**Municipal Enterprises Limited
PO Box 48100 RPO Mill Cove
Bedford, Nova Scotia
B4A 3Z2**

FOR

**Environmental Assessment Registration
Panuke Quarry Expansion Project**

March 12, 2008

Jacques Whitford
3 Spectacle Lake Drive
Dartmouth, Nova Scotia,
B3B 1W8

Phone: 902-468-7777

Fax: 902-468-9009

www.jacqueswhitford.com

EXECUTIVE SUMMARY

Municipal Enterprises Limited proposes to expand the footprint of its existing quarry in Three Mile Plains, near the community of Windsor, Hants County, Nova Scotia. The quarry property is located in the West Hants Municipal District. The proposal will allow continued aggregate production (blasting, crushing and stockpiling) to supply local construction (e.g., roadbuilding) needs. The existing quarry has been operational for over 5 years and the proposed activities will take place over approximately the next 5 years involving a total of approximately 6 ha of land immediately adjacent to the existing quarry.

The quarry opened in 2001 and produces a variety of quartzite aggregate types. The current and anticipated average production rate is approximately 60,000 tonnes per year. The current and anticipated operating schedule is based on 15 hrs/day, 7 days/week; on a year-round basis, weather permitting.

Proposed Project activities will be consistent with current quarry operations approved by Nova Scotia Environment and Labour and in accordance with the Nova Scotia Pit and Quarry Guidelines (NSEL 1999). Aggregate production will begin with drilling and blasting, which will be conducted by a qualified blasting contractor. Blasting will take place approximately two to four times per year. Portable crushing equipment will be on site to process the blasted material. Various products (i.e., various aggregate sizes) will be stockpiled at the quarry site until they are sold and transported to local markets via tandem trucks or tractor trailer trucks. The primary markets for the products are construction projects, such as road building within the Municipality of West Hants, local customers, and the Nova Scotia Department of Transportation and Infrastructure Renewal (TIR).

Municipal Enterprises Limited is required to register this Project as a Class I Undertaking pursuant to the Nova Scotia *Environment Act* and Environmental Assessment Regulations. Other relevant provincial regulations include the Activities Designation Regulations, which requires an Industrial Approval from NSEL for the quarry operation, and the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act* (2003). Provincial guidelines to be adhered to include the Nova Scotia Pit and Quarry Guidelines (NSEL 1999).

This environmental assessment registration evaluates the potential environmental effects of the Project and identifies appropriate mitigation and monitoring to minimize these effects. The document focuses on those aspects of the environment of most concern. Components evaluated include:

- fish habitat;
- rare and sensitive flora;
- wildlife;
- groundwater resources;
- archaeological and heritage resources;
- air quality; and
- socio-economic environment.

Environmental effects from the quarry expansion will include the loss of habitat within the quarry footprint. Assuming the mitigative measures specified in this report are implemented, and the quarry is operated according to existing provincial guidelines and approvals, no significant adverse residual environmental or socio-economic effects are likely.

Table of Contents

EXECUTIVE SUMMARY	i
1.0 PROPONENT AND PROJECT IDENTIFICATION	1
1.1 Proponent Information.....	1
1.2 Project Information	1
2.0 PROJECT INFORMATION	2
2.1 Description of the Undertaking	2
2.2 Geographical Location	2
2.3 Physical Components	4
2.4 Site Preparation and Construction	4
2.5 Operation and Maintenance	6
2.5.1 Quarry Operation Activities	6
2.6 Effluents and Emissions	6
2.6.1 Hazardous Materials and Contingency Planning	8
2.7 Decommissioning and Reclamation	9
3.0 SCOPE.....	10
3.1 Scope of the Undertaking.....	10
3.2 Purpose and Need for the Undertaking.....	10
3.3 Project Alternatives	11
3.4 Scope of the Environmental Assessment	11
4.0 PUBLIC INVOLVEMENT.....	13
4.1 Methods of Involvement	13
4.2 Stakeholder Comments and Steps Taken to Address Issues	13
5.0 VALUED ENVIRONMENTAL/SOCIO-ECONOMIC COMPONENTS (VEC/VSC) AND EFFECTS MANAGEMENT	14
5.1 Methodology.....	14
5.2 Fish Habitat.....	14
5.2.1 Description of Existing Conditions.....	14
5.2.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up	16
5.3 Rare and Sensitive Flora.....	17
5.3.1 Description of Existing Conditions.....	17
5.3.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up	21
5.4 Wildlife.....	23
5.4.1 Description of Existing Conditions.....	23
5.4.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up	28
5.5 Groundwater Resources	33
5.5.1 Description of Existing Conditions.....	33
5.5.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up	38
5.6 Archaeological and Heritage Resources.....	39
5.6.1 Description of the Existing Environment	39
5.6.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up	40

5.7	Air Quality.....	41
5.7.1	Description of Existing Conditions.....	41
5.7.2	Potential Effects, Proposed Mitigation, Monitoring and Follow-up	43
5.8	Socio-economic Environment	45
5.8.1	Description of the Existing Environment	45
5.8.2	Potential Effects, Proposed Mitigation, Monitoring and Follow-up	47
5.9	Other Undertakings in the Area.....	49
5.9.1	Description of the Existing Environment	49
6.0	EFFECTS OF THE PROJECT ON THE ENVIRONMENT	50
7.0	EFFECTS OF THE ENVIRONMENT ON THE PROJECT	51
8.0	OTHER APPROVALS REQUIRED	52
9.0	FUNDING.....	53
10.0	ADDITIONAL INFORMATION.....	54
11.0	REFERENCES.....	55
11.1	Literature Cited.....	55

List of Tables

TABLE 4.1	Summary of Stakeholder Comments and Concerns	13
TABLE 5.1	ACCDC Vascular Plants Potentially Found in Project Area	19
TABLE 5.2	Summary of Domestic Water Wells Records in Three Mile Plains, Nova Scotia	37
TABLE 5.3	Nova Scotia <i>Air Quality Regulations (Environment Act)</i> and <i>Canadian Environmental Protection Act</i> Ambient Air Quality Objectives.....	42

List of Figures

FIGURE 2.1	Panuke Road Quarry Site Location	3
FIGURE 2.2	Buildings and Quarry Locations within 800 m of Project	5
FIGURE 5.1	Wetlands and Surface Water	15
FIGURE 5.2	Terrestrial Habitat in the Study Area	18
FIGURE 5.3	Locations of Uncommon and Rare Plant Species in and Near the Quarry Expansion Area	22
FIGURE 5.4	Distribution of Forest Interior Habitat in the Quarry Expansion Area.....	32
FIGURE 5.5	Surficial Geology	35
FIGURE 5.6	Bedrock Geology.....	36

List of Appendices

- APPENDIX A Registry of Joint Stocks and Industrial Approval
- APPENDIX B Panuke Quarry Hydrology Study
- APPENDIX C Project Information Bulletin and Letters
- APPENDIX D Fish Habitat Survey
- APPENDIX E Vascular Plants Recorded in Study Area
- APPENDIX F Bird Species Recorded in Study Area

1.0 PROPONENT AND PROJECT IDENTIFICATION

1.1 Proponent Information

Name of the Proponent: Municipal Enterprises Limited
Postal Address: P.O. Box 48100 RPO Mill Cove
Bedford, NS
B4A 3Z2
Tel.: (902) 442-8311
Fax: (902) 420-9326

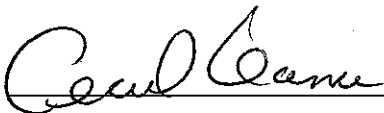
Registry of Joint Stocks for the proponent company is included in Appendix A.

Company President and/or Environmental Assessment Contact


Name: Cecil Vance
Official Title: CEO
Address: As Above
Tel.: (902) 442-8311
Fax: (902) 420-9326

Environmental Consultant Contact

Name: Angela Swaine
Official Title: Project Manager
Address: Jacques Whitford Limited
3 Spectacle Lake Drive
Dartmouth, NS B3B 1W8
Tel.: (902) 468-7777
Fax: (902) 468-9009



Signature of President



Date

1.2 Project Information

Name of the Undertaking: Panuke Quarry Expansion Project
Location of the Undertaking: Windsor, West Hants Municipality, NS

2.0 PROJECT INFORMATION

2.1 Description of the Undertaking

Municipal Enterprises Limited (MEL, the Proponent) owns and operates a quarry, located at 700 Panuke Road in Three Mile Plains, near the community of Windsor, Hants County, Nova Scotia. The quarry property is located in the West Hants Municipal District (Figure 2.1). The Nova Scotia Department of Environment and Labour (NSEL) granted approval for this quarry under DOE No. 2001-019700, effective September 14, 2001 and expiring September 9, 2011. An Industrial Approval has been obtained (No. 2006-019700-A01), pursuant to Division V of the Activities Designation Regulations, and issued by NSEL, effective from March 12, 2002 until September 9, 2011. This permit allows for construction and operation of a quarry on property parcel number 45270493. A copy of the permit is appended to this report (Appendix A).

MEL proposes to expand the approved quarry site an additional 6 ha to allow for continued aggregate production (blasting, crushing and stockpiling) and intends to supply local construction contracting needs. Excavation in quarry operations will not take place below the groundwater table; the benched face height will be no more than 27 m below ground surface with the groundwater table another metre below. The Proponent owns the existing quarry lands as well as the adjacent proposed expansion land area, which will effectively allow for the expansion on property parcel number 45336963. The existing quarry has been in operation since 2001, with a total disturbed area to date of approximately 3.9 ha.

As a result of field and desktop studies undertaken in support of this environmental registration document, the expansion area has been carefully considered so as to minimize potential environmental impacts including impacts to streams located on the proposed expansion property.

The anticipated average production rate is 60,000 tonnes per year. The current and anticipated operating schedule is 15 hrs/day, 7 days/week; on a year-round basis and weather permitting. Estimated rock reserves in the proposed expansion area is in order of 600,000 tonnes. Quarry operations will continue to take place over approximately the next five years depending upon the demand for aggregate in the area.

2.2 Geographical Location

The quarry is located at 700 Panuke Road in Three Mile Plains, near the community of Windsor, Nova Scotia (Figure 2.1). Entrance to the quarry is via a public road, known as Panuke Road. The quarry and proposed quarry expansion area are situated on lands that are owned by the Proponent that have undergone various stages of clearing over the past 5 years. The proposed expansion area supports three habitat types including mature second growth hardwood forest, clear-cut and disturbed area.

Residential development in the immediate vicinity of the Project is relatively low, with no structures unrelated to the quarry within 800 m. A local road with a low distribution of residential development extends from the eastern boundary of the proposed expansion area, approximately 3 km, to Trunk 1 (Figure 2.1). Additionally, there is a second quarry not owned by the applicant, adjacent to the proposed expansion site (Figure 2.2). It is understood that this quarry is leased to Hants County Aggregates and its use is restricted to Nova Scotia Department of Transportation and Infrastructure Renewal (TIR) contracts. The zoning of the land area is General Resource.

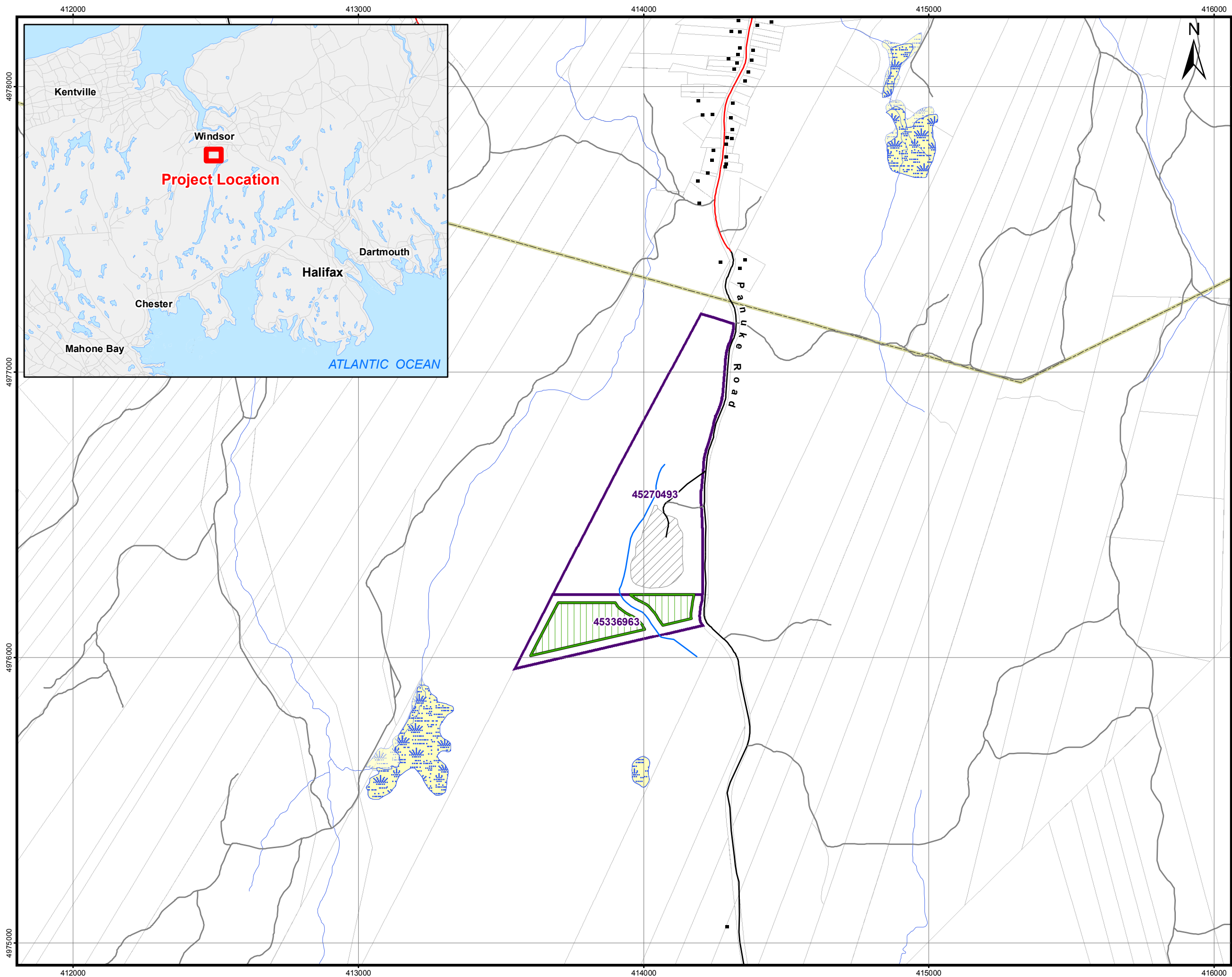
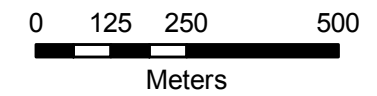


Figure 2.1
Panuke Road
Quarry Site
Location
Panuke Road
Quarry Project

- Map Features**
- Building
 - Local
 - Seasonal/Unpaved
 - Track/Trail
 - - - Driveway
 - + - - Railway
 - - - Transmission Line
 - Watercourse
 - Existing Quarry
 - Proposed Expansion Area
 - Quarry Properties
 - Property Boundary
 - Waterbody
 - Wetland



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:12,500
 Date: February 6th, 2008
 Project No.: 1014939.



2.3 Physical Components

The existing quarry operations consist of a laydown area for the portable crushing equipment, various aggregate stockpiles, quarry floor and working face, settling pond, scale and scale house, and access road. The existing property currently does not have liquid asphalt permanently stored on site, it is delivered to the site while making asphalt and it is removed thereafter. Fuel oil is stored on site in temporary above ground storage containers. These materials are currently handled in accordance with existing regulations and this will continue following the expansion. No new fuel storage or dangerous goods will be associated with the proposed expansion.

Overburden that has been stripped prior to drilling and blasting are stored on site for subsequent use during site reclamation. The piles have been hydroseeded to reduce potential for erosion and sedimentation. This, or similar practices will continue throughout the development and operation of the proposed expansion area.

The laydown area is located on the quarry floor. The crushing equipment is transported to the site as required (*i.e.*, after blasting). Aggregate stockpiles are currently located at a dedicated location within the quarry limits, as space allows. As the quarry expands, no additional stockpile areas will be established and the existing stockpile area will be used. Surface runoff and quarry drainage are collected on the quarry floor, which has the capacity to hold a significant quantity of water. Currently, overflow from the quarry floor drains to a settling pond located to the west of the existing operation. Additional settling pond volume will be developed with the expansion, as required (as indicated in Appendix B), however, a larger area was considered for that assessment than is presently being proposed for quarry expansion (10 ha versus 6 ha). As such, estimates of the volume increase in surface water runoff and other associated measurements resulting from that assessment will serve as over or conservative estimates for proposed operations. Details regarding the amount of additional settling pond volume required for proposed quarry operations will be further refined at the Industrial Approval application stage. Excavation will not take place below the groundwater table; the benched face height will be no more than 27 m below ground surface with the groundwater table another metre below.

The nearest residence is located greater than 800 m from the boundary of the proposed quarry expansion limits. As shown in Figure 2.2, there are no businesses located within 800 m. The general direction of quarry advancement will be south and southwest from the existing quarry face. The potential for acid drainage production in this area is low.

2.4 Site Preparation and Construction

The existing quarry has been in operation for over 5 years. Access to the existing quarry development is along existing roads. To minimize the potential for erosion and sedimentation, grubbing and removal of overburden has been and will continue to be conducted on an as needed basis, to accommodate drilling and blasting activities. Topsoil, grubbed material and overburden are stockpiled on site and have been stabilized with hydroseed for subsequent use during site reclamation. These, or similar stabilization procedures will continue throughout the operations of the proposed expansion.

Quarry drainage and surface runoff collects on the quarry floor. Overflow from the quarry floor is currently directed to a settling pond located to the west of the existing developed area, which eventually drains into the partially subterranean stream that runs along quarry activities. Additional pond volume will be developed as the expansion proceeds, as required. Water from the settling ponds will be used to provide a water supply for dust suppression during crushing in dry periods.

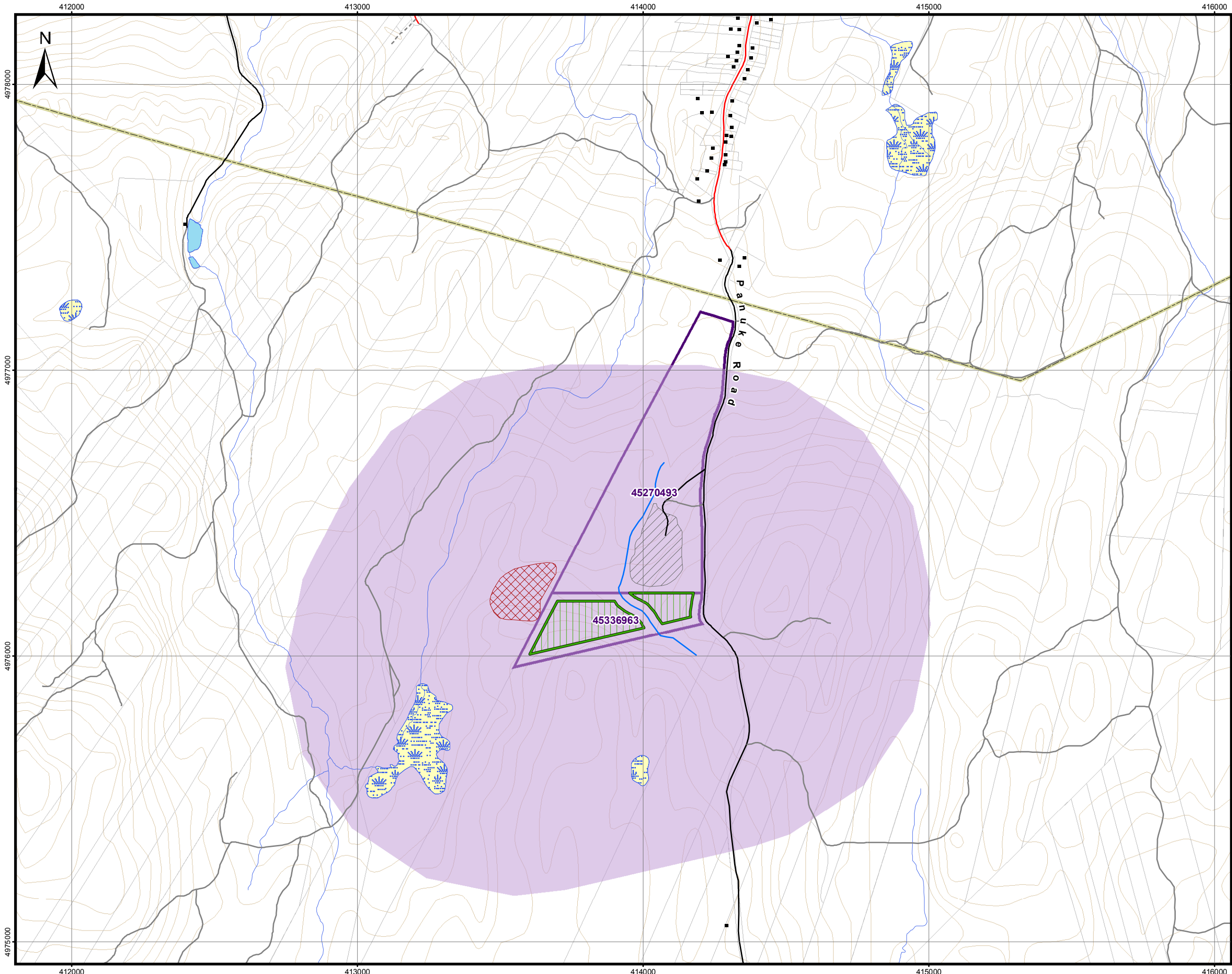
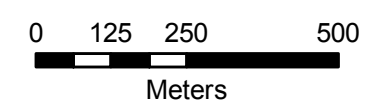


Figure 2.2
Building & Quarry Locations
Within 800 m
of Project
Panuke Road
Quarry Project

- Map Features**
- Building
 - Local
 - Seasonal/Unpaved
 - Track/Trail
 - - - Driveway
 - + — Railway
 - Transmission Line
 - Watercourse
 - Contour (5m)
 - Waterbody
 - Wetland
 - Existing Quarry
 - TPW (TIR Quarry)
 - 800 Metre Expansion Area Buffer
 - Quarry Properties
 - Proposed Expansion Area
 - Property Boundary



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:12,500
 Date: February 06th, 2008
 Project No.: 1014939.



2.5 Operation and Maintenance

2.5.1 Quarry Operation Activities

The proposed Project activities will be consistent with the current quarry operations approved by NSEL (DOE No. 2006-019700-A01) and will be in accordance with the Pit and Quarry Guidelines (NSEL 1999). These guidelines apply to all pit and quarry operations in the province of Nova Scotia and provide: separation distances for operations, including blasting; liquid effluent discharge level limits; suspended particulate matter limits; sound level limits; and requirements for a reclamation plan and security bond.

Aggregate production begins with drilling and blasting. It is anticipated that blasting will occur two to four times a year. This is consistent with current approved operations. A qualified blasting company will conduct this work. The blasting sub-contractor is responsible for blast designs and methods in accordance with the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act* (1996). Blasting activity will be conducted in accordance with the Pit and Quarry Guidelines. Details of a blast design plan and blast monitoring program will be provided in the application for Industrial Approval. Where appropriate, consideration will be given to recommendations provided in *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998). Excavation of aggregate in quarry operations will not take place below the groundwater table; the benched face height will be no more than 27 m below ground surface with the groundwater table another metre below.

The blasted rock will be processed by portable crushing equipment that will be on site. The various aggregate products will be stockpiled in designated areas within the quarry. Piles will be built in layers to minimize segregation and prevent contamination by mixing of different piles. Material is hauled and moved within the quarry with a loader. Other equipment will likely include an excavator. Products will be transported from the quarry via tandem and tractor trailer trucks along Panuke Road. The number of trucks hauling aggregates currently averages approximately 2,000 per year, or between zero and 85 trucks per day depending on production, and is expected to remain unchanged although this may fluctuate periodically due to local market conditions.

The existing quarry currently employs one seasonal employee in the scale house; however, there are more employees during aggregate production. This number is expected to remain the same following site expansion. Drilling and blasting activities involve additional resources; these activities are sub-contracted to a professional blasting company. Hauling of materials from the quarry also involves additional labour and equipment requirements. Hauling (or trucking) is typically arranged through the customers.

2.6 Effluents and Emissions

In accordance with best practices and standard NSEL requirements, runoff controls will be in place to ensure that effluent generated during operations is managed appropriately. Surface runoff at the quarry collects on the quarry floor. Overflow from the quarry floor drains to a settling pond constructed in the western side of the developed area and eventually drains into a partially subterranean stream running along the quarry. Additional pond volume will be installed, as required, in accordance with

NSEL's Erosion and Sedimentation Control Handbook for Construction Sites (NSEL 1988) and the quarry's approval to operate, and in consultation with NSEL's engineers/inspectors.

A hydrological review of the Panuke Quarry and the proposed expansion was conducted by Hydro-Com Technologies (refer to Appendix B). The assessment considered a larger expansion area for that assessment than is presently being proposed (10 ha versus 6 ha). As such, estimates of the volume increase in surface water runoff and other associated measurements resulting from that assessment will serve as over or conservative estimates for proposed operations. Details regarding the amount of additional settling pond volume required for proposed quarry operations will be further refined at the Industrial Approval application stage. The report states that the quarry expansion will result in an increase in the volume of surface runoff (by a factor of between 5% and 20%) will occur as a result of the quarry development.

Currently, overland flow drains into a settling pond which ultimately drains into a partially subterranean stream running along the quarry property. It is expected that the effects on the downstream flows and on water quality associated with the proposed ultimate level of quarry development can be fully mitigated using the placement of free-draining material (*i.e.*, rock/gravel) and properly sized flow retention/siltation treatment areas. Following the use of these mitigative measures, the remaining residual effects on downstream water quality are expected to be minor.

Overflow, if any, will be monitored and sampled according to the terms and conditions of the existing approval (and future updates) and the Pit and Quarry Guidelines to ensure total suspended solids levels do not exceed the approved final effluent discharge limits. In the unlikely event that overflow, in the event of a significant rain fall, exceeds final effluent discharge limits as determined through monitoring, contingency measures may include pumping of sediment laden water to vegetated areas (away from watercourses) or through filter bags for additional filtration and/or use of additional filtration devices or structures. A stormwater management plan will be submitted as part of the quarry development plan during the Industrial Approval application process.

Dust emissions will be controlled with the application of water, obtained from the water contained in the settling pond(s) or water that is pooled on the quarry floor. To minimize generation of dust, the working areas and laydown areas will be covered with blasted rock. Stockpiled topsoil and overburden material will be seeded and covered with hay. Monitoring of airbourne particulate emissions (dust) will be conducted at the request of NSEL and in accordance with the Pit and Quarry Guidelines and the Nova Scotia Air Quality Regulations.

Combustion emissions will be generated from the operation of vehicles and equipment. Given the scope of the planned operations, these emissions will be minimal, localized and similar in quantities to the operation of a small construction project using one or two pieces of heavy equipment. Emissions will be reduced through proper equipment maintenance and inspection. Consideration will be given to methods to reduce idling, as feasible. Ambient air monitoring will be conducted at the request of NSEL.

As per the Pit and Quarry Guidelines, sound levels from quarry operations will be maintained at a level not to exceed the following sound levels (Leq) at the property boundaries:

Leq 65dBA 0700-1900 hours (Days);
60dBA 1900-2300 hours (Evenings); and
55dBA 2300-0700 hours (Nights).

Sound monitoring will be conducted at the request of NSEL.

Light emissions will be generated from road and parking lot lighting, exterior decorative lighting, such as spotlights or floodlights with a function of highlighting features of buildings *etc.*, and for the safety of employees. Emissions will be minimized by shielding lights to shine down only where it is needed, without compromising safety. Road and parking lot lighting will also be shielded so that little escapes into the sky and it falls where it is required. Generally, exterior decorative lights such as spotlights or floodlights with a function of highlighting features of buildings, *etc.* will be avoided, or the time of their operation restricted to where only necessary to ensure safety of employees, particularly during the migratory season for most birds, when the risk of drawing birds to the site is greatest.

Solid waste generated on-site will be minimal (office and domestic refuse). All solid waste will be properly collected and stored until such time that it can be transported to a provincially approved waste disposal facility.

Details of any monitoring programs required by NSEL (*e.g.*, surface water, noise, dust) will be developed in consultation with NSEL and outlined in the Industrial Approval amendment application.

2.6.1 Hazardous Materials and Contingency Planning

There is no plan for additional storage of hazardous materials or petroleum products at the quarry site other than temporary above-ground storage. As noted in Section 2.3, existing storage facilities on the expansion property are operating in compliance with applicable regulations. A qualified company will be contracted to conduct regular maintenance of equipment. Used oil and filters are currently removed from the site and this practice will continue with the proposed expansion.

Refuelling of equipment will be conducted onsite on a regular basis, under contract by a tanker truck. Refuelling activities will not be conducted within 100 m of any surface water, and equipment operators will remain with the equipment at all times during refuelling in accordance with the Petroleum Management Regulations of the Nova Scotia *Environment Act*.

In the event of a leak or spill during refuelling, maintenance, or general equipment operation, immediate action will be taken to stop and contain the spilled material. All contaminated material will be collected and stored in an appropriate manner so as not to be re-released to the environment until such time as it will be transported to an approved treatment/disposal facility. All spills will be reported to the 24-hour environmental emergencies reporting system (1-800-565-1633) in accordance with the Emergency Spill Regulations of the Nova Scotia *Environment Act*. A Spill Contingency Plan will be developed in support of the application for amendment to the existing Industrial Approval.

2.7 Decommissioning and Reclamation

MEL will undertake a progressive reclamation program at the quarry site. In the progressive reclamation process only the area needed for quarry expansion in any one year would be grubbed. The subsoil, topsoil and root mat of this area would be placed in a portion of the pit that is no longer in use. Overburden will be stockpiled for use in future reclamation.

Hydroseeding stockpiles, as conducted for current operations, will be an acceptable alternative to utilizing root mats in future activities. This approach would provide a source of native plant species well adapted to local soil and climatic conditions and would greatly reduce the need to fertilize the reclaimed pit. If it is necessary to seed reclaimed areas where grubblings have not produced sufficient plant biomass to stabilize soils, wherever practical, native plants should be used for site reclamation. In lieu of native species, seed mixes containing naturalized species which are well established in Nova Scotia and which are not aggressive weeds in the plant communities which are present in the area should be used for reclamation.

The rehabilitation process at the quarry began during initial site development with the preservation of overburden for future rehabilitation of the quarry. As distinct areas within the quarry become inactive, the area will be graded to a stable slope (2:1), covered with overburden, and seeded in the absence of laying a root mat. At the end of the quarry operation (within six months of abandonment), rehabilitation will consist of: grading and contouring of all slopes and exposed rock faces in consideration of rock falls, slope stability, and safety; spreading existing stockpiled topsoil; and hydroseeding in the absence of laying a root mat. The laydown area within the quarry, which is covered with quarried materials, will be graded, as required, and leveled to allow for future commercial, industrial, recreational, or residential land use, or to allow for restoration of the area for wildlife habitat. All areas affected by quarry activities including the setting ponds and quarry floor will be rehabilitated. A reclamation plan will be developed for the expanded site and submitted to NSEL as part of the quarry development plan, to be included in the Industrial Approval amendment application. The reclamation plan will include information on such things as the proposed final topography, maximum slopes, revegetation plans and an outline of the plan for progressive reclamation at the site.

3.0 SCOPE

3.1 Scope of the Undertaking

The proposed Project, as described in Section 2.0, consists of expansion of the existing quarry footprint to allow for continued quarry development and additional stockpiling. The following is a description of the spatial and temporal boundaries of the proposed Project to be considered in the assessment.

The quarry opened in 2001 and produces a variety of quartzite aggregate types. The working face is approximately 20 m (66 ft) in height and does not go below the natural groundwater table (*i.e.*, the quarry floor is not under the groundwater table and has not flooded since the quarry opened). The Proponent will continue to excavate from the existing working face.

The facilities and infrastructure associated with the existing quarry include: an access road and gate; various aggregate stockpiles; topsoil and overburden stockpiles; the quarry floor/laydown area (for portable crushing equipment); a scale and scale house; the working face; and a settling pond. Additional facilities and infrastructure associated with the proposed expansion will likely include additional flow retention structures.

Expansion of the quarry will be initiated following approval from NSEL, as the existing developed area becomes depleted of aggregates. The proposed expansion area will cover a total of approximately 6 ha. Setback distances described in the Pit and Quarry Guidelines will be adhered to.

The proposed operating schedule will be based on 15 hrs/day, 7 days/week, year-round and weather permitting. Blasting of aggregate is expected to occur two to four times a year. The current and anticipated production rate is approximately 60,000 tonnes per year. Transport of aggregates from the quarry is via tandem and tractor trailer trucks to local markets. The average number of trucks leaving the quarry is 2,000 per year (although this fluctuates depending on market demand) and this number is expected to remain unchanged following the expansion.

MEL will undertake progressive reclamation activities at the quarry. Refer to Section 2.7 for additional information related to decommissioning and abandonment activities

3.2 Purpose and Need for the Undertaking

The purpose for the Project is to allow MEL to expand the existing quarry footprint and continue operations at their quarry on Panuke Road. The quarry is currently operating under DOE No. 2006-019700-A01, issued by NSEL and effective on March 12, 2002. This permit is for a quarry operation on property parcel 45270493. A copy of the NSEL Approval is included in Appendix A.

The aggregates produced at the quarry are an important requirement in construction projects in the region and are of an appropriate quality for highway construction and maintenance projects. The Proponent anticipates the source material in the proposed expansion area to be of similar quality to the material currently extracted at the existing quarry.

The quarry under consideration as well as other quarries in Nova Scotia are an important component of the natural resource sector of the economy and provide essential raw materials to the province's

construction industry. The quarry also provides direct and indirect employment for its workers and suppliers, as well as for the transportation and construction industries.

3.3 Project Alternatives

Other methods for carrying out the undertaking may include different methods of extraction of the resource and alternative facility locations. The current method of aggregate extraction at the Panuke Quarry is drilling and blasting. Alternative methods for extraction of the rock (*i.e.* mechanical means) are not practical or feasible in this instance due to the nature and characteristics of the rock (*e.g.*, hard and dense). Therefore, there are no feasible alternatives to drilling and blasting as a means of extracting this material.

An alternative facility location is also not a feasible alternative. The expansion is occurring in an area that has been previously disturbed and is already exposed to mining/quarrying activities. Expansion of the quarry will not require immediate construction of any new facilities (*i.e.*, roads or buildings), as the existing facilities are at present sufficient for the current and expanded operations. Additional flow retention structures will be installed/constructed as the quarry develops to accommodate the additional surface runoff and quarry drainage. Relocation of the quarry to another location may likely require development of a new site, construction of new facilities, and would potentially have greater effect on the surrounding biophysical and socio-economic environment.

3.4 Scope of the Environmental Assessment

The proposed Project must be registered for Environmental Assessment under the Environmental Assessment Regulations of the Nova Scotia *Environment Act* as a Class I Undertaking. This report fulfils the primary requirements for project registration under this legislation.

Other relevant provincial regulations and guidelines include the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act* (1996) and the Nova Scotia Pit and Quarry Guidelines (NSEL 1999). Relevant federal legislation and policies include the *Species at Risk Act*, *Migratory Birds Convention Act*, A Wildlife Policy for Canada, the Federal Water Policy, the Toxic Substances Management Policy, and the federal strategy for pollution prevention.

The scope of the environmental assessment in relation to the proposed Project has been determined by the Proponent and their consultant and is based upon the proposed Project elements and activities, the professional judgment and expert knowledge of the study team, consultations with the public and regulatory authorities on this and similar projects, and the results of field studies conducted in support of this environmental assessment. The Guide to Preparing an EA Registration Document for Pit and Quarry Developments in Nova Scotia (NSEL 2002) was also used to determine/focus the scope of the assessment. The Proponent and their consultant met with NSEL on October 3, 2007 to discuss the location of proposed expansion, and elements and activities associated with the proposed Project, in an effort to further focus the scope of the assessment. Landowners adjacent to the quarry were also contacted (see Section 4.0) for the purpose of issues identification.

This environmental assessment evaluates the potential environmental effects of the proposed Project elements and activities, for all Project phases, with regard to each Valued Environmental Component (VEC) and Valued Socio-economic Component (VSC). By assessing potential impacts on VECs/VSCs

within the study boundaries, a meaningful evaluation of project effects on relevant environmental aspects is achieved. The following VECs/VSCs were identified based on government guidance, consultation and professional judgment of the study team noted above:

- fish habitat;
- rare and sensitive flora;
- wildlife;
- groundwater;
- archaeological and heritage resources;
- air quality; and
- socio-economic environment.

4.0 PUBLIC INVOLVEMENT

4.1 Methods of Involvement

In October 2007, a Project Information Bulletin (Appendix C) was distributed to landowners within approximately 3 km of the quarry. Approximately 120 bulletins were delivered door-to-door. The purpose of the bulletin was to advise local residents and businesses immediately adjacent to the quarry (*i.e.*, those who are potentially most affected) of the proposed expansion and provide them with an opportunity to comment on the proposed undertaking. No letters or emails were received; one phone call was received as indicated in Table 4.1.

A letter was posted on October 10, 2007 to the Confederacy of Mainland Mi'kmaq, the Annapolis Valley First Nation, the Glooscap First Nation and the Shubenacadie First Nation (Appendix C), to encourage the submission of comments, concerns and questions regarding the Project. No submissions were received in response to the letters, and on November 14, 2007, phone calls were made to follow-up on these letter requests. To date, no comments have been received from First Nations Communities.

A letter was sent on October 12, 2007 to Chuck Porter, the MLA for Hants West (Appendix C), to encourage the submission of comments, concerns and questions regarding the Project. No submissions were received in response to this letter. This consultation effort assists with issues scoping and development of appropriate mitigation for potential adverse effects.

4.2 Stakeholder Comments and Steps Taken to Address Issues

One comment has been received to date. Table 4.1 summarizes the issues and the Proponent's response/proposed resolution.

TABLE 4.1 Summary of Stakeholder Comments and Concerns

Stakeholder	Issue/Concern	Response/Proposed Resolution
Local Resident	<ol style="list-style-type: none"> 1. Identified a watercourse not shown on mapping (Mill Lake Brook), as well as a new house that may not appear. 2. Concerned with effects of pollution from temporary asphalt facilities and blasting within 800 m of homes. 3. Concerned with effects on watershed area, lack of shoulders on highway and level of truck traffic. 	<ol style="list-style-type: none"> 1. Field work was conducted to assess the on site stream which does not show upon Provincial mapping layers. Ground truthing determined that the "new house" is not within 800 m of the proposed expansion area. 2. The expansion area proposed allows for quarrying to continue in the exact opposite direction of the residence from the existing quarry operation. 3. Both traffic and hydrology studies have been completed in support of this EA and are considered as VEC's within this report (refer to Section 5.0). The Proponent is proposing to operate the facility with existing guidelines and any conditions of approval.

5.0 VALUED ENVIRONMENTAL/SOCIO-ECONOMIC COMPONENTS (VEC/VSC) AND EFFECTS MANAGEMENT

5.1 Methodology

Field studies were conducted by Jacques Whitford between July 7 and August 8, 2006, and again between June 20 and August 18, 2007, to investigate and establish the existing conditions and to determine appropriate mitigation, if necessary, to minimize environmental effects from the proposed expansion Project. These surveys consisted of: vegetation surveys; survey to identify existing wetlands (none were observed); breeding bird survey; mammal survey; and herpetile survey. These surveys were undertaken by qualified terrestrial ecologists employed by Jacques Whitford. An assessment of potential archaeological and heritage resources was undertaken by a qualified archaeologist. A reconnaissance survey of road conditions was carried out by a qualified transportation engineer. A water well “windshield” survey was conducted by a Jacques Whitford hydrogeologist on November 5, 2007. For this type of survey, information is collected regarding the locations of water wells by driving through the intended area (within 800 m of the proposed expansion site) and viewing these wells from an automobile. Additional information, in support of the field studies and the assessment, was gathered through a review of: air photos; site mapping; and other information sources, such as the Nova Scotia Museum, Statistics Canada, the Nova Scotia Department of Transportation and Infrastructure Renewal, and the Nova Scotia Department of Natural Resources.

Temporal and spatial boundaries encompass those periods and areas within which the VECs and VSCs are likely to interact with, or be influenced by, the Project. Both the temporal and spatial boundaries for the assessment vary according to the VEC/VSC. Temporal boundaries are generally limited to the duration of, and for a period of time after, the Project activities. Spatial boundaries are generally limited to the immediate project area unless otherwise noted.

To assess the potential environmental effects of a project and determine the significance of an effect, it is important to consider the magnitude, frequency, duration, geographical extent and reversibility of the potential effect. The study team has considered these elements for each VEC/VSC.

5.2 Fish Habitat

5.2.1 Description of Existing Conditions

Fieldwork was conducted on September 20, 2006 by two Jacques Whitford aquatic scientists to describe the fish habitat present within the Project boundaries. Habitat was described along one partially subterranean stream which did not appear on provincial mapping databases but was identified on site by JW field biologists (Figure 5.1). The stream is a tributary to the St. Croix River. Assessment of aquatic habitat consisted of identifying physical units (*i.e.*, riffles, pools, and runs), in-stream cover, substrate composition, stream depth and width, overhead cover, water colouration, and existing anthropogenic impacts on the stream. The presence of fish, aquatic invertebrates, amphibians and wildlife using the riparian zone of the stream were noted. No electro-fishing was conducted during this survey as DFO regulations prohibit electro-fishing in the St. Croix River and its tributaries. Photographs were taken along the streams to document habitat.

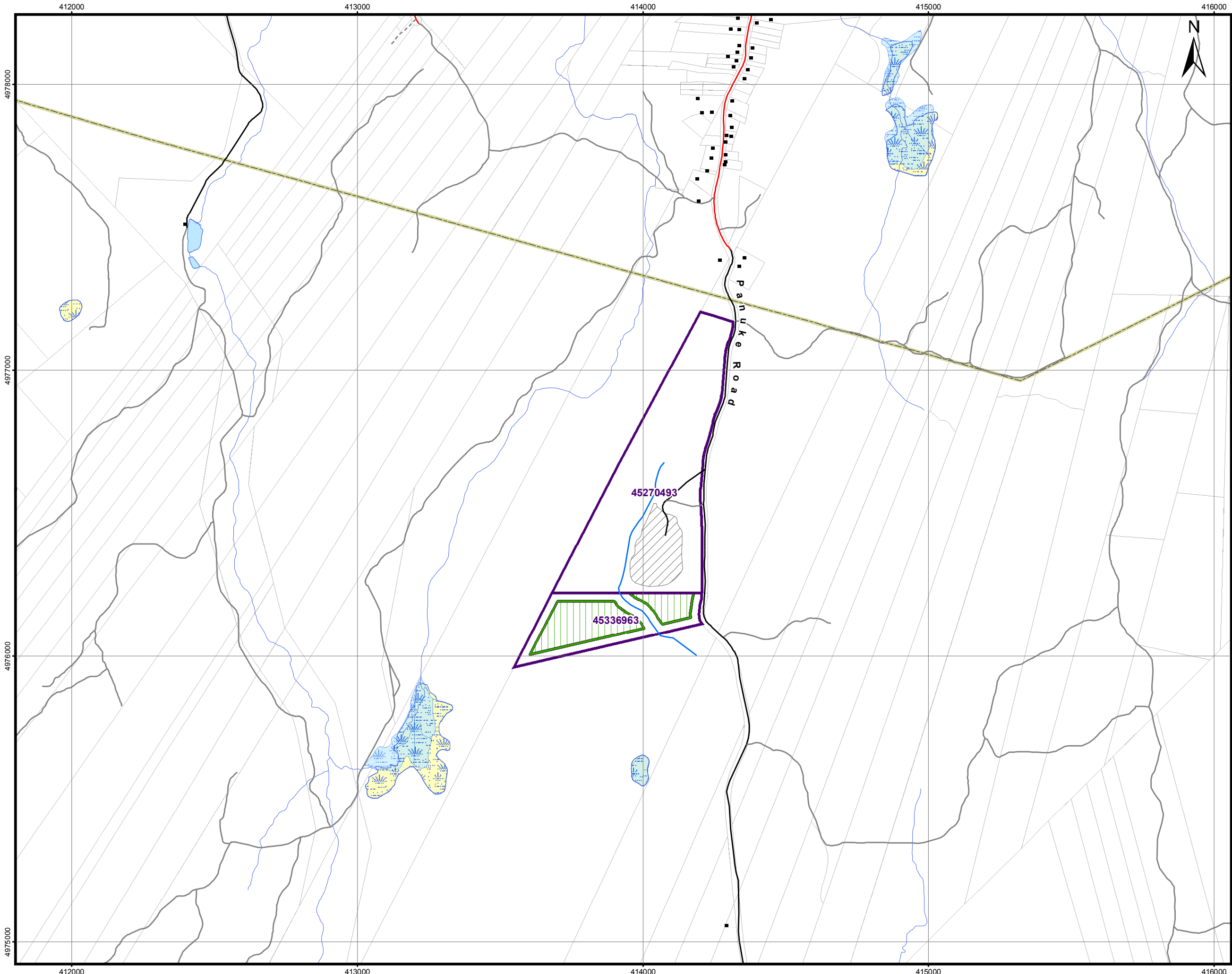
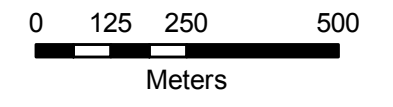


Figure 5.1
Wetlands & Surface Water
Panuke Road Quarry Project

Map Features

- Building
- Local
- Seasonal/Unpaved
- Track/Trail
- - - Driveway
- + Railway
- Transmission Line
- Watercourse
- Existing Quarry
- Quarry Properties
- Proposed Expansion Area
- Property Boundary
- Waterbody
- NS 10K Wetlands
- NSDNR Wetlands



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:12,500
 Date: February 06th, 2008
 Project No.: 1014939.



Several locations along the partially subterranean stream were identified as fish habitat. Generally, the water clarity was good, with no signs of turbidity due to silt run-off. Sections along the perimeter of the existing quarry are protected by silt fences. The stream bed was completely dry in many places on the day of the survey leaving isolated pools along several stretches. Where water was present, the flow conditions were extremely low, but the stream did support abundant aquatic life, including unidentified fish species, amphibians and invertebrates. The water appeared well oxygenated despite the limited flow rates. Some shallow sediment was found to be anoxic due to anaerobic microbial respiration; however, this represents natural conditions for organic laden sediments that were found in the stream. Depth of the stream varied between 10 to 50 cm, with velocities ranging from <0.1 to 0.2 m/s. The wet width varied from 1 to 5 m and the bank heights varied from 0 to 45 cm. The bottom substrate consisted of angular boulders, cobbles, gravel, and shallow silty sediments mixed with detritus. A detailed description of specific sites surveyed along the stream is included in Appendix D.

The Inner Bay of Fundy populations of Atlantic salmon (including the St. Croix River) are listed as endangered on Schedule 1 of the federal *Species at Risk Act (SARA)*. It is unlikely that salmon occur in the on site stream given its small size and paucity of suitable spawning habitat (*i.e.*, well aerated gravel beds).

5.2.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

Fisheries and Oceans Canada (DFO) has developed the *Policy for the Management of Fish Habitat* (1986), which applies to all development and industrial projects, both large and small, in or near watercourses that could alter, disrupt, or destroy fish habitat by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. As specified in Nova Scotia Pit and Quarry Guidelines, no active areas will be located within 30 m of the banks of all streams identified on the property and natural vegetation will be maintained within this buffer. No Project-related vehicles will be driven through streams.

Clearing, grubbing, and topsoil stripping activities can increase the potential for sediment erosion and deposition downgradient, particularly during periods of heavy rainfall or snow melt. These activities will also result in a reduction of evapotranspiration and a corresponding increase in surface runoff, which in turn increases potential for sediment erosion and deposition. The concern with this Project is the potential sedimentation effects on fish habitat present in the on site stream.

The placement of free-draining material (*i.e.*, blasted rock) over disturbed areas and the use of properly sized flow retention structures are expected to mitigate erosion and sedimentation effects. As the quarry develops, exposed soil capable of producing sediment laden-runoff will be stabilized with blasted rock and stockpiles of topsoil and overburden will be stabilized with hydroseed or root mat. Additional retention capacity on the quarry floor will be created as the quarry develops and additional settling pond volume will be installed, as needed. A stormwater management plan will be submitted as part of the quarry development plan during the Industrial Approval amendment application process.

Surface runoff will be directed to the settling pond. Overflow from the final settling pond, in the event of significant rainfall, will be monitored and sampled in accordance with the terms and conditions of the existing Approval (and future updates) and the Pit and Quarry Guidelines to ensure suspended solids levels do not exceed the approved final effluent discharge limits. Details on proposed discharge

locations and outlet structures will be submitted as part of the quarry development plan during the Industrial Approval amendment application process.

A phased approach to development of the quarry will allow for an adaptive approach to monitoring and management of potential effects to surface water and groundwater resources which in turn may affect fish habitat. Linking site expansion to environmental effects management performance criteria is an effective mitigation strategy to deal with uncertainties and ensure sustainable development.

Based on the results of the fish and fish habitat assessment and the mitigation proposed, there is very low potential for quarry activities to interact with fish and fish habitat and significant Project-related effects on fish and fish habitat are not likely to occur.

5.3 Rare and Sensitive Flora

5.3.1 Description of Existing Conditions

The site was surveyed for vascular plants by a senior terrestrial ecologist (Mr. Michael Crowell) on July 7 and August 8, 2006; and June 20 and August 18, 2007. The study area varied between 2006 and 2007. In 2006, the study area consisted of the proposed quarry expansion area as well as an area of forest habitat extending approximately 200 m north of the proposed quarry expansion area. In 2007 only the proposed quarry expansion area was surveyed. The proposed expansion area supports three habitat types including mature second growth hardwood forest, clear-cut and disturbed area. Figure 5.2 shows the distribution of these habitats in the study area.

The area immediately south of the existing pit has been harvested and grubbed and is now largely devoid of vegetation. Vegetation consists of scattered patches of tree and shrub seedlings and ruderal forbs. Some of the more abundant species include paper birch (*Betula papyrifera*), pin cherry (*Prunus pensylvanica*), bristly sarsaparilla (*Aralia hispida*), and pearly everlasting (*Anaphalis margaritacea*). The central portion of the quarry expansion area located southwest of the existing pit is located on a relatively steep slope that is covered by mature second growth hardwood forest approximately 60 years old. This stand is dominated by yellow birch (*Betula alleghaniensis*), paper birch, red maple (*Acer rubrum*), and sugar maple (*Acer sacharrum*). The shrub understory is composed mainly of saplings of striped maple (*Acer pensylvanicum*) and balsam fir (*Abies balsamea*). Common ground vegetation species include wild sarsaparilla (*Aralia nudicaulis*), Christmas fern (*Polystichium acrostichoides*), New York fern (*Thelypteris noveboracensis*), Clinton lily (*Clintonia borealis*), marginal wood-fern (*Dryopteris marginalis*), and wild lily-of-the-valley (*Maianthemum canadense*). The western end of the property has been recently harvested. In 2007, this area supported a sparse cover of tree seedlings and stump sprouts as well as a variety of forest ground vegetation species.

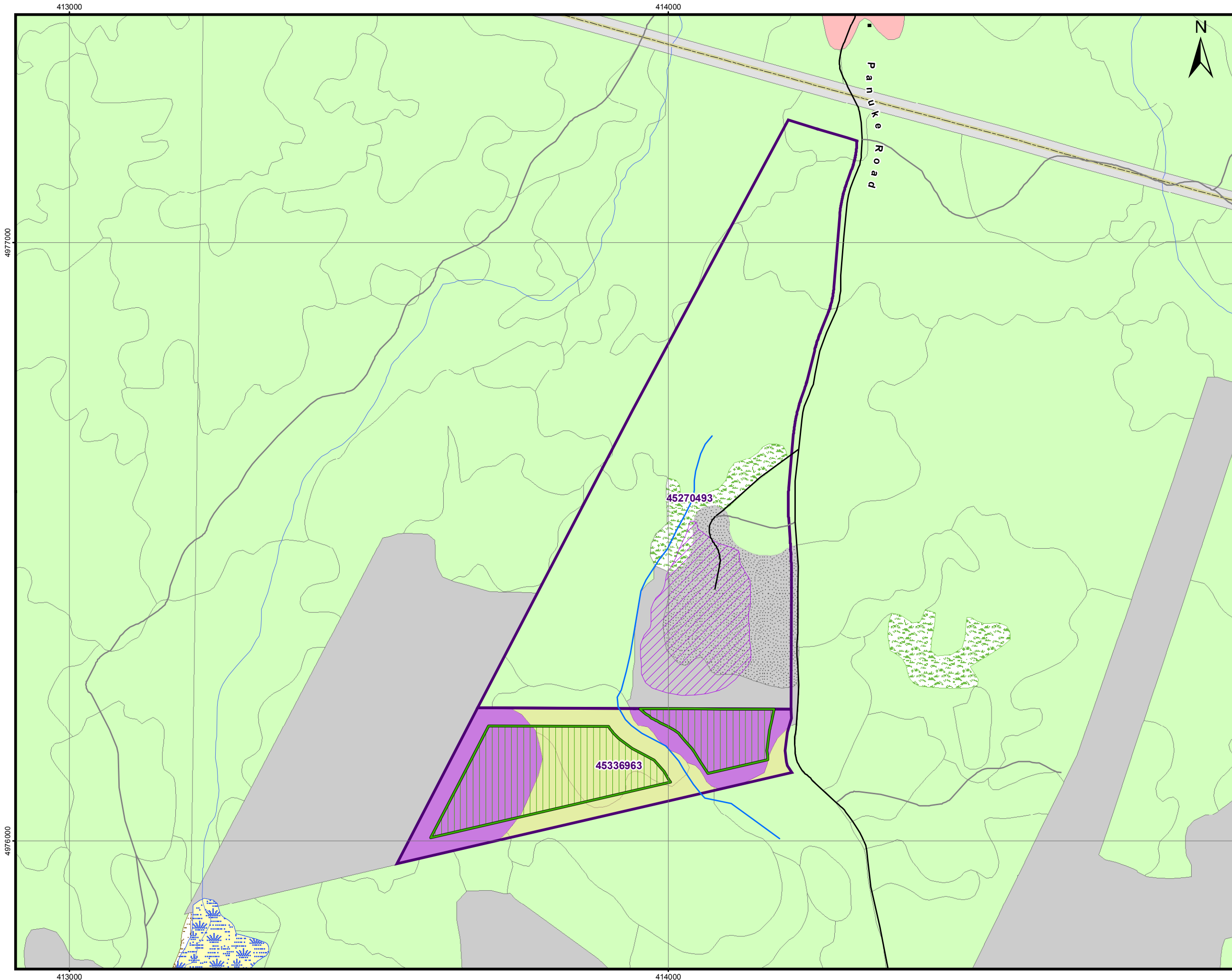


Figure 5.2
Terrestrial Habitat
in the Study Area

Panuke Road
Quarry Project

Map Features

- Building
- Local
- Seasonal/Unpaved
- Track/Trail
- - - Driveway
- + + + Railway
- Transmission Line
- Watercourse
- Waterbody
- NSDTB Wetland

- Existing Quarry
- Quarry Properties
- Proposed Expansion Area

Habitat Within Expansion Area

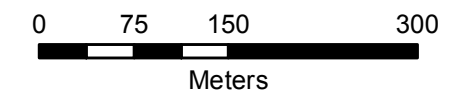
Area Hectares

- Natural Forest Stand (4.58 Ha)
- Clear Cut (5.67 Ha)

Forest Habitat

Classification

- Natural Forest Stand
- Clear Cut
- Partial Depletion
- Treed Bog
- Urban
- Gravel Pit
- Corridor



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:12,500
 Date: February 6th, 2008
 Project No.: 1014939.



Rare Vascular Plants

A rare plant modeling exercise was performed to determine the likelihood of presence of rare or sensitive plants within the Project area. As part of the modelling exercise, all records of vascular plant species listed by the Nova Scotia Department of Natural Resources (NSDNR) as risk (Red listed) or sensitive to human activities or natural events (Yellow listed) (NSDNR 2007) within a radius of 100 km were compiled by means of an Atlantic Canada Conservation Data Center (ACCDC) data search. The habitat requirements of these species were compared to the habitat descriptions compiled for the Project area to determine if suitable habitat was present for these species. In instances where appropriate habitat was present for a particular species, that species was considered to be potentially present and the suitable habitat in the Project area was identified as a target for field surveys. The phenology and ease of identification of each of the species potentially present in the Project Area was also incorporated into the model in order to determine the best times to conduct the field surveys.

A total of 192 Red or Yellow-listed vascular plant species have been recorded within 100 km of the Project area. Based on the results of the habitat model, 18 Red or Yellow-listed species could potentially be present in the Project area. Table 5.1 lists these species and the habitats present in the Project area where they could potentially be found.

TABLE 5.1 ACCDC Vascular Plants Potentially Found in Project Area

Binomial	Common Name	NSDNR Rank	Preferred Habitat	SARA Rank	ACCDC Rank
<i>Carex hystricina</i>	Porcupine Sedge	Red	Swamps, swales and along brooks	Not listed	S1S2
<i>Conopholis americana</i>	Squaw-root	Red	Associated with oaks and other deciduous trees	Not listed	S1S2
<i>Desmodium canadense</i>	Showy tick-trefoil	Red	Open woods, thickets and river banks	Not Listed	S1
<i>Hepatica nobilis</i>	Round-lobe Hepatica	Red	Dry, usually mixed deciduous forest	Not listed	S1
<i>Osmorhiza depauperata</i>	Blunt-fruited sweet cicely	Red	Moist woods and clearings	Not listed	S1
<i>Solidago hispida</i>	Hairy goldenrod	Red	Woods and forest edges	Not listed	S1?
<i>Botrychium lanceolatum</i>	Triangle grape-fern	Yellow	Rich, wooded hillsides	Not Listed	S2
<i>Botrychium simplex</i>	Least Grape-fern	Yellow	Usually on lakeshores or the mossy edges of streams or waterfalls although it has been reported in a wide variety of habitats	Not listed	S2S3
<i>Cardamine parviflora</i>	Small-flower bitter-cress	Yellow	Dry woods, shaded or exposed ledges, and in sandy soils	Not listed	S2
<i>Carex houghtoniana</i>	A sedge	Yellow	Sandy soils and roadside banks	Not listed	S2?
<i>Carex tenera</i>	Slender sedge	Yellow	Meadows, woodlands, and moist, dry openings	Not listed	S1S2
<i>Floerkea proserpinacoides</i>	False mermaid-weed	Yellow	Deciduous ravine slopes, river margins, and intervale forests	Not listed	S2S3
<i>Hieracium robinsonii</i>	Robinson's hawkweed	Yellow	Rock crevices and cliffs, cobble shores, and along streams	Not listed	S2

TABLE 5.1 ACCDC Vascular Plants Potentially Found in Project Area

Binomial	Common Name	NSDNR Rank	Preferred Habitat	SARA Rank	ACCDC Rank
<i>Platanthera macrophylla</i>	Large round-leaved orchid	Yellow	Rich old deciduous and mixed woods	Not listed	S2
<i>Salix sericea</i>	Silky Willow	Yellow	Low thickets and stream banks	Not listed	S2
<i>Symphyotrichum boreale</i>	Boreal American-aster	Yellow	Gravelly soil of lake beaches, along streams and the edges of bogs	Not listed	S2?
<i>Symphyotrichum ciliolatum</i>	Lindley's aster	Yellow	Open fields, lawns and the edges of thickets	Not listed	S2S3
<i>Viola nephrophylla</i>	Northern Bog Violet	Yellow	Cool mossy bogs, the borders of streams, and damp woods	Not listed	S2
Atlantic Canada Conservation Data Centre Species Rank Definitions					
S1	Extremely rare throughout its range in the province (typically 5 or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation.				
S2	Rare throughout its range in the province (6 to 20 occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors.				
S3	Uncommon throughout its range in the province, or found only in a restricted range, even if abundant at some locations. (21 to 100 occurrences).				
S#S#	Numeric range rank: A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2)				
S#?	Inexact or uncertain ranking.				
Nova Scotia Department of Natural Resources General Status Ranks					
Red	Known to be or thought to be at risk.				
Yellow	Sensitive to human activities or natural events.				
Source: ACCDC 2007; NSDNR 2007					

The results of the habitat modeling exercise indicate that all habitat types present in the Project area could potentially harbour rare species that have been recorded within a 100 km radius of the Project area. As such, during the field surveys, all habitat types present in the study area were surveyed. The model results suggest that surveys should be conducted in April, May, June and August to detect all of the 18 species identified by the model as potentially present during the period when they are in flower. Flowering specimens are often required for vascular plant identification, particularly by inexperienced botanists. The Project area was visited by an experienced botanist on July 7 and August 8, 2006 and June 20 and August 18, 2007. One of the 18 species that could potentially be present, silky willow (*Salix sericea*), flowers between late March and early May. It was not possible to conduct a site visit early enough to detect this species in flower. Fortunately, this species is quite distinctive, having narrowly elliptic leaves with dense silvery hairs on the undersides of the leaves. No willows having these characteristics were encountered in the Project area. An early May field survey would have been required to coincide with the flowering period for round-lobe hepatica (*Hepatica nobilis*). Fortunately, the foliage of this species is very distinctive and is present throughout the growing season and it can be readily identified outside its flowering period.

The results of the vegetation surveys conducted in the proposed quarry expansion area are presented in Appendix E. A total of 150 vascular plant species were recorded on the property. All species of vascular plant encountered during the surveys were identified and their population statuses in Nova Scotia were determined through a review of the species status reports prepared by NSDNR (NSDNR 2007), ACCDC (ACCDC 2007), and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007).

Two vascular plant species listed as rare or uncommon by ACCDC were recorded during the field survey including Hickey's clubmoss (*Lycopodium hickeyii*), and Hooker orchis (*Platanthera hookeri*). The Hooker orchis is listed as S3 by ACCDC indicating that the Nova Scotia population is uncommon. This species is considered by NSDNR to be secure in Nova Scotia (Green listed). A single large Hooker orchis was found near the southwestern corner of the quarry expansion area at the edge of the new clear-cut. This species was found at two other locations north of the quarry expansion area (Figure 5.3). This included a single plant located just north of the property and a group of seven plants located approximately 200 m north of the expansion area.

Hickey's clubmoss is listed as S2? indicating that it is believed to be rare but its population status is uncertain. NSDNR lists this species as status undetermined which also indicates that there is insufficient data to assess its population status in the province. The uncertainty regarding the status of this species largely derives from the fact that it was formerly a variety of tree clubmoss (*Lycopodium obscurum*) which is abundant in Nova Scotia. Until old herbarium specimens are reexamined and new specimens are collected, the status of this species will remain uncertain. It is our opinion that Hickey's clubmoss is more common than records would indicate. Within the past year Jacques Whitford botanists have encountered this species near Port Hawkesbury, Big Indian Lake and two locations near Cloverdale. They found another site near Enfield about five years ago. Hickey's clubmoss was found at three locations in the mature hardwood forest stand in the quarry expansion area (Figure 5.3). Seventeen Hickey's clubmoss shoots were found at the first location, five at the second location and seven at the third location.

5.3.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

Expansion of the quarry will result in the loss of all of the Hickey's clubmoss (29 plants at three locations) and Hooker orchis (one plant) found in the quarry expansion area. It is likely that more Hickey's clubmoss are present both inside and outside of the quarry expansion area; however, it is difficult to distinguish Hickey's clubmoss from treelike clubmoss (*Lycopodium dendroideum*) and tree clubmoss in the field. All three of these species were recorded in the quarry expansion area. Seven other large roundleaf orchids were found outside of quarry expansion area.

The Nova Scotia population of Hooker orchis is considered to be secure so the loss of one plant in the quarry expansion area is not expected to have a significant adverse effect on the local or regional population. The population status of Hickey's clubmoss is less well understood but given our experience with this species over the past few years it is unlikely that the plants present in the quarry expansion area represent a significant portion of the local or regional population. The loss of these plants is not expected to have a significant adverse effect on local or regional populations. Given the undetermined status of Hickey's clubmoss it is recommended that prior to expansion of the quarry a field survey be conducted to determine the distribution of this species both inside and outside of the quarry expansion area to determine whether or not the premise that this species is more widespread and abundant than existing records would indicate is true. Hickey's clubmoss is an evergreen species so this survey could be conducted at any time of the year so long as no snow cover is present. Other than this survey no other mitigation is recommended for this species at this time.




















Figure 5.3
Locations of
Uncommon &
Rare Plant
Species in and
Near the Quarry
Expansion Area

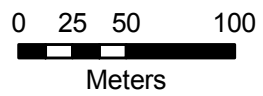
Panuke Road
Quarry Project

Map Features

Uncommon & Rare Plant Locations

Plant Species

-  *Lycopodium hickeyi*
-  *Platanthera hookeri*
-  Building
-  Local
-  Seasonal/Unpaved
-  Track/Trail
-  Driveway
-  Railway
-  Woods Road
-  Transmission Line
-  Watercourse
-  Waterbody
-  NSDTB Wetland
-  Existing Quarry
-  Quarry Properties
-  Proposed Expansion Area
-  Clear Cut



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:3,000
 Date: November 16th, 2007
 Project No.: 1014939.



Other mitigation employed in the expansion of the quarry will include the use of progressive reclamation and the use of native plant species wherever possible in the reclamation process. In the progressive reclamation process only the area needed for quarry expansion in any one year would be grubbed. The subsoil, topsoil and root mat of this area would be placed in a portion of the pit that is no longer in use. Topsoil and root mat would be stockpiled temporarily (no more than one year) until the subsoil was placed. The topsoil would then be placed over the subsoil and dressed with the root mat. The root mat would provide a source of native plant species propagules in the form of buried seeds, roots, shoots and rhizomes as well as soil micro-organisms, however, hydroseeding stockpiles is an acceptable alternative to utilizing root mats. This approach would provide a source of native plant species well adapted to local soil and climatic conditions and would greatly reduce the need to fertilize the reclaimed pit. If it is necessary to seed reclaimed areas where grubblings have not produced sufficient plant biomass to stabilize soils, wherever practical, native plants should be used for site reclamation. In lieu of native species, seed mixes containing naturalized species which are well established in Nova Scotia and which are not aggressive weeds in the plant communities which are present in the area should be used for reclamation.

In summary, significant Project-related effects on rare or uncommon flora are not likely to occur provided mitigative measures are employed.

5.4 Wildlife

5.4.1 Description of Existing Conditions

Information regarding use of the study area by wildlife was derived from several sources including field surveys and reviews of existing data sources. Field surveys were conducted on four occasions (July 7 and August 8, 2006; and June 20 and August 18, 2007) by a senior terrestrial ecologist (Mr. Michael Crowell). During these surveys, information was collected regarding the presence of birds, mammals and herpetiles (amphibians and reptiles). Existing sources of data were also consulted. An ACCDC data search was conducted to determine if any rare or sensitive wildlife species have been recorded in the vicinity of the study area. The ACCDC data were also incorporated into a wildlife model to determine the likelihood of the presence of rare or sensitive wildlife species within the Project area. As part of the modelling exercise, all records of wildlife species listed by the NSDNR as at risk (Red listed) or sensitive to human activities or natural events ("Yellow" listed) (NSDNR 2007) within a radius of 100 km were compiled. The habitat requirements of these species were compared to the habitat descriptions compiled for the Project Area to determine if suitable habitat was present for these species. In instances where appropriate habitat was present for a particular species, that species was considered to be potentially present and the suitable habitat in the Project area was identified as a target for field surveys.

Reference sources such as the Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992) and Amphibians and Reptiles of Nova Scotia (Gilhen 1984) were also consulted to provide records of wildlife in the vicinity of the study area.

Birds

Breeding bird surveys were conducted at the site on July 7, 2006 and June 20, 2007. Additional bird observations were recorded during the vegetation surveys conducted on August 8, 2006 and August 18, 2007. The surveys were conducted between the hours of 06:00 and 12:00. During the surveys representative habitats on the property were visited by a birder with 20 years experience and all birds heard or observed were recorded. Examples of all habitat types present in the study area were surveyed. The breeding status of each species recorded was determined using the methodology employed by the Atlas of Breeding Birds of the Maritimes program (Erskine 1992). Species identified but not exhibiting signs of breeding (such as flyovers) were classified as non-breeders. Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were classed as probable breeders:

- courtship behaviour between a male and female;
- birds visiting a probable nesting site;
- birds displaying agitated behaviour; and
- male and female observed together in suitable nesting habitat.

Species were confirmed as breeding if any of the following items or activities were observed:

- nest building or adults carrying nesting material;
- distraction display or injury feigning;
- recently fledged young;
- occupied nest located; and
- adult observed carrying food or faecal sac for young.

The population status of each species was determined from existing literature. Lists of provincially rare or sensitive birds were derived from the General Status of Wildlife in Nova Scotia (NSDNR 2007) and Species at Risk in Nova Scotia (NSDNR 2007) while nationally rare species were derived from COSEWIC (2007) and the *Species at Risk Act (SARA 2007)*.

Two breeding bird surveys were conducted on or in the vicinity of the quarry expansion area in 2006 and 2007. The 2006 survey incorporated the proposed quarry expansion area but also included property to the north of the proposed quarry expansion area. The 2007 breeding bird survey was conducted within the quarry expansion area. Lists of bird species recorded during the two surveys are presented in Tables F1a and F1b, Appendix F. A total of 107 birds representing 32 species were recorded during the 2006 breeding bird survey and a total of 67 birds representing 26 species were recorded during the 2007 breeding bird survey. In 2006, the most abundant species in descending order of abundance were Ovenbird (18.7% of all birds recorded), Black-capped Chickadee (9.3%), Black-throated Green Warbler (8.4%), and Red-eyed Vireo (6.7%). Together these species accounted for 43% of the total number of birds recorded during the survey. The study area for this survey included a substantial amount of mature mixedwood forest located north of the quarry expansion area which accounted for the abundance of Black-throated Green Warblers. In 2006, two species were confirmed as breeding on the site, eight were listed as probable breeders, 19 were listed as possible breeders, and no evidence of breeding activities were found for three species.

In 2007, the most abundant species in descending order of abundance were Red-eyed Vireo (11.9% of all birds recorded), Ovenbird (10.4%), Northern Parula Warbler (9.0%), and American Robin (9.0%). Together these species accounted for 40% of the total number of birds recorded during the survey. This study area consisted largely of mature hardwood forest. Clear-cut habitat was also abundant but supported few birds. In 2007, two species were confirmed as breeding on the site, eight were listed as probable breeders, and 16 were listed as possible breeders.

None of the bird species recorded during the breeding bird surveys is considered to be rare or uncommon in Nova Scotia by the ACCDC (2007). Two of the species recorded during the breeding bird surveys are listed by NSDNR as sensitive to human activities or natural events (Yellow listed). These included Common Nighthawk and Canada Warbler. Common Nighthawk has also recently been declared a threatened species under the *Nova Scotia Endangered Species Act*. All other species recorded during the breeding bird survey are considered to be secure in Nova Scotia by NSDNR.

Common Nighthawks nest on the ground usually in cut-over and burned forests or on the flat roofs of buildings in urban areas (Erskine 1992). This species has undergone moderate population declines particularly among the urban nesting populations. During the 2007 breeding bird survey, one Common Nighthawk was flushed from the new clear-cut on the western side of the quarry expansion area. No nest was found and no evidence of nesting other than the presence of a Common Nighthawk in suitable nesting habitat was recorded. Given this evidence, it was classed as a possible nester.

Canada Warblers are usually found in dense understory vegetation of wet mature to mid-age hardwood and mixed forests, and are most closely associated with broad-leafed trees and shrubs, usually with conifers present as well (Erskine 1992). This species has undergone significant population declines although it is still fairly common in Nova Scotia. This species has also been recently added to the list of bird species considered by NSDNR to be sensitive to human activities or natural events. In 2006, one Canada Warbler was recorded approximately 200 m north of the quarry expansion area in mature mixedwood forest. This bird was heard singing in suitable nesting habitat and was classed as a possible nester.

The Canadian Wildlife Service has identified a number of priority species for the bird conservation region in which the study area is found (Bird Conservation Region 14). These priority species have been identified as species for which conservation initiatives are recommended. These include both rare and common species. Some of the common species are undergoing population declines and other common species have stable or increasing populations but have a large proportion of their global population located within a particular physiographic region and are therefore vulnerable to large scale land use changes within that physiographic area. Eight very high or high priority species were recorded in the study area during the breeding bird survey including Common Nighthawk, Eastern Wood Pewee, Pileated Woodpecker, Brown Creeper, Northern Parula Warbler, Canada Warbler, Blackburnian Warbler, and Black-throated Blue Warbler. Information regarding the distribution and abundance of six of these species in the study area are provided. Common Nighthawk and Canada Warbler have been discussed earlier.

Eastern Wood Pewees prefer to nest near gaps and edges in hardwood forest (Erskine 1992). This species has undergone significant declines but is still fairly common in Nova Scotia. One Eastern Wood Pewee was heard singing in mature hardwood habitat in the study area during the 2006 breeding bird survey approximately 100 m north of the quarry expansion area. None were detected in the quarry expansion area during the 2007 breeding bird survey.

Pileated Woodpeckers nest in mature hardwood and mixedwood stands containing trees large enough to provide nesting cavities. This species has increased in abundance in recent years but there is concern regarding the availability of large nest trees. The distinctive oval workings of this species were noted on a tree in the quarry expansion area in 2007. Although no evidence of nesting was noted during the breeding bird surveys, suitable nesting habitat including large trees suitable for nest holes is present in the quarry expansion area.

Brown Creepers nest in mature coniferous and mixedwood forest. No population trends have been detected for this species in the Maritime Provinces; however, there is some concern regarding the availability of large nesting trees. Brown Creepers were recorded during both breeding bird surveys. One bird was detected in mature mixedwood forest habitat in 2006 and a second was recorded in mature hardwood forest in 2007. Suitable nesting habitat is present within the quarry expansion area.

Northern Parulas nest in mature conifer and mixedwood stands where *Usnea* lichens are present. They use these lichens to construct their nests (Erskine 1992). The Maritime population is currently stable or increasing; however, there is some concern regarding the future availability of mature conifer and mixedwood habitat. Five Northern Parulas were heard in mature mixedwood and mature hardwood forest during the 2006 breeding bird survey. Six were recorded in the same habitat types in 2007. The quarry expansion area provides relatively poor nesting habitat since the mature hardwood forest that occupies most of the quarry area produces little *Usnea* lichen in which nests can be constructed. Areas of mixedwood forest located to the north and south of the quarry expansion area provide better nesting habitat. The mature hardwood forest in the quarry expansion area may be used mainly as foraging habitat.

Blackburnian Warblers are most frequently encountered in mature conifer and mixedwood stands where spruce (*Picea* spp.) and/or eastern hemlock (*Tsuga canadensis*) are present. Although the abundance of this species has increased in the Maritime Provinces in recent years there is high regional concern. Blackburnian Warblers were recorded during both the 2006 and 2007 breeding bird surveys. Two were detected in 2006, one in mature hardwood forest and one in mature mixedwood forest. In 2007, one Blackburnian Warbler was recorded in mature hardwood forest. The mature hardwood forest found in the quarry expansion area would provide poor nesting habitat but may be used by foraging Blackburnian Warblers.

Black-throated Blue Warblers typically nest in mature hardwood forest with dense understory shrub cover. The Maritime Provinces population of this species is stable or possibly increasing; however, there is concern regarding loss of non-breeding habitat for Black-throated Blue Warbler. In addition, this species occurs in low densities and much of the breeding population of this species is focused in a relatively small portion of Northeastern North America. Four Black-throated Blue Warblers were recorded during the 2006 breeding bird survey in mature mixedwood and mature hardwood habitat. None were recorded during the 2007 breeding bird survey. Most of the Black-throated Blue Warblers were recorded in the area north of the quarry expansion area. This area had a relatively dense shrub understory that would provide suitable nesting habitat. The quarry expansion area was characterized by an open shrub understory that would provide poor Black-throated Blue Warbler nesting habitat.

Additional information regarding possible use of the area by bird species of concern was derived from a review of the Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992) as well as through an ACCDC data request. A total of 65 bird species have been recorded within the 10 km X 10 km breeding bird atlas square within which the study area is situated. These species along with their

breeding status in the square and their provincial population status are listed in Table F2 of Appendix F. Five of these species are considered to be rare, uncommon or sensitive in Nova Scotia by ACCDC, NSDNR or SARA including Boreal Chickadee, Canada Warbler, Barn Swallow, Common Loon, and Common Nighthawk. Both the Canada Warbler and the Common Nighthawk were encountered in the study area during the field surveys.

Boreal Chickadees are considered to be uncommon to fairly common by ACCDC and NSDNR lists the Nova Scotia population as Yellow. Boreal Chickadees nest in coniferous forest, particularly stands dominated by black spruce and balsam fir. No mature coniferous forest was present in the quarry expansion area. Boreal Chickadees will sometimes nest in mature mixedwood forest; however, none were recorded during the breeding bird survey or any of the other field surveys.

Common Loon is Yellow listed by NSDNR and is considered to be fairly common (S4) by ACCDC. Although relatively common, Common Loons are sensitive to various human activities including lead poisoning through ingestion of lead sinkers, flooding of nests by power boat wakes, loss of nesting habitat as a result of cottage and home construction, and disturbance of nesting loons by recreational activities. Common Loons nest on the shores of lakes. No suitable Common Loon nesting habitat is found near the proposed quarry expansion area.

Barn Swallows are listed as fairly common (S4) by ACCDC and are Yellow listed by NSDNR. Barn Swallows typically nest on or in buildings or other manmade structures that provide a dry nest site. Natural nesting sites such as overhanging cliffs and caves are only rarely used. Several small buildings are present in the existing quarry but none are present in the proposed quarry expansion area. No Barn Swallows were detected during either the 2006 or 2007 breeding bird surveys.

The ACCDC habitat model did not identify any rare or sensitive bird species as being potentially present in the study area.

Mammals

Information regarding the presence of rare mammals and sensitive mammal habitat within the study area was derived from field surveys and a review of the Nova Scotia significant habitat mapping data base (NSDNR 2006). Field surveys were conducted concurrently with vegetation and breeding bird surveys on July 7 and August 8, 2006; and June 20 and August 18, 2007. The field surveys provide a good indication of the presence of large mammal species in the study area. Knowledge of the distribution of small mammals in the study area is limited by their secretive nature. Fortunately, many small, rare mammals have very specific habitat requirements, which can be used to predict areas where they are likely to be found.

The quarry expansion study area is characterized by relatively low habitat diversity due to its small size. Approximately 56% of the study area has been disturbed in the recent past. This includes 20% that was cleared and grubbed around the margin of the existing quarry and 36% that has been clear-cut. The remaining 44% of the quarry expansion area is composed of mature second growth forest which consists mainly of mature hardwood forest with some mature mixedwood forest.

The surveys conducted in 2007 focussed on the quarry expansion area while the surveys conducted in 2006 looked at both the quarry expansion area and the area extending approximately 200 m north of the quarry expansion area. The species recorded in the study area are generally typical of woodland habitats. Species recorded during the field surveys included American Red Squirrel (*Tamiasciurus hudsonicus*), Eastern Chipmunk (*Tamias striatus*), Varying Hare (*Lepus americanus*), Coyote (*Canis latrans*), Bobcat (*Lynx rufus*), American Black Bear (*Ursus americanus*), Raccoon (*Procyon lotor*) and White-tailed Deer (*Odocoileus virginianus*).

A review of the NSDNR significant habitat mapping database (NSDNR 2006) did not reveal the presence of any rare or sensitive mammal species in the vicinity of the study area or critical habitat such as deer wintering areas. All of the habitats present in the study area are commonly encountered throughout the province and are unlikely to provide habitat for rare small mammal species.

The ACCDC habitat model identified one rare or sensitive mammal species, Hoary Bat (*Lasiurus cinereus*), as being potentially present in the study area. The Hoary Bat is a migratory species which is present in Nova Scotia during the summer and early fall. In General, the Hoary Bat is a solitary tree roosting bat. They are usually observed foraging in open areas in wooded habitat as well as in areas of human habitation where shade trees are present. No Hoary Bats were observed during the field surveys but this is not unexpected given the nocturnal nature of bats and the fact that Hoary Bats can be expected to be widely scattered throughout the landscape. There is a possibility that Hoary Bats could be present in the study area. However, the habitat within the study area is typical of much of Nova Scotia and it is unlikely that the study area provides critical habitat for this species.

Herpetiles

Information regarding amphibians and reptiles and their habitat within the study area was also derived during the field surveys. Field surveys were conducted concurrently with vegetation and breeding bird surveys conducted on July 7 and August 8, 2006; and June 20 and August 18, 2007.

Five herpetile species were encountered during the surveys: Wood Frog (*Rana sylvatica*), American Toad (*Bufo americanus*), Mink Frog (*Rana septentrionalis*), Northern Spring Peeper (*Pseudacris crucifer*), Northern Redbelly Snake (*Storeria occipitomaculata*), and Maritime Garter Snake (*Thamnophis sirtalis*). None of these species is considered to be uncommon, rare or sensitive in Nova Scotia by ACCDC (2007) or NSDNR (2007).

No rare herpetile species were identified by the wildlife model as potentially present in the study area.

5.4.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

One of the bird species found in the Project area, Common Nighthawk, has recently been listed as threatened under the Nova Scotia *Endangered Species Act*. Canada Warbler, a bird species considered to be sensitive to anthropogenic activities (Yellow listed by NSDNR) was recorded during the breeding bird surveys. A single Common Nighthawk was observed in suitable nesting habitat;

however, no other evidence of nesting activity was recorded and the bird was observed on only one occasion. This evidence is not proof that Common Nighthawks nest in this clear-cut. It is therefore recommended that a follow-up survey be conducted to determine if this species is actually nesting within the clear-cut in which it was observed. No project-related activity will take place within this clear-cut area prior to the start of the Common Nighthawk breeding survey. Should any new clear-cuts be created as a part of quarry development activities, it is recommended that a Common Nighthawk breeding survey take place prior to the commencement of any project-related activities within that area. Additionally, should any birds be found nesting in these cuts, regulators will be consulted to determine appropriate mitigative measures such as buffers *etc.*

The Common Nighthawk breeding survey would consist of observing the clear-cut area at dawn or dusk on five occasions during the month of June with surveys beginning in early June. The observer would take up position at the edge of the clear-cut in late afternoon and would watch and listen for displaying male Common Nighthawks. Observation of breeding displays such as booming or of pairs of Common Nighthawks would indicate that nesting activity is occurring nearby. In the event that breeding activity is observed, the observer would then try to determine if the birds are nesting in the clear-cut. This would involve conducting a grid search of the clear-cut in mid to late June to attempt to flush the female off of the nest site. Females will often hiss at intruders or feign injury if an intruder approaches the nest. Males will sometimes swoop on intruders and hiss at them. Observation of these behaviors will be considered to be proof of a nest.

If Common Nighthawks nest in the clear-cut no development of the clear-cut will be permitted until the habitat is no longer used as nesting habitat by this species. In addition, a buffer zone would be established around the perimeter of the clear-cut to reduce disturbance associated with quarrying activities. Common Nighthawks are quite tolerant of human activities and will nest on gravel roofs in urban areas. As such, it is anticipated that a buffer zone of 50 m wide would be sufficient. The size of the buffer zone will be confirmed in consultation with NSDNR and/or CWS. The effectiveness of the proposed mitigation will be monitored by observing whether or not birds return to the nests and are successful in fledging young.

Common Nighthawks prefer to nest in open habitats. Over time the clear-cut will revegetate and will no longer be suitable nesting habitat. It is estimated that Common Nighthawks could use the clear-cut as nesting habitat for between five and ten years. Nesting surveys will be required to confirm that the habitat is no longer being used for nesting. Once the site has been abandoned by nesting Common Nighthawks quarrying activities can begin in this area.

One Canada Warbler was noted during the 2006 breeding bird survey. This bird was recorded approximately 200 m north of the proposed quarry expansion area and was listed as a possible nester. The proposed quarry expansion area does not provide suitable nesting habitat for this species due to the open nature of the understory. The Canada Warbler is a forest interior species and as such the creation of nearby edge habitat can also adversely affect populations. Forest interior species are often susceptible to depredation by generalist predators attracted to forest edges or to parasitism by Brown-headed Cowbirds. The adverse effects of edges generally extend up to 100 m into the forest. As such, the ability of intact forest habitat to support Canada Warblers could be degraded up to 100 m beyond the cleared edge of the quarry. The Canada Warbler recorded during the breeding bird survey was located outside of the area potentially affected by edge effect created by expansion of the quarry. In addition, the area where the Canada Warbler was recorded is currently affected by edge effects created by the existing Panuke Quarry and the adjacent quarry used to produce aggregate for Nova

Scotia Department of Transportation and Infrastructure Renewal projects. Given these circumstances, expansion of the quarry is not expected to have significant adverse effects on local or regional populations of Canada Warbler.

Expansion of the quarry will result in the loss of habitat for migratory birds. Migratory birds are protected under the *Migratory Birds Convention Act*. It is illegal to kill migratory bird species not listed as game birds (and game birds outside of established hunting seasons) or destroy their eggs or young. Other bird species not protected under the federal *Act* such as raptors are protected under the provincial *Wildlife Act*.

To ensure compliance with these regulations, clearing and grubbing of areas to be used as quarry sites will be conducted outside of the breeding season for most bird species (May 1 to August 31) so that the eggs and flightless young of birds are not inadvertently destroyed. Should a nest be discovered at any time throughout quarry development, a 30 m vegetative buffer zone will be established around the nest and project activities in the immediate area will be minimized until nesting is complete and the chicks have migrated naturally from the area. Additionally, should a nest be found in piled overburden, nests will not be hydroseeded and alternate measures will be taken to reduce potential for erosion, protecting the nest until chicks have fledged and left the area.

In order to avoid drawing bird to the site, lighting utilized for the safety of employees will be shielded to shine down only where it is needed, without compromising safety. Road and parking lot lighting will also be shielded so that little escapes into the sky and it falls where it is required. Generally, exterior decorative lights such as spotlights or floodlights with a function of highlighting features of buildings, etc. will be avoided, or the time of their operation restricted to where only necessary to ensure safety of employees, particularly during the migratory season for most birds, when the risk to birds is greatest.

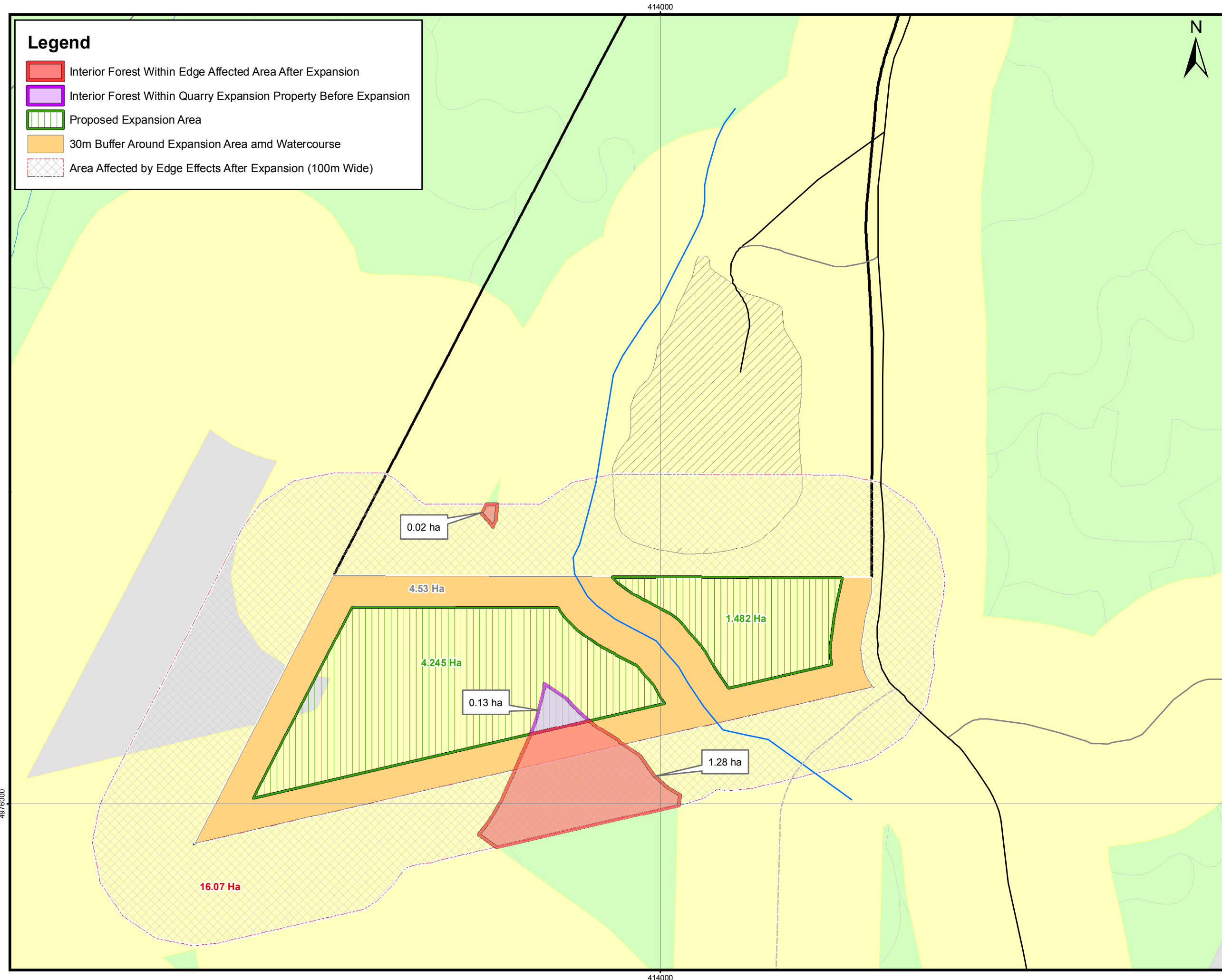
Forest interior birds are particularly sensitive to habitat loss since they are affected both by direct habitat loss and through the adverse effects of habitat edge. The most valuable forest interior habitat consists of mature forest situated at least 100 m away from an edge. The amount of forest interior habitat in the quarry expansion area was determined by establishing 100 m buffers around edge producing features such as the existing quarry, heavily disturbed non-forested habitat, woods roads and recent clear-cuts. Areas remaining after buffering these features were classed as forest interior habitat (all remaining forest habitat regardless of age class) and high quality forest interior habitat (all remaining mature forest habitat). As can be seen in Figure 5.4, 0.13 ha of forest interior habitat is present in the quarry expansion area. All of this is high quality forest interior habitat. This area represents 2.2 % of the entire area available for quarry expansion. Expansion of the quarry will result in the development of edge effect around the margin of the new quarry. Given the area and shape of the quarry expansion area and assuming that edge effects extend 100 m into surrounding habitat, 20.5 ha of edge affected habitat will be created by the new quarry (Figure 5.4). Approximately 19.2 ha (94%) of this area is already affected by edge produced by existing infrastructure and disturbances, leaving 1.3 ha (6%) of forest interior habitat affected by edge effect associated with quarry expansion. This entire forest interior habitat is classed as high quality forest interior habitat.

The proposed quarry expansion site is a reasonably good choice since only 2.2% of the site currently supports forest interior habitat and the expansion of the quarry into this area will only affect 1.3 ha of adjacent forest interior habitat. This is attributable to the location of the proposed quarry expansion area adjacent to the existing Panuke quarry site to the northeast and the PWC quarry site to the west. More edge habitat would be created by the development of a second disjunct quarry site. A quarry expansion area of similar size and shape situated in an area composed entirely of forest interior habitat

would produce edge effects in 20.5 ha of the forest interior habitat rather than the 1.3 ha associated with the proposed quarry expansion.

Mitigation to reduce the effects of loss of forest interior habitat would include:

- Clearing only the amount of forest habitat required for any one year's expansion. Cleared areas should not be irregularly shaped to reduce the amount of habitat edge created by forest harvesting.
- Creation of new forest habitat through progressive reclamation of the site.



Legend

- Interior Forest Within Edge Affected Area After Expansion
- Interior Forest Within Quarry Expansion Property Before Expansion
- Proposed Expansion Area
- 30m Buffer Around Expansion Area and Watercourse
- Area Affected by Edge Effects After Expansion (100m Wide)

Figure 5.4
Distribution of Forest Interior Habitat in the Quarry Expansion Area

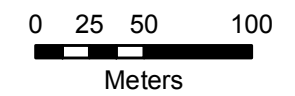
Panuke Road Quarry Project

Map Features

- Building
- Local
- Seasonal/Unpaved
- Track/Trail
- Driveway
- Railway
- Woods Road
- Transmission Line
- Watercourse
- Waterbody
- NSDTB Wetland
- Existing Quarry
- Quarry Properties

Forest Cover

- TYPE**
- Forested
 - Non Forest
 - Forest Interior Buffers (100m)



Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale: 1:3,000
 Date: February 06th, 2008
 Project No.: 1014939.



No critical areas for mammals such as deer wintering areas or critical herpetile habitats are known to exist in the study area. The species recorded in the study area are generally typical of woodland habitats. The field survey and a review of existing records (NSDNR 2006) did not reveal the presence of any rare mammal or herpetile species in the vicinity of the study area. The habitats present in the study area are commonly encountered throughout the province and are unlikely to provide habitat for rare small mammal species. The wildlife model identified one rare or sensitive mammal species, Hoary Bat, that could potentially be present in the study area. It is unlikely that the study area provides critical habitat for this species.

5.5 Groundwater Resources

5.5.1 Description of Existing Conditions

Groundwater, an integral component of the hydrologic cycle, originates from percolation of rain, snowmelt, or surface water into the ground. This infiltrating water fills voids between individual grains in unconsolidated materials and fills fractures developed in consolidated materials. The upper surface of the saturated zone is called the groundwater table. The groundwater table intersects the surface at springs, lakes and streams where interaction between the groundwater and the surface water environment can occur. Groundwater flows through soil and bedrock from areas of high elevation (recharge areas) to areas of low elevation (discharge areas) where it exits the sub-surface as springs, streams, and lakes. There is a dynamic interaction between groundwater resources and surface water resources in Nova Scotia. Groundwater generally sustains the base flow of springs, streams and wetlands during dry periods of the year. More rarely, surface water bodies can contribute to groundwater storage under specific hydrogeological conditions.

Groundwater yield of dug or drilled water wells can vary greatly, depending on the hydraulic properties of overburden or bedrock aquifers through which the wells are constructed. An aquifer is a geological formation or group of formations that can store or yield useable volumes of groundwater to wells or springs. Natural groundwater quality is directly influenced by the geochemical composition of the aquifer materials through which it passes, and the time the water resides within that material.

The groundwater resource is a VEC because it provides potable water supply to approximately half of the total population of Nova Scotia, including almost all unserved rural residences.

The proposed quarry expansion is approximately 6 hectares in area, located south of the existing quarry.

Spatial boundaries for the assessment of groundwater resources are based on a combination of aquifer hydraulic properties, expected groundwater flow directions, and the distance between the proposed quarry expansion and wells that may be affected by quarry activities. For example, the area of influence or capture area of a typical low yield domestic water well is usually less than about 100 m, and generally in a direction hydraulically up-gradient of the well. A quarry that is excavated below the local groundwater table could be considered to behave like a large well, and groundwater draining into the quarry would influence water levels immediately surrounding the excavation to a distance proportional to the size of the quarry.

Project-related contamination (e.g., accidental petroleum hydrocarbon spills from machinery or blasting chemicals (i.e., nitrate and fuel oil)) could theoretically impact the groundwater at the quarry and potentially affect well water quality downgradient of the Project, however most potential hazards should be contained within the quarry dewatering system.

Vibration damage to a drilled or dug well is generally a function of the distance between the energy source and the receptor well, and the seismic properties of the intervening aquifer materials. With respect to rock type, risk of water well damage is greater for fractured crystalline bedrock than for overburden wells or soft bedrock (e.g., sandstone or shale) wells. Based on professional experience, the risk from blasting or major excavation is considered to be greatest within 50 m, moderate from 50 to 200 m, and minimal beyond about 200 m (Dave MacFarlane, pers. comm.).

Blasting effects are conservatively considered for drilled wells within 800 m of the proposed quarry expansion (i.e., the minimum distance from structures allowed for blasting without owner permission specified by the Pit and Quarry Guidelines). Potential effects of accidental spills are considered for all wells hydraulically downgradient of the proposed quarry expansion. In general, the extent of the area potentially affected is dependent on the size and type of release, surface drainage and surficial geology; it can extend 200 m in sand and gravel, and up to 50 m in till.

The following discussion of the local groundwater resources and hydrogeology is based on a desktop study including review of relevant geological maps and records in the Nova Scotia Well Drillers Logs Database, as well as a "windshield" survey. The investigation did not include any water well inspection, groundwater sampling and analysis, or groundwater depth measurements.

The site is located in the transition between the South Mountain highland and the Hants-Colchester lowland. Elevations in the Project area range from approximately 130 to 160 m above sea level. The relief is typically less than 60 m, and the topography is gently rolling.

The surficial geology in the Project area (Figure 5.5) consists of the Lawrencetown Till. These tills are derived from both local and distal bedrock sources (Stea, Conley, and Brown, 1992). Its thickness and composition strongly reflect the nature of the underlying bedrock and range from thin silty sand tills with gravel and boulders to thick reddish-brown clay tills. These tills are often found in beds of fluvially stratified drift. Borehole logs in the region indicate that the surficial geology nearest the site is commonly estuarine clay over poorly sorted outwash sand and gravel deposits.

Bedrock underlying the site (Figure 5.6) consists of Cambrian-Ordovician aged Goldenville Formation of the Meguma Group. The Goldenville Formation is comprised of thickly stratified and resistant metamorphosed quartz sandstones (quartzite) interbedded with slate. The rocks have distinct cleavage where they have been tightly folded (trending northeasterly). The permeability of these rocks to groundwater is through the numerous shallow fractures on this cleavage (Trescott, 1969).

Approximately 1500 m north of the property boundary is the Late Devonian - Early Carboniferous Cheverie Formation of the Horton Group. The Cheverie Formation consists of fluvial sandstone, siltstone and conglomerate originating from the granites and quartzites of the metamorphic and igneous rock of the central interior. The Horton Group is underlain by the limestone and gypsum of the Windsor Group. Many of the domestic water wells north and northwest of the Project area are constructed in these sedimentary bedrock units while wells to the east and northeast are generally constructed in Goldenville Formation quartzite.

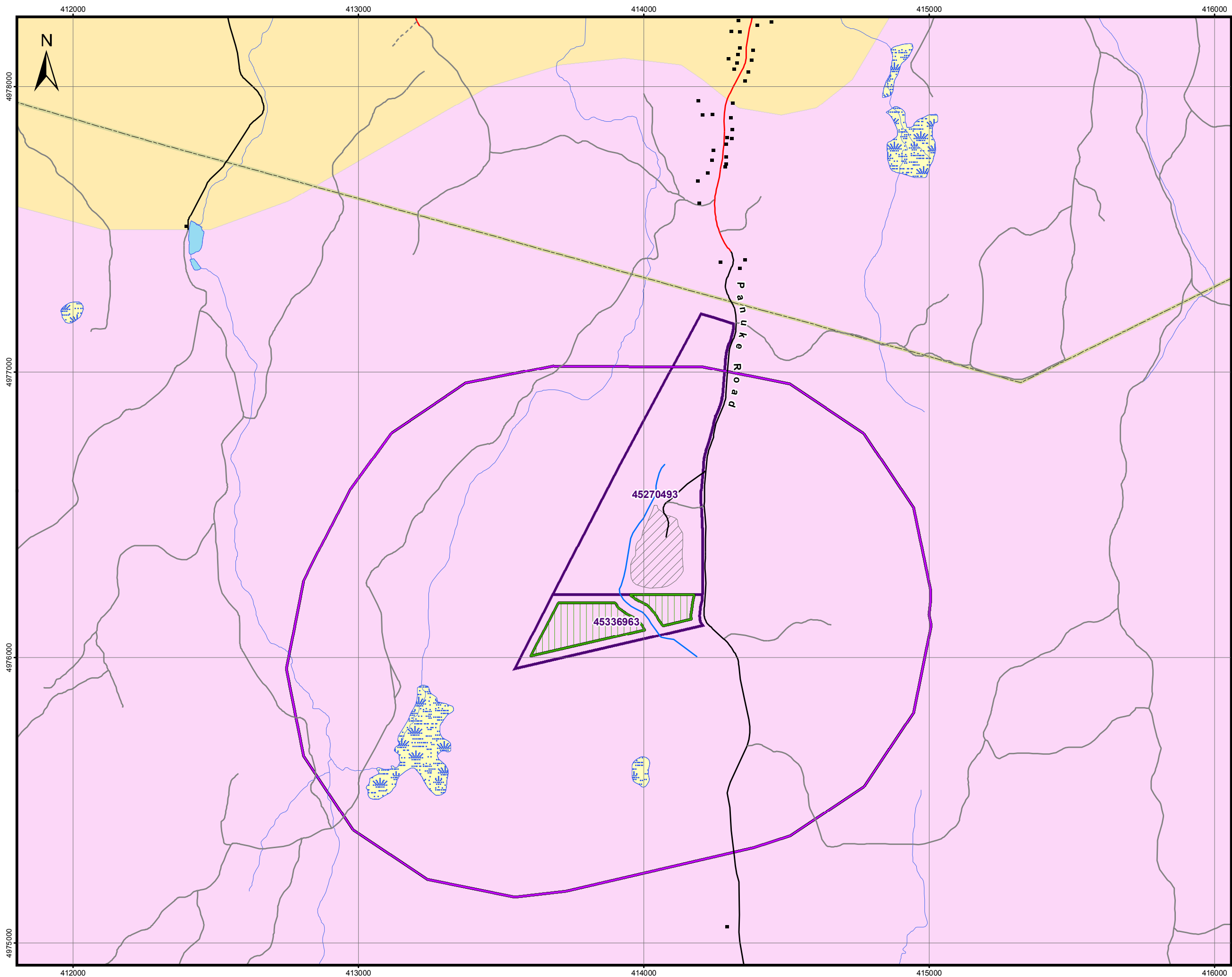
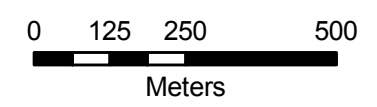


Figure 5.5
Surficial Geology
Panuke Road Quarry Project

- Map Features**
- Building
 - Local
 - Seasonal/Unpaved
 - Track/Trail
 - - - Driveway
 - + Railway
 - Transmission Line
 - Watercourse
 - Waterbody
 - Wetland
 - Existing Quarry
 - 800m Expansion Area Buffer
 - Proposed Expansion Area
 - Quarry Properties
- Surficial Geology**
- Sub Unit**
- Silty Till Plain
 - Stony Till Plain



Note: Surficial Geology mapping obtained from "NSDNR - Mineral Resources Branch Digital Products" - DP ME D92-03, Version 1, 1997. Digital version of Nova Scotia Department of Natural Resources Map ME 1992-3, Surficial Geology Map of the Province of Nova Scotia, 1:500 000, 1992. - <http://www.gov.ns.ca/natr/meb/pubs/pubs3.htm>

Map Parameters
 Projection: UTM-NAD83-Zone20
 Scale 1:12,500
 Date: February 06th, 2008
 Project No.: 1014939.



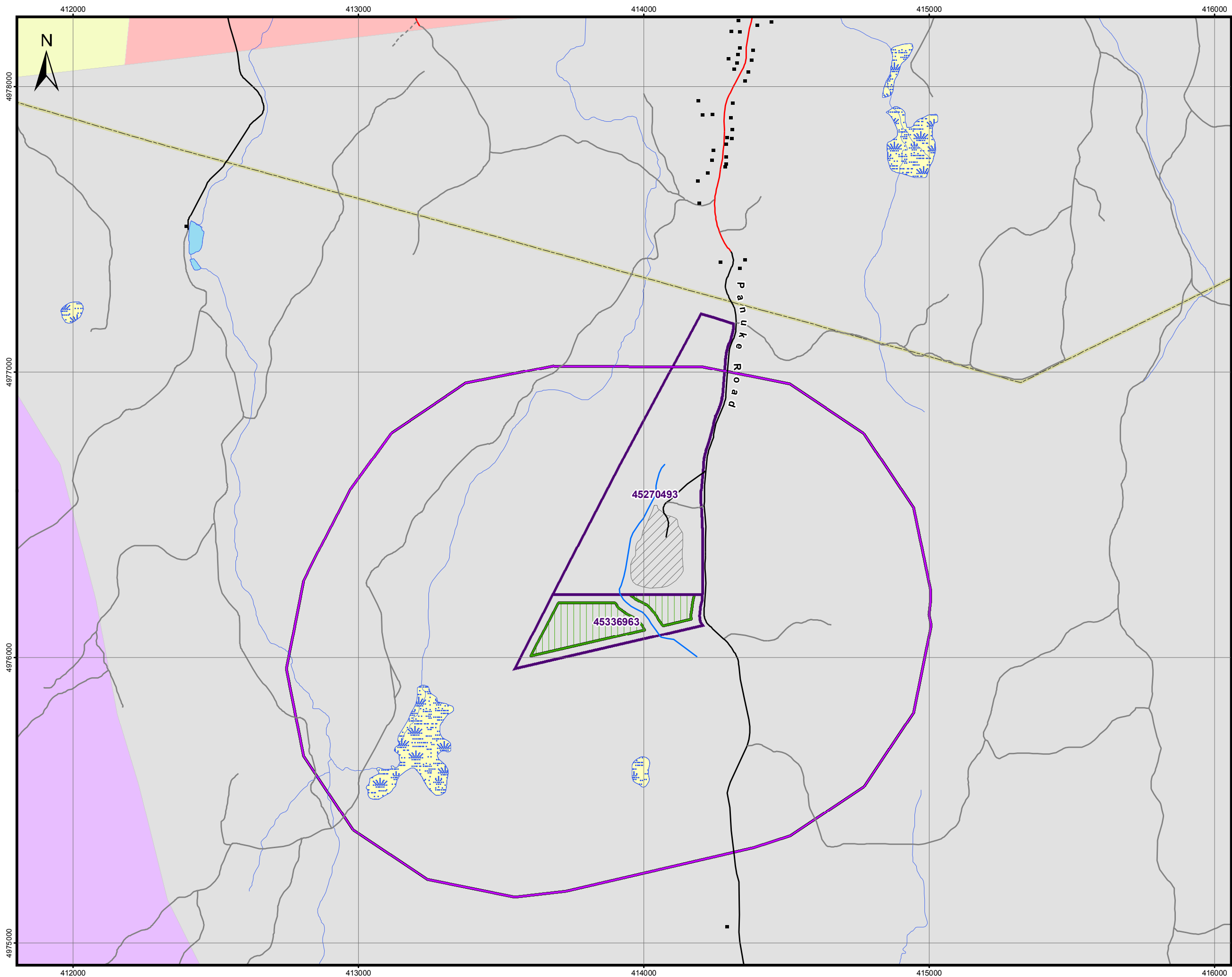
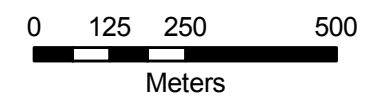


Figure 5.6
Bedrock
Geology
Panuke Road
Quarry Project

- Map Features**
- Building
 - stream
 - Local
 - Seasonal/Unpaved
 - Track/Trail
 - - - Driveway
 - + Railway
 - Transmission Line
 - Watercourse
 - Waterbody
 - Wetland
 - Existing Quarry
 - 800m Expansion Area Buffer
 - Quarry Properties
 - Proposed Expansion Area

- Bedrock Geology**
Group/Formation
- Meguma Group - Goldenville Formation
 - Granodiorite
 - Horton Group - Cheverie Formation
 - Windsor Group - White Quarry, Macumber, Stewiacke, Carrolls Corner, Meaghers Grant, & Grays River Formations



Note: Bedrock Geology mapping obtained from "NSDNR - Mineral Resources Branch Digital Products" - DP ME D00-01, Version 1, 2000. Digital version of Nova Scotia Department of Natural Resources Map ME 2000-1, Geological Map of the Province of Nova Scotia, scale 1:500 000, 2000. - <http://www.gov.ns.ca/natr/metb/pubs/pubs3.htm>

Map Parameters
 Projection: UTM-NA83-Zone20
 Scale 1:12,500
 Date: February 06th, 2008
 Project No.: 1014939.



Due to its situation with respect to the local topography, the Project is expected to lie within a local groundwater recharge area. Regional groundwater flow is inferred to be north and northwest from the South Mountain Highlands towards the Avon River and one of its principal tributaries, the St. Croix River.

A windshield water well survey was conducted on November 5, 2007 to determine the locations of water wells located within 800 m of the Project. No water wells are located within 800 m of the Project area (Figure 2.2). Water supplies for residences farther than 800 m from the Project area located along Panuke Road, Highway #1, Windsor Back Road, Old Halifax Road and side roads located off these arterial roads. These supplies are derived primarily from privately owned drilled and dug wells. Additionally, it should be noted that the Mill Lakes/Fall Brook Water Supply Area is located more than 5 km west of the Project, but due to the large distance separating project activities from this area, no impacts to the water supply are anticipated.

A review of available NSEL domestic water well records provided information for only one water well located directly north of the property on Panuke Road; it is located south of Highway #1, approximately 500 m outside of the 800 m Project site buffer. This well is shallow and draws water from the permeable sandstone of the Cheverie Formation at an estimated yield of 80 gallons per minute (gpm) or 6 litres per second (L/s). To date, there have been no reported interactions between quarry activities and local water supply wells. In both current and future quarry operations, there is to be no excavation of aggregate below the groundwater table; the benched face height will be no more than 27 m below ground surface with the groundwater table another metre below.

To provide a general description of aquifer properties in the vicinity of the Project, a summary of domestic well records for the communities of Three Mile Plains and Five Mile Plains (located north of the project site), is provided in Table 5.2. None of these wells are located within 800 m of the Project. However, the conditions encountered within these wells are indicative of the soil conditions and bedrock aquifers located on the Project site, and within the community of Three Mile Plains.

TABLE 5.2 Summary of Domestic Water Wells Records in Three Mile Plains, Nova Scotia

Goldenville Formation	Well Depth (m)	Casing Length (m)	Estimated Yield (igpm)	Water Depth (m)	Overburden Thickness (m)
Minimum	3.66	3.66	0.50	0.00	0.00
Maximum	74.68	31.39	90.00	24.38	31.39
Average	29.79	13.25	22.71	4.68	6.20
Median	24.38	10.06	9.00	1.83	0.61
Number of Wells	14	14	14	14	14
Horton Group	Well Depth (m)	Casing Length (m)	Estimated Yield (igpm)	Water Depth (m)	Overburden Thickness (m)
Minimum	3.66	3.66	0.50	0.00	0.00
Maximum	74.68	30.48	80.00	24.38	21.34
Average	28.65	13.64	15.63	5.72	6.93
Median	22.86	11.28	6.00	1.52	2.74
Number of Wells	8	8	8	8	8

Note: Information was obtained from the Nova Scotia Well Log Database including wells constructed between 1940 and 2004.

Water Quality

Water quality potential is determined from known water quality characteristics for each unit. This includes naturally occurring water quality concerns such as hardness and presence of arsenic and iron. Except in localized mineralized zones in the Meguma terrain, quartzite bedrock is expected to provide

water quality with most parameters within acceptable drinking water guidelines (Health Canada, 2006). However, arsenic in excess of the 0.01 milligrams per litre (mg/L) health-based guideline can occur in the Goldenville bedrock aquifer, particularly along the crests of anticlines in designated Gold-Bearing areas. Further, elevated iron and manganese in excess of respective aesthetic guidelines of 0.3 mg/L and 0.05 mg/L can occasionally occur within this formation.

Within the metamorphic Meguma Group bedrock (*i.e.*, Goldenville Formations), the waters are typically calcium bicarbonate and low in dissolved solids and hardness. The waters tend to be slightly acid and can contain high levels of sulphate, iron and manganese. Aesthetic drinking water guidelines for sulphate, iron and manganese are ≤ 500 mg/L, ≤ 0.3 mg/L, and ≤ 0.05 mg/L respectively.

Just north of the Project, the groundwater of the Cheverie Formation (Horton Group) produces good quality, slightly basic, calcium bicarbonate groundwater low in dissolved solids, hardness and iron. However it is typically high in sulphate and dissolved solids when in association to the gypsum and limestone of the Windsor Group (Trescott, 1969).

In addition to the above naturally-occurring water quality issues, common problems reported by Nova Scotia well owners include: elevated sodium and chloride from road salt; coliform bacteria from surface sources impacting poorly constructed dug and drilled wells; and low pH and/or associated plumbing corrosion in shallow wells constructed in sand aquifers or fractured crystalline bedrock (Dave MacFarlane, per.comm). To date, there have been no reported groundwater quality issues related to the existing quarry activities.

5.5.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

The potential environmental effects on surrounding groundwater resources from a quarry operation include: groundwater table lowering close to the quarry's high wall, depressurization of downgradient springs, temporary siltation of nearby wells due to intermittent blasting or heavy equipment operation, decrease in well yield due to groundwater level lowering or interception of recharging bedrock fractures, and possible water quality deterioration at down-gradient wells from accidental releases of deleterious substances such as petroleum hydrocarbons or acidic drainage production if in the unlikely event that a mineralized zone is encountered within the quarry area. Potential impacts to domestic water wells are a function of distance, location of a well and the quarry with respect to groundwater flow directions, depth of excavation below the water table, intensity and frequency of blasting, and individual well construction methods.

Water Quantity Effects

If the quarry encounters increased groundwater seepage as it expands, water will collect within its lowest point (*e.g.*, a settling pond or sump). Depending on the floor elevation and the resulting amount of groundwater encountered, dewatering of the proposed quarry expansion may be required should there be an event of significant rain. There are no plans in the proposed quarry area to mine below the groundwater table; the benched face height will be no more than 27 m below ground surface with the groundwater table another metre below. Therefore, no water quantity effects are anticipated.

Water Quality Effects

Changes in water quality may theoretically occur as a result of excavations in the recharge area of the wells. Potential impacts include: temporary siltation from blasting, oil and nitrate from blasting operations, lubricant compounds, and other chemical releases within the quarry area. A possible long term impact of well water quality is decreased pH or increased dissolved solids from attenuation of acidic drainage from exposed sulfide-rich bedrock, if present. The potential for acid drainage production in this area is low; there were no reported acid generating rocks encountered in the existing quarry. Although not expected, localized acid generating bedrock is possible within mineralized zones if encountered in the proposed quarry.

Mitigation of Effects

Due to distance, significant impacts on groundwater supplies are not anticipated due to natural attenuation primarily by dilution and dispersion along the groundwater pathways. Short-term turbidity impacts caused by blasting vibration, though highly unlikely given the distance to offsite wells, would likely involve a temporary disruption and could be mitigated by provision of bottled water to affected residents. In the unlikely event of persisting long-term degraded water quality, or a well yield loss event, the proponent will replace or repair any water supply well found to be adversely affected by their quarry operation to the satisfaction of the owner. Acid generating bedrock is not expected, however should a mineralized zone be encountered the rock will be tested for acid generating potential. If determined to be acid generating bedrock, the material will be handled as prescribed in the Nova Scotia Sulfide Bearing Material Regulations. As previously discussed, no residential water wells are located within 800 m of the Project and therefore above impacts to offsite wells are not anticipated. In summary, significant Project-related effects on groundwater resources are not likely to occur.

5.6 Archaeological and Heritage Resources

5.6.1 Description of the Existing Environment

For the purposes of this assessment, archaeological and heritage resources are defined as physical remains that inform us of the human use of and interaction with the physical environment. These resources may be above or below the surface of the ground and cover the earliest Pre-Contact times to the relatively recent past.

Heritage resources are generally considered to include historic period sites such as cemeteries, heritage buildings and sites, monuments, and areas of significance to First Nations or other groups. Pre-Contact refers to the time before the arrival of non-Aboriginal peoples.

The assessment of heritage resource potential within the proposed expansion area incorporated sources that included archaeological site records at the Nova Scotia Museum and archival resources.

Background research was conducted using the records at the Public Archives of Nova Scotia, the Nova Scotia Museum, as well as those available on the Internet. Maps consulted included those by Anson (1893), Wentworth (1827), A.F. Church (1871) and Faribault (1909).

The Nova Scotia Museum's Archaeological Site Database shows no recorded pre-Contact archaeological sites within the study area.

The potential for a site to contain First Nations archaeological resources is generally determined by the presence of resources that the Mi'kmaq people depended upon, such as food and water, as well as proximity to watercourses that were large enough to be used as a transportation route or were used to access such a route. Given the location of the study area the potential for it containing pre-Contact archaeological resources should be considered low. The nearest watercourse, Maple Brook, is a minor one and is located more than 200 metres west of the site. There do not appear to be any other features or resources that would have attracted First Nation's settlement. It is much more likely that the Mi'kmaq settled along the Avon and St. Croix rivers to the north and the St. Croix River/Panuke Lake system to the south.

There are no recorded historic archaeological sites or heritage resources within or near the expansion area. There are no obvious buildings, areas of cultivation, or other settlement features evident on the modern aerial photos.

There is very little historical evidence of settlement within or close to the site. While land grants in the area were awarded to Joshua Mauger and others in 1759, settlement in the area did not begin until the nineteenth century. The 1893 Anson map is interesting as it shows a short section of road that became the north end of Panuke Road, running off of what is now Highway 1. Unfortunately, it appears as if the quarry site is just off the map to the southeast. Similarly, the 1827 Wentworth map stops just west of Panuke Road. The 1871 map by A.F. Church finally shows Panuke Road, basically as it appears today, running all of the way to Panuke Lake. The map does show relatively dense settlement on the northern half of the road, about 13 houses, but only a single house in the south half, on the banks of Panuke Lake. Finally, the 1909 Geological Survey of Canada map shows 26 buildings in the north half of Panuke road, but nothing in the south half.

Based on the background research the historical archaeological potential for the Project area is considered low. The research showed that the north end of Panuke Road was subject to moderate settlement and growth from the early to the end of the nineteenth century but that there was no historic settlement or significant activities within the Project area.

5.6.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

Certain activities associated with the Project (*i.e.*, blasting, road construction), could affect archaeological or heritage sites if they were present within the zone of surficial and subsurface disturbance. These disturbances, if unmitigated, could result in the loss of resources and the potential knowledge to be gained from its interpretation.

The Project area has low potential for identifiable human use in the pre-Contact and historic periods. No archaeological/heritage resources or areas of elevated heritage potential were identified. It is assumed that no areas beyond the Project area will be disturbed during the development and operation of the proposed quarry expansion. As such, development and operation of the proposed quarry are not expected to have any adverse environmental effects on heritage resources.

If archaeological or heritage resources are discovered during development and operation of the Project, the find will be immediately reported to the Curator of Archaeology and the Manager Special Places at the Nova Scotia Museum. If the resources are thought to belong to First Nations, the Chief of the nearest Mi'kmaq band will also be contacted. In the case of suspected human remains, the RCMP will

be called. The appropriate authorities will determine further actions to be undertaken which could include avoidance and further assessment.

In summary, assuming appropriate measures are undertaken in the event archaeological or heritage resources are discovered, significant Project-related effects on these resources are not likely to occur.

5.7 Air Quality

5.7.1 Description of Existing Conditions

The Project area and Nova Scotia in general, has good air quality due to the combination of maritime climate and relatively small population and industrial bases (NSDOE 1998). Climatic conditions provide good dispersion of air contaminants. The ambient air quality also benefits from the infusion of relatively clean polar and arctic air masses. Occasionally, however, long-range transport of air masses from central Canada or the eastern seaboard may transfer contaminants into the area, causing occasions of poorer air quality.

In general, the air quality of Nova Scotia meets the desired ambient air quality criteria (NSDOE 1998). Motor vehicles, electrical power generation, pulp and paper processing and oil refining are the major local sources of air pollutants in the province. Port Hawkesbury is the only area in the province that experiences periodic exceedences in air quality. All other air quality exceedences in the province are caused by ground level ozone, generated outside the region.

Ambient air quality is monitored in Nova Scotia with a network of 28 sites, operated by NSEL, Environment Canada, and Nova Scotia Power Inc. (NSPI). Other industries may also monitor for air quality. Common air pollutants monitored regularly are sulfur dioxide (SO₂), particulate matter (PM), carbon monoxide (CO), ground level ozone (O₃), nitrogen dioxide (NO₂), and hydrogen sulfide (H₂S). The closest NSEL monitoring site to the Panuke Quarry is located in Aylesford, Nova Scotia (NSEL, 2006). In addition, since 2002 the province began continuous reporting of an air quality index for the Halifax-Dartmouth region. Since reporting began, air quality has been predominantly in the "Good" category.

The Panuke Quarry is located in a rural setting with little industrial development within a distance of 5 km. It is not anticipated that the common air pollutants are exceeded at the quarry location due to the separation distance from any large urban centre. Limited residential development can be found within 1 km of the site.

The spatial boundary for the assessment of air quality is the approximate zone of influence affected by the quarrying activities. This zone lies within close proximity to the community of Windsor, Nova Scotia.

The VEC spatial boundaries were set so that the effects on potential receptors (e.g., residential, institutional development) were considered. The potential effects of routine air emissions from the Project are evaluated to such a distance that the concentration falls to near background level.

Temporal boundaries for the assessment of air quality have been developed in consideration of those time periods during which Project air emissions have the potential to degrade ambient air quality. In general, emissions that could affect air quality will be relatively short-term from such operations as blasting; however, emissions from such sources as vehicles and construction equipment will be fairly regular.

Other temporal considerations for atmospheric emissions include variations in meteorological conditions, which are related to the capacity for contaminant transport. Sensitivity of receptors to certain atmospheric contaminants (e.g., dust) may also vary by season (i.e., more sensitive in warm weather with increased outdoor activities). Winds blow predominantly from the south in the summer with an average speed of about 13 to 17 km/h. In the winter months the predominant direction is from the west with an average speed of 16 to 19 km/h. Therefore, the community of Windsor would be likely be the most probable receptor of air emissions from the Project site in the winter and Halifax County the most probable receptor in the summer.

Ambient air quality in Nova Scotia is regulated by the provincial government. The federal government has set objectives for air quality, which are taken into account by federal agencies in a project review. These objectives form the basis for the air quality regulations of several provinces, including Nova Scotia. The Nova Scotia regulated limits correspond to the upper limit of the Maximum Acceptable category for air quality, which are set under the *Canadian Environmental Protection Act (CEPA)*. These guidelines may have also been used as a reference by provincial or federal regulators. The air quality guidelines of tolerable, acceptable, and desirable, as defined under *CEPA*, will be used in the evaluation of significance. The maximum tolerable level denotes a concentration beyond which appropriate action is required to protect the health of the general population. The maximum acceptable level is intended to provide protection against effects on soil, water, vegetation, visibility, and human wellbeing. The maximum desirable level is the long-term goal for air quality. Additional guidelines are under development by the Canadian Council of Ministers of the Environment (CCME), and ultimately this body will develop Canada-Wide Standards that harmonize the regulations in all jurisdictions.

The contaminants regulated by the Province of Nova Scotia, or which are listed in *CEPA* are discussed below, indicating how the Project may contribute to their release.

Table 5.3 presents the Nova Scotia Air Quality Regulations and *CEPA* Ambient Air Quality Objectives. These standards can be used as comparison to ensure acceptable ambient air quality levels are being met throughout the life of the Project.

TABLE 5.3 Nova Scotia Air Quality Regulations (Environment Act) and Canadian Environmental Protection Act Ambient Air Quality Objectives

Pollutant and units (alternative units in brackets)	Averaging Time Period	Nova Scotia	Canada			
		Maximum Permissible Ground Level Concentration	Canada Wide Standards (pending)	Ambient Air Quality Objectives		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Nitrogen dioxide $\mu\text{g}/\text{m}^3$ (ppb)	1 hour	400 (213)	-	-	400 (213)	1000 (532)
	24 hour	-	-	-	200 (106)	300 (160)
	Annual	100 (53)	-	60 (32)	100 (53)	-
Sulphur dioxide $\mu\text{g}/\text{m}^3$ (ppb)	1 hour	900 (344)	-	450 (172)	900 (344)	-
	24 hour	300 (115)	-	150 (57)	300 (115)	800 (306)
	Annual	60 (23)	-	30 (11)	60 (23)	-
Total Suspended Particulate Matter (TSP) $\mu\text{g}/\text{m}^3$	24 hour	120	-	-	120	400
	Annual	70	-	60	70	-
PM2.5 $\mu\text{g}/\text{m}^3$	24 hour, 98 th percentile averaged over 3 consecutive years	-	30 (by 2010)	-	-	-

TABLE 5.3 Nova Scotia Air Quality Regulations (Environment Act) and Canadian Environmental Protection Act Ambient Air Quality Objectives

Pollutant and units (alternative units in brackets)	Averaging Time Period	Nova Scotia	Canada			
		Maximum Permissible Ground Level Concentration	Canada Wide Standards (pending)	Ambient Air Quality Objectives		
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable
PM _{2.5-10} $\mu\text{g}/\text{m}^3$		-	Under review in 2003	-	-	-
Carbon Monoxide mg/m^3 (ppm)	1 hour	35 (31)	-	15 (13)	35 (31)	-
	8 hour	15 (13)	-	6 (5)	15 (13)	20 (17)
Oxidants – ozone $\mu\text{g}/\text{m}^3$ (ppb)	1	160 (82)	-	100 (51)	160 (82)	300 (153)
	8 hour, based on 4 th highest annual value, averaged over 3 consecutive years	-	128 {by 2010} (65)	-	-	-
	24 hour	-	-	30 (15)	50 (25)	-
	Annual	-	-	-	30 (15)	-
Hydrogen sulphide $\mu\text{g}/\text{m}^3$ (ppb)	1 hour	42 (30)	-	-	-	-
	24 hour	8 (6)	-	-	-	-

5.7.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

Quarrying activities can generate dust (*i.e.*, particulate emissions) which has the potential to be transported offsite. As per the conditions of the existing Panuke Quarry Industrial Approval amendment and the Pit and Quarry Guidelines, particulate emissions will not exceed the following limits at the site property boundaries:

- Annual Geometric Mean 70 $\mu\text{g}/\text{m}^3$; and
- Daily Average (24 hrs) 120 $\mu\text{g}/\text{m}^3$.

There are a variety of activities that can lead to the generation of particulate matter on the construction site. The primary potential sources of TSP include:

- Exhaust gas emissions due to incomplete combustion from diesel compression engine;
- Road dust;
- Wind erosion on storage piles;
- Blasting activities;
- Conveyors;
- Crushing operations;
- Screening operations;
- Material handling;
- Material transport; and
- Truck loading / truck unloading.

Some of the more pertinent contributors are discussed in detail in the following paragraphs.

- Blasting can result in a concentrated plume of particulate matter, but the volume and time duration of such plumes are constrained. Even when blasts result in a visible plume, the contribution to 24-hour averages, as in the *Air Quality Regulations*, will be negligible. Much of the material in the initial plume is larger than the aerodynamic diameter of particles that can remain suspended in the air, and deposit within a relatively short distance (e.g., 100 m) of the blast site.
- Both crushing and screening are mineral extracting operations that involve the generation of particulate emissions. Uncontrolled processing operations like these can produce nuisance problems and can have an effect upon attainment of ambient particulate standards.
- Material handling activities can result in the generation of particulate matter. The reason for these emissions is often the vertical drop of material movement. As the fine material passes through the air, the finest material may become windblown and travel downwind.
- Storage piles and exposed areas are often left uncovered due to the need for frequent material transfer, which can lead to considerable dust generation. Dust emissions can take place during several points in the storage cycle, including material loading onto the pile, disturbances by strong wind currents, and removing loads from the pile. The potential drift distance of particles caused by wind is determined by the initial injection height of the particle, the terminal settling velocity of the particle, and the degree of atmospheric turbulence.
- Particulate emissions can occur whenever vehicles travel over both paved and unpaved surfaces. Particulate emissions from paved roads are caused by direct emissions from vehicles such as exhaust, brake wear and tire wear emissions and resuspension of loose material on the road surface. Resuspended particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface. Regarding unpaved roads, the force of the wheels on the road surface causes pulverization of surface material. Particles are picked up and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake following the vehicle continues to act on the road surface after the vehicle has passed.
- Although there are also emissions of combustion gases and products of incomplete combustion from the exhaust of the on-site vehicles and equipment, these are considered nominal.

Efforts to minimize the generation of dust at the site include covering work and laydown areas with blasted materials, and covering stockpiled topsoil with seed and hay. Fugitive dust emissions will be controlled as necessary with the application of water obtained from the settling pond(s) with the use of a water truck. Monitoring of particulate emissions (dust) will be conducted at the request of NSEL.

Dust generated by truck movement will be minimized by speed control, proper truck loading, application of water for dust suppression, proper construction of on-site roads, and/or other means as required by NSEL. Details of any required monitoring will be included in the Industrial Approval amendment application.

Exhaust emissions from equipment and vehicles will be mitigated by ensuring vehicles are maintained in good working order to ensure efficient operation and minimization of emissions. Consideration will be given to methods to reduce idling, as feasible.

The air quality impacts of the Panuke Quarry can be controlled by standard mitigation practices and the Project is not likely to create significant adverse impacts on air quality. Significant impacts on air quality are defined as persistent exceedences of criteria provided in Table 5.3 after application of mitigative measures.

5.8 Socio-economic Environment

5.8.1 Description of the Existing Environment

Population and Employment

The Panuke Quarry is located in Hants County, southwest of Windsor. The quarry is located in a rural setting along a local road with a low distribution of residential development extending from the eastern boundary of the proposed expansion area, approximately 3 km to Trunk 1 (Figure 2.1). The population in the general area (*i.e.*, Hants County) is 41,182. The population in this area has increased by 1.7 % between 2001 and 2006 (Statistics Canada 2006). The employment rate in the County is 56.6 % while the unemployment rate is 8.9% (Statistics Canada 2001). Sales and service occupations make up the largest proportion of experienced labour force with approximately 25.6% of experienced labour, followed by trades, transport and equipment operators (24.2%), and business, finance and administration occupations (14.79%).

The majority of the aggregates from the quarry to date have been sold to customers in the West Hants Municipality, local customers, and NSTIR, predominantly for construction projects. The closest town to the Study Area is Windsor, where the population is 3,709, which is a 1.8% decrease since 2001 (Statistics Canada 2006). The employment rate in the Windsor is 54.7 % while the unemployment rate is 6.0%. The sales and service industry consists of the largest percentage of the total experience labour force, comprising 31.7% of total experienced labour force, followed by business, finance and administration occupations (16.7%) and trades, transport and equipment operators and related occupations (12.5%) (Statistics Canada, 2001).

The existing quarry currently employs one seasonal employee. Drilling and blasting activities require additional resources; these activities are sub-contracted to a professional blasting company. Hauling of materials from the quarry also involves additional labour resources; hauling (or trucking) is typically arranged through the customers.

Land Use

Mining

A review of NSDNR Abandoned Mine Openings Database indicates that there is one Mine Shaft within a 10 km radius of the boundaries of the Project property.

The status of this shaft is not known. However, none are in close proximity to the Project property and no interaction is predicted between the mine shaft and the proposed quarry expansion.

Agriculture

The Panuke Quarry Expansion Project is not located in a region where conflict with current and future agricultural practices is anticipated. The districts which are considered very important with regards to agriculture are Upper Falmouth and Avondale-Poplar Grove, while the Panuke Quarry is located in Three Mile Plains.

Forestry

A large part of the southern and north-eastern part of the municipality is Crown land or land owned by large forestry companies. The forested lands provide local employment, wildlife habitat and outdoor recreation opportunities, and potential future water supply sources are located in these areas (West Hants Municipal Planning Strategy, 2007). The area in which the Panuke Quarry is located is zoned as general resource, which includes forest harvesting (Windsor-West Hants Joint Planning Advisory Committee).

Recreation and Tourism

West Hants has a large amount of parkland dedicated to public recreational use, including provincial parks and municipally owned parkland and facilities. In addition, there are a number of commercial recreation sites, including Martock ski hill and various golf courses and campgrounds. The Panuke Quarry is not located adjacent to these sites.

Transportation

A transportation assessment and discussion of potential impacts of the quarry operation was conducted by Atlantic Road and Traffic Ltd. in support of the environmental registration. A description of the existing conditions in the area is included in the following paragraphs.

Road Descriptions

MEL has been operating the Panuke Quarry for over five years. The quarry is located on the west side of Panuke Road about three kilometers south of the Trunk 1 intersection. There is a railroad crossing with warning signals on Panuke Road immediately south of Trunk 1. The first 2.5 km section from Trunk 1 is paved (6.4 m wide pavement) with a yellow center line and gravel shoulders. The remaining approximately 0.5 km to the quarry entrance is a gravel road. While the 6.4 m wide pavement is adequate for the traffic volumes and vehicles using the road, additional care with vehicle tracking is required at a curve at the MacLeod Court intersection, as well as at reverse curves at the south end of the paved section.

The paved section of the road is of a residential character with driveways and several minor road intersections. There are approximately three residential driveways on the north end of the gravel section just south of the end of pavement. The posted speed limit on the paved section of Panuke Road is 50 km/h, in keeping with the residential character of the road.

Panuke Road intersects with the south side of Trunk 1 in Three Mile Plains. Trunk 1, which was the main highway between Halifax and Windsor previous to construction of Highway 101 about 30 years ago, has a rural cross section, including two paved lanes, gravel shoulders, and open ditches. The Panuke Road intersection is located on a relatively flat section of roadway and has adequate sight distances for both approaches for the 70 km/h posted speed limit on Trunk 1.

Traffic Volumes

While traffic volume data is not available for Panuke Road, a site visit indicated that volumes are light, possibly in the order of 500 to 1000 vehicles per day (vpd). This suggests a two-way peak hour volume of about 50 to 100 vehicles per hour (vph).

Traffic volumes on Trunk 1 just east of Panuke Road have increased from 1060 vehicles per day Annual Average Daily Traffic (AADT) in 1971 to 2040 vpd in 2007. Hourly volumes obtained by traffic count machines in 2002, 2004, and 2007, indicate 2007 AM peak hour volumes of about 100 vph and PM peak hour volumes of about 215 vph. Regression analysis of historical data indicates a low annual growth rate of about 25 vehicles per day per year for Trunk 1 volumes at this location. Ten years from now, in 2017, the AADT volume is projected to be about 2550 vpd.

Collision Data

The relative 'safety' of an intersection is generally evaluated by review of collision data for reported collisions at or near the intersection being studied. A review of collision data for Trunk 1 did not indicate any history of collisions at the Panuke Road intersection during the past five years. Since sight distances are adequate and there have not been any reported collisions at the Trunk 1 / Panuke Road intersection, there is nothing to suggest any existing safety problems at the intersection.

There were two reported property damage collisions on Panuke Road, one in 2002 involving a four wheeler striking a vehicle backing into a driveway, and another in 2006 that occurred when an automobile exited a private driveway without yielding to another passenger vehicle traveling on the road.

Quarry Traffic

The current and projected production rate for the quarry is approximately 60,000 tonnes per year. The current and anticipated operating schedule is 15 hours per day, weather permitting, with an average of 2000 truck loads shipped each year.

Since the quarry has been operating for over five years, and since the proposed quarry expansion is not expected to change production rates or affect the existing aggregate transport truck volumes, there should not be any noticeable impacts to the level of performance of Panuke Road as a result of the quarry expansion.

Human Health

Human health related aspects and potential effects on environmental health include potential impacts on air quality (*i.e.*, particulate emissions) and safety of commuters. Air quality is addressed in Section 5.7, and Section 5.8.1 presents traffic collision data.

5.8.2 Potential Effects, Proposed Mitigation, Monitoring and Follow-up

Population and Employment

The direct and indirect employment associated with operation of the Panuke Quarry may be considered a benefit, or positive effect, to the regional economy. In addition, the quarry produces valuable products that support development and infrastructure, and the growth of the region's economy.

Expansion of the Panuke Quarry to allow for continued operation will result in an overall positive effect on the regional economy. The availability of additional supply to the market place should encourage a more stable price for aggregate. In some cases (*i.e.*, markets in close proximity to quarries) the overall price for aggregates will be lower; since cost of aggregate largely reflects the distance it has to be hauled. This, in turn, can significantly reduce costs of construction, which, in the case of public

infrastructure such as highways, communities, public works agencies, and taxpayers should result in financial benefits (NSDNR 2006).

Another interpretation of Project-related employment effects is that they may be considered neutral. This is because the market that Panuke Quarry is supplying is not new, the products are not new, and the demand for aggregate in the local market is currently being met by existing quarries, including the existing Panuke Quarry.

Land Use

Due to the existing industrial activity onsite (*i.e.*, quarry) and the distance from residences, impacts on existing and future adjacent land uses are not expected. Quarry activities will be conducted in accordance with the Pit and Quarry Guidelines and all setback distances specified in the Guidelines will be maintained.

Quarrying activities will produce noise from equipment operation and blasting. The proposed expansion area is located greater than 800m from the nearest residence. The potential for noise from the quarry site to have a significant effect on residents is minimal.

Blasting operations associated with the proposed expansion will be conducted in accordance with current operations at the quarry as permitted by NSEL (Approval No. 2006-019700-A01), in accordance with the Pit and Quarry Guidelines (NSEL 1999) and with a frequency similar to past operations at the site. Blasting will be conducted in accordance with the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act* (1996). It is understood that additional blast monitoring activities and/or reporting may be required by NSEL. A blast design plan and monitoring program will be developed for the application for Industrial Approval amendment.

As per the requirements of the current operating Industrial Approval amendment and standard provincial guidelines, sound levels from the operation in the expansion area will be maintained at a level not to exceed the following sound levels (Leq) from the property boundaries:

Leq 65dBA 0700-1900 hours (Days);
60dBA 1900-2300 hours (Evenings); and
55dBA 2300-0700 hours (Nights).

Sound monitoring will be conducted at the request of NSEL. Details of any required monitoring will be included in the Industrial Approval amendment application.

Transportation

In general, truck traffic associated with this Project is not anticipated to increase above that of the existing operation.

The transportation impacts of the proposed quarry expansion can be summarized by the following:

- The Panuke Road intersection is on a level section of Trunk 1 with adequate sight distances.
- Daily and peak hourly volumes on Panuke Road are estimated to be low.
- Traffic counts have indicated that daily and peak hourly volumes on Trunk 1 are low to moderate.

- Review of collision data does not indicate any history of collisions at the Panuke Road / Trunk 1 intersection.
- There have only been two property damage collisions, neither involving heavy trucks, on Panuke Road during the past five years.

Since the quarry has been operating for over five years, and since the proposed quarry expansion is not expected to affect existing average daily or hourly aggregate transport truck volumes, there should not be any noticeable impacts to the level of performance of the road network.

Recreation and Tourism

The Panuke Quarry is not located adjacent to any major municipal recreation facilities or commercial recreation areas so there will be little to no impact on tourism and recreation in the area.

Human Health

Human health related issues are discussed in Section 5.7 Air Quality and Sections 5.8.1 (traffic collision data). The health and safety of nearby residences is not expected to be affected by the Project.

In summary, assuming effective application of mitigative measures (*e.g.*, Pit and Quarry Guidelines, dust suppression) significant adverse Project-related effects on the socio-economic environment are not likely to occur. Continued operation of the quarry will result in economic benefits, including employment and ongoing business opportunities.

5.9 Other Undertakings in the Area

5.9.1 Description of the Existing Environment

The Proponent is not aware of any active pit operations licensed to operate within a 10 km radius of the Project. The Proponent is aware of two active quarry operations licensed to operate within a 10 km radius of the Project. Both Williams and Alva Construction Limited, operate quarries in the region between Five Mile Plains and St. Croix. Additionally, there is an adjacent quarry operation located due west of the Panuke Quarry under a lease from Hants County Aggregates Limited. Aggregate from this quarry is exclusively used to supply NSTIR developments. All operations are currently functioning with out any issues, in terms of noise, dust, emissions, traffic, *etc.*, and as the proposed expansion does not include an increase in production, assuming the effective application of mitigative measures, significant adverse Project-related effects regarding other undertakings in the area are not likely to occur.

6.0 EFFECTS OF THE PROJECT ON THE ENVIRONMENT

Activities associated with the proposed quarry expansion and operation will be conducted in accordance with terms and conditions of the existing Industrial Approval amendment for the MEL existing quarry operation, as well as future amendments to the Approval, and the Pit and Quarry Guidelines. Environmental effects of the quarry expansion will include the loss of some habitat within the proposed revised quarry expansion area. The Proponent has redesigned the Project to avoid interactions with the watercourse identified onsite. Field surveys conducted to date indicate that this area does not include unique habitat or rare or sensitive species; therefore, these effects are not anticipated to be significant.

There are no structures located within 800 m of quarry activities. Minor, localized impacts on air quality can be expected through the formation of airborne particulate matter. These impacts are readily controlled through standard mitigative measures (*e.g.*, dust suppression) and follow-up monitoring as necessary.

Assuming the mitigative measures specified in this report are implemented, and the quarry is operated according to existing provincial guidelines and approvals, no significant adverse residual environmental or socio-economic effects are likely. Continued operation of the quarry will result in economic benefits, including employment and ongoing business opportunities.

A stormwater management plan will be submitted as part of the quarry development plan during the Industrial Approval amendment application process.

7.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The definition of an environmental effect often includes any change to the project that may be caused by the environment. In the case of a quarry operation, potential effects of the environment on the Project are limited to climate and meteorological conditions, specifically precipitation. Precipitation and runoff may cause temporary delays in quarry construction, operation, and rehabilitation activities. Wet weather or snow may also affect hauling of material from the site.

On a national basis, Canada shows a warming and cooling pattern with a higher overall warming trend of approximately 1.1 °C since 1895. The Atlantic Region, however, shows a warming trend from 1895 which peaked in the mid 1950s followed by a cooling trend in the 1990s. The overall warming trend of 0.4 °C in Atlantic Canada since 1895 is not statistically significant. With respect to precipitation, the Atlantic Region shows an overall increasing trend in precipitation since 1948, with an increasing trend in the number of daily precipitation events above 20 mm and a very slightly increasing trend in the number of daily snowfall events above 15 cm (Lewis 1997).

There are a number of planning, design, and construction strategies intended to minimize the potential effects of the environment on the Project so that the risk of damage to the Project or interruption of service can be reduced to acceptable levels. Mitigation measures include, but are not limited to, designing and installing erosion and sediment control structures to accommodate appropriate levels of precipitation, and considering weather conditions when scheduling activities, including scheduling of activities to accommodate weather interruptions. All Project activities will be taking place out-of-doors and thus weather has been and will be factored into all Project phases and activities. The Proponent proposes that the quarry remain operational year round, weather depending, and will consider severe winter weather conditions when planning activities. Heavy snowfalls and significant snow accumulation will have an impact on the quarry's ability to remain open.

In summary, climate and meteorological conditions, including climate change, are not anticipated to significantly effect the operation of the quarry over its proposed lifetime.

8.0 OTHER APPROVALS REQUIRED

As stated in Section 2.0, the Proponent is required to register this Project as a Class I Undertaking pursuant to the Nova Scotia *Environment Act* and Environmental Assessment Regulations. Other relevant provincial regulations include the Activities Designation Regulations, which requires an amendment to the existing Industrial Approval from NSEL for operation of the Project; and the General Blasting Regulations made pursuant to the Nova Scotia *Occupational Health and Safety Act* (1996). Provincial guidelines to be adhered to include the *Pit and Quarry Guidelines* (NSDOE 1999). No municipal approvals are required.

9.0 FUNDING

The proposed expansion will be 100 percent privately funded.

10.0 ADDITIONAL INFORMATION

No additional information is provided in support of this document.

11.0 REFERENCES

11.1 Literature Cited

- Anson, William. 1893. Plan of the Township of Windsor from an actual survey. c.1820, copy by J.A. McCallum.
- Atlantic Canada Conservation Data Centre (ACCDC). 2007. Species Lists and Rare Species. Internet Publication: <http://www.accdc.com/products/lists/>.
- Church, A. F. 1871. Topographical Township Map of Hants County, Nova Scotia. A.F. Church & Co., Bedford, N.S.
- Conrad, Margaret. 1988. They Planted Well: New England planters in Maritime Canada. Fredericton, N.B: Acadiensis Press.
- COSEWIC. 2007. Canadian Species at Risk. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.
- Dawson, J. 2007. Mapmakers Legacy: Nineteenth-Century Nova Scotia through Maps. Halifax: Nimbus Publishing Ltd.
- Dawson, J. 1988. The Mapmaker's Eye: Nova Scotia through early maps. Halifax: Nimbus Publishing Ltd.
- Erskine, A. J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, 270 pp.
- Faribault, E.R. and Fletcher, Hugh. 1909. Province of Nova Scotia. Hants County. Windsor Sheet No. 73. Ottawa: Department of Mines.
- Gilhen, J. 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax, N.S. 162 pp.
- Health Canada. 2006. Guidelines for Canadian Drinking Water Quality.
- Keppie, J.D. 2000. Geological Map of the Province of Nova Scotia. Nova Scotia Department of Natural Resources (NSDNR) Minerals and Energy Branch. Map ME 2000-1. Scale 1:500 000.
- Lewis, P. J. 1997. Trends. In: Shaw, R.W. (ed.). Climate Variability and Climate Change in Atlantic Canada. Proceedings of a Workshop Halifax, Nova Scotia, 3-6 December 1996. Prepared for Environment Canada.
- Nova Scotia Department of Natural Resources (NSDNR). 2007. Endangered Species and Status of Wildlife. Internet Publication: <http://www.gov.ns.ca/natr/WILDLIFE/genstatus/specieslist.asp>.
- Nova Scotia Department of Natural Resources (NSDNR). 2007. Species at risk in Nova Scotia. Wildlife Species Protected under the Endangered Species Act in Nova Scotia. Internet Publication: <http://www.gov.ns.ca/natr/wildlife/endnrgd/specieslist.htm>.
- Nova Scotia Department of Natural Resources (NSDNR). 2006. Significant Habitat Mapping. Internet Publication: <http://gis1.gov.ns.ca/website/nssighabpub/viewer.htm>.

- Nova Scotia Department of Environment and Labour (NSEL). 2006. Nova Scotia Ambient Air Quality Monitoring Stations. Internet publication. <http://www.gov.ns.ca/cnla/air/docs/AirMonitoringNetworkMap.pdf>.
- Nova Scotia Department of Environment and Labour (NSEL). 2002. Guide to Preparing an EA Registration Document for Pit and Quarry Developments in Nova Scotia.
- Nova Scotia Department of Environment and Labour (NSEL). 1999. Pit and Quarry Guidelines. Revised May 1999.
- Nova Scotia Department of Environment and Labour (NSEL). 1988. Erosion and Sedimentation Control Handbook for Construction Sites.
- Nova Scotia Department of the Environment (NSDOE). 1998. "The State of the Nova Scotia Environment 1998". July 1998. Halifax, Nova Scotia.
- Nova Scotia Environment and Labour (NSEL). 1940-2004. Well Driller Log Database.
- Nova Scotia Watershed Series, 1980.
- Province of Nova Scotia. Crown Land Grants Index Sheet No. 73.
- Public Archives of Nova Scotia (2004). Place-Names and Places of Nova Scotia. www.gov.ns.ca/nsarm/cap/places.
- Statistics Canada. 2006. Population Census. Available at: <http://www.statcan.ca/>.
- Statistics Canada. 2001. Population Census. Available at: <http://www.statcan.ca/>.
- Stea, R.R., Conley, H., and Brown, Y. 1992. Surficial Geology Map of the Province of Nova Scotia. NSDNR. Map ME 1992-3. Scale 1:500 000.
- Tuck, J. (1984). Maritime Provinces Prehistory. Ottawa: Archaeological Survey of Canada.
- Trescott, Peter, 1969. Groundwater Resources and Hydrogeology of the Windsor-Hantsport-Walton Area, Nova Scotia. Province of Nova Scotia, Department of Mines, Groundwater Section. Report 69-2.
- Vaughan, Garth. 2006. Historic Windsor. Halifax: Nimbus Publishing.
- West Hants Municipality, Municipality of the District of West Hants Municipal Planning Strategy, Draft for Community Meetings. 2007. Available at: <http://www.windsorwesthantsplanning.ns.ca/docs/review/WHMPSdraft.pdf>.
- Wentworth, Henry. 1827. Windsor, Nova Scotia. Plan No. 1 Shewing the site of Fort Edward at Windsor with the Town Ground and Rivers around it.
- Windsor-West Hants Joint Planning Advisory Committee, Zoning Maps, Available at: <http://www.windsorwesthantsplanning.ns.ca/draftzoningmaps.html>.
- Wright, D.G. and G.E. Hopky. 1998. Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters. Canadian Technical Report of Fisheries and Aquatic Sciences 2107. Science Directorate, Central and Arctic Region and Habitat Management and Environmental Science, Directorate, DFO.