6.0 VALUED ENVIRONMENTAL COMPONENTS AND EFFECTS MANAGEMENT

6.1 GEOLOGY

6.1.1 EXISTING ENVIRONMENT

Physiography

The regional physiography of the western part of Hants County, surrounding the project area has been influenced by the variable hardness of four rock groups, soft sediments and the changing sea level. The Avon River Valley, with the St. Croix River, Kennetcook River, Cogmagun River and many other smaller streams draining into it, is located mainly on the softer rocks of siltstone, sandstone, gypsum and anhydrite of the Windsor Group and on the unconsolidated clay, silt, sand and combinations thereof with enclosed pebbles and cobbles (glacial and recent deposits).

The higher land to the south and west of the Avon River Valley is composed of harder sandstone and shale of the Horton Group, the slates and hornfels of the Meguma Group, and the intruded granitic rocks. The elevation on the highlands is at a maximum of approximately 240 masl at Moses Mountain and Upper Vaughan and averages about 150 to 200 masl.

The lowlands are hummocky with stream valleys and tidal marshlands. The elevation of the lowlands seldom exceeds 50 masl, with a few points reaching 90 metres at Cheverie Mountain and East Walton. There are some flat areas with bogs between Stanley and Kennetcook. There are only a few small lakes on the lowlands. Neily *et al*. (2003) identified 11,715 hectares of karst topography in the lowlands of Hants and Colchester counties.

The Avon Peninsula is defined as being within the perimeter formed by the St. Croix, Avon and Kennetcook Rivers and the Lawrence Road. It consists of tidal marshlands, dyked land, small drainage areas and many hills generally 30 to 60 metres high with a maximum height of 75.4 metres. The hill tops are 500 to 1000 metres apart. The area is underlain by the Windsor Group of rocks consisting of gypsum, anhydrite, limestone and siltstone. The surficial material over areas where there is no bedrock outcropping consists of silts, clays, and muds with scattered cobbles and some sandy areas. There are karst features throughout the area but they are more abundant in the higher central area.

Recent 2006 aerial photography indicates that there are more than 50 small ponds in the area. A large pond in the Highfield community has an area of 3.1 hectares and is used as a water supply for fire departments.

The area within the proposed Miller's Creek mine extension footprint consists of hills and drainage areas leading to Hemlock/Shaw brook. The maximum elevation is 73.8 masl and the lowest is 18 masl. The maximum relief occurs east of the Newport Plaster Mining and Manufacturing Company #2 Quarry where the hill is 72 masl and the small valley to the east of it is 22 masl.

Rock outcrops consisting of limestone, siltstone and gypsum occur throughout the footprint but are most common in the eastern half. Outcrops can occur near the top of the hills, the side of the hills, or on the valley floors.

The most abundant karst/sinkhole features occur on the side of hills and mainly follow the gypsum bedding. The size of the sinkholes varies from 0.5 x 1 m to 5 x 3 m. There is a large sinkhole near the north central part of the footprint with the Alison Pond at the base of it. Its lowest rim occurs at an elevation of 56 masl. It is 100 metres in diameter and 12 metres deep.

Karst Topography

Karst is a topographic feature with distinctive characteristics of relief and drainage arising from a higher than normal degree of solubility in rock, especially carbonate rocks and evaporites (Jennings 1971). The solution processes developed over many thousands of years manifests itself at the surface in the form of sinkholes, vertical shafts or pipes, disappearing streams, and springs to complex caves and underground drainage systems. Solution caves are known to occur in gypsum and limestone areas (Davies & Browne 1996).

In Nova Scotia, the gypsum-anhydrite strata, known as the Windsor Group, outcrop over extensive areas extending from the Minas Basin at Windsor to Antigonish and much of lowlands of Cape Breton, including the Bras d'Or Lakes costal areas. The Windsor Group underlies about 5.5% of the province's geology (Figure 6-1.1). Karst development across the province can be variable, depending on things such as bedrock type and purity, physiographic location and biogeoclimatic setting. Several periods of glaciation have exposed, eroded and reburied earlier developed karst leaving a thick deposit of glacial drift over many of these beds. However, where the strata have become exposed at the surface, a distinctive highly karsified landscape is evident. There is potential for karst development in any formation that contains highly soluble rock. While other formations exist that contain lesser amounts of evaporites (gypsum, anhydrite, limestone), the Windsor Group rocks with near surface gypsum and anhydrite is regarded to have the highest potential for karst development.

Paleokarst features have often been exposed during mining operations at the Miller's Creek and Bailey Quarries. An organic sample from the bottom of a 20 m section of drift at the mine was dated at 33,200 years B.P. (Roland 1982). This indicates that the topography was formed during the last interstadial and extending into the last interglacial periods.

Karst topography does not easily lend itself to development. Typically it is avoided for development because of the potential for sinkholes. The general unevenness of the terrain does not afford easy cultivation of forests or agricultural use unless a thick overburden or a smoother undulating surface is present. Karst is a unique resource with significant biological, scientific, cultural, recreational, and economic values. Karst areas in Nova Scotia have remained, except for mining activities, undeveloped.

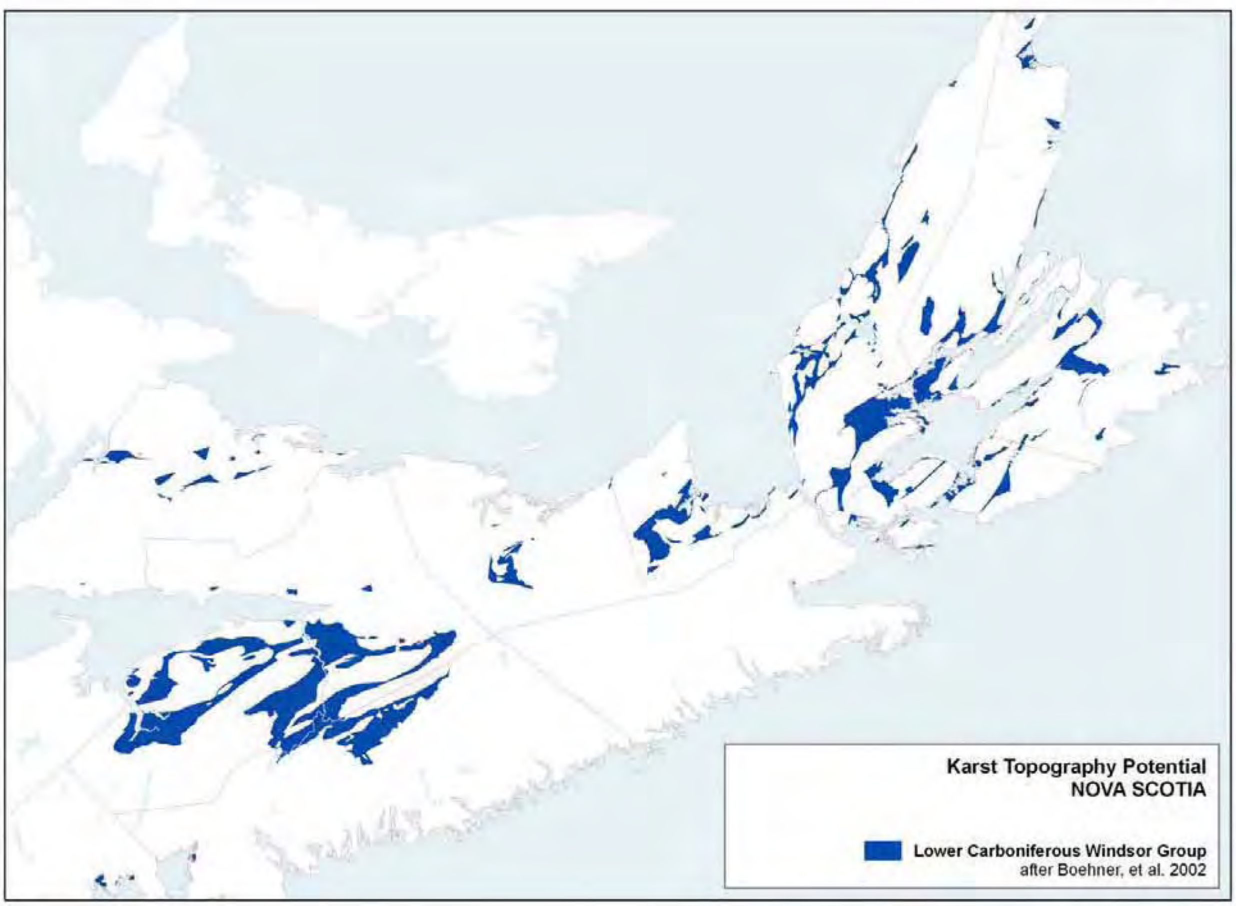


Figure 6.1-1 Karst Topography Potential in Nova Scotia

Surficial Geology

Regionally there are a wide variety of unconsolidated sediments on the bedrock and these vary widely in size of deposit and quality. Most of the material consists of mixed silt and clay with pebbles and cobbles of basalt, granite and occasionally gypsum. However, there are well sorted sand deposits along the east branch of the Avon River where it descends from the highlands, south of the area. There are less well sorted sand and gravel deposits along the St. Croix, Herbert, and Kennetcook Rivers.

In the Mudbank and Retreat Quarries of Fundy Gypsum, just north of Highway 14, east of Windsor, there are red uniform clay beds overlying a sand layer with wood fragments overlying the gypsum. In the Bailey Quarry, near Mantua, there are unconsolidated sands with occasional large wood fragments and occasional kaolinite clay within the gypsum that has been dated as Cretaceous by Falcon-Lang *et al.* (2006). This was overlain by cobble filled mud. On the west end of the Bailey Quarry, there was a river channel filled with gravel and sand that had flowed north to south and had eroded down to the gypsum before the channel was filled. A mastodon tusk was found in a fossil sink hole below 36 metres of overburden, about 350 metres to the east of this paleoriver channel.

There are tidal marshlands along the upper part of the Avon River that are dyked and undyked. This sediment is deposited during the upper half of the high tide when the turbid water floods into an area. The highland areas have abundant cobbles and boulders in with the unconsolidated sediment.

Unconsolidated tidal flat sediments occur along the river courses. The unconsolidated sediment consists of tidal river deposits along the flat areas along the dykes. Along the northern end of the Shaw Valley, there are small sand and gravel deposits. Fletcher (2004) identified a gravel filled channel above the limestone gypsum strata on the shore just north of Newport Landing.

The unconsolidated sediment is composed of clay, silt and cobbles. The thickest deposit was noted in borehole 657. It was 44 metres thick and is located in the southern part of the footprint.

Bedrock Geology

In the lowlands, the youngest bedrock is the Late Carboniferous Scotch Village Formation. It occurs mainly north of the Kennetcook River and extends from the Avon River on the West to beyond the Kennetcook River on the east and North toward

Walton. The sandstones are up to 300 metres thick (Moore *et al.* 2000). Highly folded and faulted marine sedimentary rocks lie below the Scotch Village Formation. These include the rocks of the Windsor Group. The previously mentioned sediments lie above the Horton Group sandstones and shales which were derived from the slates, hornfels, and granites of the surrounding highlands.

The bedrock below the unconsolidated surface material is shown on a Nova Scotia Department of Natural Resources Map 86-2 (Moore *et al.* 1986) as the Windsor Group and Canso Group. The Windsor Group consists of interbedded limestones, siltstones, anhydrite, salt and gypsum. Most of the limestones are less than 10 metres thick. The massive anhydrite at the base of the Windsor group is estimated to be 200 to 400 metres thick. The following thicknesses are based on (Moore *et al.* 2000): The Miller Creek Formation is approximately 72 metres thick at the type section; the Wentworth Formation above it is approximately 45 metres thick; and the Murphy Road formation above it is approximately 185 metres thick. The general trend of the strata is in an east west to east northeast to west northwest direction. There are abundant folds and faults in the strata. The faults have many orientations shown on the map (Moore *et al.* 1986). The oldest bed identified on this map is the Fisher Limestone member of the Miller Creek Formation in the Visean Series of the Carboniferous System. The youngest strata in the area are in the Canso Group, which consists of siltstones and gypsum and by definition does not contain a marine limestone bed.

The oil well Avondale #2 located at N4987830 E5529443 NSMTM 1979, close to the Avon River, intersected at the most only 19 metres of the MacDonald Road Formation (MacDonald 2003). Locally, this stratigraphic interval is referred to as the Miller Creek and Wentworth Station Formation. The oil well also intersected the salt zone of the Stewiake Formation at 199 metres below the surface.

Excluding household water wells the area has been explored and sampled with 153 diamond drilled test holes.

Stratigraphy

The footprint of the West Quarry project is underlain by the Miller Creek Formation, the Wentworth Station Formation, the Pesaquid Lake Formation and the Murphy Road Formation. All of the siltstone, limestone and gypsum beds of the Miller Creek formation are present. From oldest to youngest, they are the Basal Siltstone with an occasional massive fossiliferous bioherm, the Union Corner Dolostone, the McCulloch Dolostone, the Fisher Siltstone, the Fisher Limestone, the Mantua Limestone, the Belmont Siltstone, the Belmont Limestone, the Chambers Siltstone capped with a dolostone, the Big Red Siltstone, a green siltstone, the Marker Bed Limestone, and the Sanford Limestone. These units are interbedded with gypsum and anhydrite. The stratigraphic thickness is approximately 72 metres and comprises approximately 70% evaporite, 13% siltstone and 17% carbonate in the type section according to Moore *et al*. (2000).

The Wentworth Formation in the area consists of siltstones, limestones and sulphates. The non-sulphates from oldest to youngest are the St. Croix Siltstone capped with a limestone, the Phillips Limestone, the Dimock Siltstone and Limestone, and the North 60 Limestone. According to Moore *et al.* (2000), the thickness of the formation is approximately 45 metres in the type section and it consists of 61% evaporite, 29% siltstone and 10% carbonate.

In the outlined proposed extraction area, the rock consists of +/- 72% evaporites, +/- 13% carbonates, and +/- 15% siltstones.

Above the described Wentworth Station Formation there are additional limestones, siltstones and minor sulphates. One of the members is light beige oolitic limestone, which is 6 or more metres thick, and may have been referred to as the Miller Creek Oolite with a thick siltstone below it. There is also a thinner brown oolitic limestone in this stratigraphic section. All of these units probably occur within the Pesaquid Formation (Moore *et al.* 2000).

Other thick massive limestones and siltstones were intersected north and south of the deposit. These were not identified but belong to the Murphy Road Formation. No sodium chloride layers were found (Stewiacke Formation) but they may exist at depth in the White Quarry Formation.

Structure

The mine extension footprint is located on an eroded anticlinorium domal structure that has its main axis east-west. In the structure, the siltstones, limestones, gypsum and anhydrite have undergone intense plastic deformation. The limestones are generally stretched and pulled apart. The thicker siltstones frequently form the fold axis of tight folds. The wave length of the antiforms is generally 200 to 400 metres apart. Although the fold axes occur in a general east west direction, they can occur in all directions of the three dimensions.

There is faulting in the rock. It is generally identified when non-stratigraphic mudstones occur in the drill core or is known when stratigraphic intervals are missing. The more obvious faults occur near the base of the Murphy Road Formation and above the White Quarry Formation. The White Quarry formation was not found during Fundy Gypsum's core drilling programs in this area, but it is assumed that it lies at 200 to 300 metres depth.

Gypsum Conversion

Anhydrous Calcium Sulphate (anhydrite) is not stable in the presence of water on the earth surface in our current climate. It slowly converts to gypsum. The gypsum under the proposed footprint was derived from the anhydrite as indicated by the occasional anhydrite remnants found within the gypsum next to the anhydrite. With a microscope, one would be able to see the partly dissolved anhydrite crystals converting to gypsum Holleman (1976).

The gypsum is most common next to the siltstone and limestone beds. In the thicker sulphate beds, the anhydrite most frequently occurs at the centre. In the proposed mine extension deposit, the anhydrite generally begins 40 to 50 metres below the bedrock contact. At the middle of the deposit the anhydrite occurs 0 to 20 metres above sea level. On the west end it extends down to 15 masl and on the east end it goes down an average of 10 metres below sea level. Where a limestone or siltstone is vertical the hydration can go to more than 100 metres below the surface but those small areas are not mineable.

6.1.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP MONITORING

Acid Consumption and Production in Bedrock

Twenty-eight bedrock samples (Table 6.1-1) were sent to Dalhousie University to be tested for acid production/acid consumption capability. The samples came from representative strata that would be encountered during development of the mine extension area. The strata sampled were the Union Corner Dolomite, the McCulloch Dolomite, the Fisher Siltstone, the Mantua Limestone, the Belmont Limestone, the Chambers Siltstone, the Big Red Siltstone, the Sanford Limestone, the St. Croix Limestone, the Phillips Limestone, the Dimock Limestone, the North 69 Limestone and the interbedded gypsum and anhydrite.

The rock beds that will be disturbed and are net acid producing, as shown in the table are the gypsum beds between the Belmont Limestone and the Fisher Limestone. All other units are net acid consuming. The volume of net acid consuming units represents approximately 70% of the total volume to be mined. The remaining 30% that is net acid producing is product that will be shipped off-site.

The rock at the proposed mine extension site is similar to the rock in Fundy Gypsum's current Bailey Quarry. The monthly test results on the water drainage from this pit have been continually alkaline rather than acidic. The monthly average pH from January 2001 until October 2007 is 7.85. The maximum high and low numbers during that period is 7.21 and 8.2 (Figure 6.1-2)

Figure 6.1-2 Bailey Quarry Water Sample pH Values

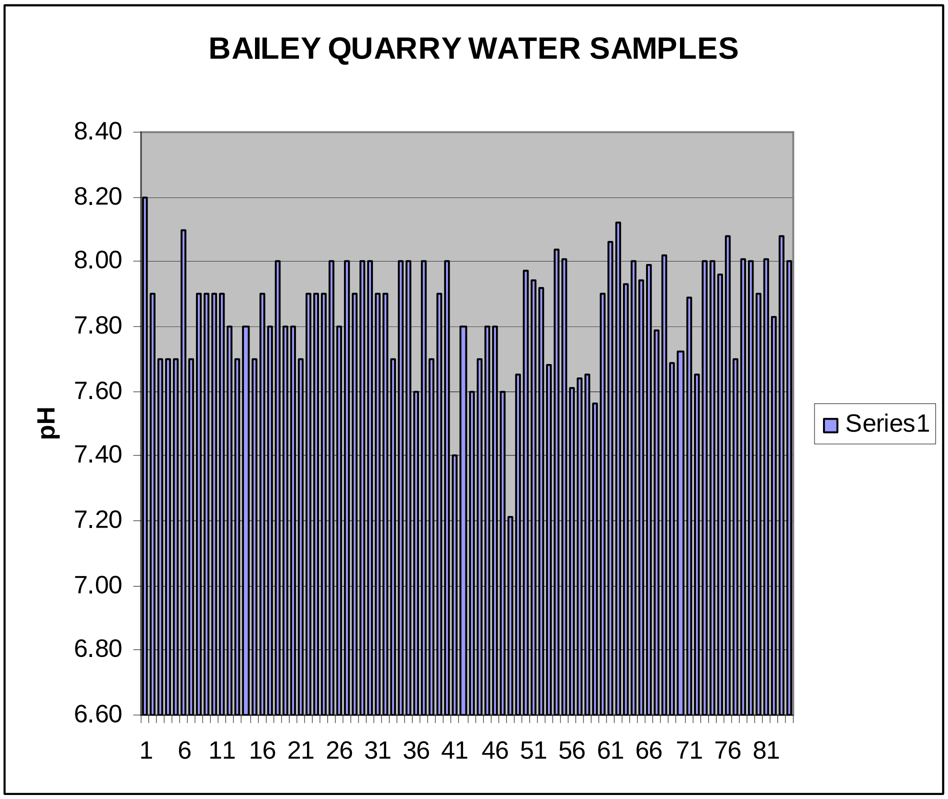


TABLE 6.1-1 – ACID PRODUCTION / ACID COMSUMPTION CAPABILITY													
		18-May-07						REPEAT ANALYSIS (31-May-07)					
		Wt. % S *			kg/t			Wt. % S			kg/t		
Sample	**Sample Description**	**Total**	**Sulphate**	**Sulphide**	**Acid Prod. Potential**	**Acid Cons. Ability**	**pH**	**Total**	**Sulphate**	**Sulphide**	**Acid Prod. Potential**	**Acid Cons. Ability**	**pH**
A-07-01	Dimock Lst/Slt	1.94	0.98	0.96	29.47	215.3	8.20						
A-07-02	Gyp above Dimock	18.27	17.32	0.95	29.14	29.3	6.70						
A-07-03	North 60 Dol/Slt	3.46	2.57	0.89	27.23	273.4	7.60						
A-07-04	Fisher Lst/Shl	1.93	0.79	1.13	34.70	217.8	7.65						
A-07-05	Gyp below Fisher	18.79	15.15	3.64	111.21	154.7	7.25						
A-07-06	Chambers Lst/Slt	5.25	5.17	0.08	2.53	44.0	6.90						
A-07-07	Sanford Lst	1.86	1.32	0.54	16.45	509.1	7.60						
A-07-08	Gyp above Sanford	19.72	19.66	0.06	1.77	34.2	7.25						
A-07-09	St. Croix Lst/Slt	2.27	1.67	0.60	18.49	375.2	7.90						
A-07-10	Basal Slt	4.93	4.57	0.36	11.13	22.0	7.30						
A-07-11	Union Corner Dol	8.25	7.54	0.72	21.94	395.2	8.65						
A-07-12	Gyp above Union Corner	17.87	16.93	0.94	28.80	92.1	6.95						
A-07-13	Gyp above Basal	19.65	18.59	1.06	32.43	14.7	5.90	18.86	18.59	0.27	8.41	14.7	5.90
A-07-14	McCulloch Dol	1.50	1.25	0.25	7.69	516.3	8.60						
A-07-15	Gyp above McCulloch	18.98	18.47	0.51	15.58	19.6	6.15						
A-07-16	Fisher Slt	4.72	4.71	0.02	0.49	73.4	7.90						
A-07-17	Gyp above Fisher Slt	19.31	18.26	1.05	32.11	67.3	6.90						
A-07-18	Belmont Lst/Shl/Slt	2.06	0.96	1.09	33.41	498.5	7.70						
A-07-19	Gyp above Belmont	17.33	17.29	0.04	1.34	78.2	6.85						
A-07-20	Mantua Lst (w gyp/anhy)	10.33	10.00	0.33	10.17	411.3	7.60						
A-07-20A	Gyp/Anhy b/w Fisher/Belmont	22.86	20.07	2.79	85.49	44.0	7.20	22.68	20.07	2.61	79.93	44.0	7.20
A-07-22	Big Red Slt	6.37	6.35	0.02	0.71	19.6	6.75						
A-07-23	Marker bed above Big R. (w gyp/anhy)	11.64	11.44	0.20	6.24	63.5	6.70						
A-07-24	Phillips Lst	2.22	1.27	0.95	29.08	179.8	7.50						
A-07-25	Gyp/Anhy b/w Phillips/Dimock	19.94	19.79	0.15	4.51	10.5	7.10						
A-07-26	Lst (monitoring well 2)	0.16	0.14	0.02	0.50	744.5	8.50						
A-07-27	Shl (monitoring well 2)	1.49	0.56	0.93	28.47	244.0	7.30						
A-07-28	Slt (monitoring well 2)	0.059	0.059	<0.01	<0.30	23.2	8.80						

Note: * **wt.%S + weight % sulphur**

Paleontology

The gypsum rock is not known to contain any fossils. However, the limestones, dolostones, siltstone and mixtures thereof interbedded with the gypsum contain fossil marine plants and animals of the Mississippian Period. The most obvious are the brachiopod, clams, crinoids, corals, bryozoa and ostracods. There are also many microscopic species described in the scientific literature. Dalhousie University makes frequent fossil collecting field trips to the quarries. The marine fossils can be rare or occur as fossil mounds as is exposed in the Avon River Bank by the old Newport Plaster Mining and Manufacturing shipping Wharf at Avondale (Newport Landing). Kerry Fletcher, a local geologist from Avondale, described the sand and clay deposits on top of and within the gypsum. Some deposits contain ancient tree fragments from the Cretaceous period.

Prior to the glaciers covering this area, there was ongoing sinkhole activity in the gypsum and limestone rocks. A mastodon tusk was found in a fossil sinkhole by equipment operators A. Wilcox and C. Card in the Bailey Quarry. The tusk was overlain by 36 metres of mud. The Nova Scotia Museum of Natural History was called in and additional paleontological work was done in the area. The tusk is now on display at the museum.

FG will continue to work with the Nova Scotia Museum and other interested parties as in the past if paleontological resources are found.

6.2 SURFACE WATER

Surface water resources (streams, ponds, lakes) are identified as a VEC for the Project. In this context, the VEC refers to surface water quantity and quality within the Project site and downstream. This VEC is also closely linked to fish and fish habitat, which has also been identified as a separate VEC and is discussed in detail in Section 6.7. To some extent, surface water resources will also have an interaction with groundwater resources (and vice-versa), which are described in Section 6.3.

Surface water resources have been identified as a VEC due to the interaction of the Project with local surface water elements. Potential regulatory issues governing this VEC include NSEL Watercourse Alteration (Water Approval) legislation, any Industrial Approval issued for the project with limits governing mine discharge, and CCME Guidelines for the Protection of Aquatic Life governing discharge and downstream water quality. A major concern for local residents is the potential impact on runoff and water quantity in existing streams, some of which are used for water supply in farming operations.

6.2.1 EXISTING ENVIRONMENT

The proposed mine extension is located on the Avon Peninsula, bounded by Avondale, Belmont and Ferry Roads. The site is characterized by a series of low rolling hills (described as knobs or knolls), with moderately incised drainages and valleys. Surface elevations across the site range from approximately 20 to 75 masl, with slopes ranging from 1 to 3%, with some local grades of up to 10%.

The peninsula is bounded to the north by the Kennetcook River and to the south by the St. Croix Rover. Both rivers flow west into the Avon River, which forms the western boundary of the peninsula. The Avon River then flows northwest, emptying into the Minas Basin.

The peninsula itself is drained by several small streams and creeks, as well as man-made agricultural drainage ditches. Many of the streams are ephemeral in nature, flowing only after rainfall events and during the spring freshet period. The drainage pattern is generally radially outward from the centre of the peninsula to the north, south and west, with ultimate discharge across the Avondale and Belmont Roads into the Kennetcook, St. Croix and Avon Rivers. Figure 6.2-1 shows the mapped watercourses on the peninsula.

The majority of the streams mapped in Figure 6.2-1 were examined at the locations where they cross below the Avondale and Belmont Roads. A baseline monitoring program was established by CRA in October, 2005 to monitor flow at each identified stream crossing on a monthly basis (if flow was present). Flow was monitored using a portable flow meter to measure depth/velocity across a stream cross section. For smaller streams with perched culverts, a bucket/stopwatch method was also used.

Table 6.2-1 presents a summary of the stream characteristics at each crossing location and the range of stream flows measured during the baseline-monitoring program. The streams included in the baseline monitoring are indicated in Figure 6.2-1. The complete flow data for the baseline flow monitoring is presented in Appendix B.1. Surface water samples were collected in accordance with industry standard protocol (Appendix B.4). Based on the tabulated data, it is evident that most of the streams flowing on the peninsula are ephemeral in nature.

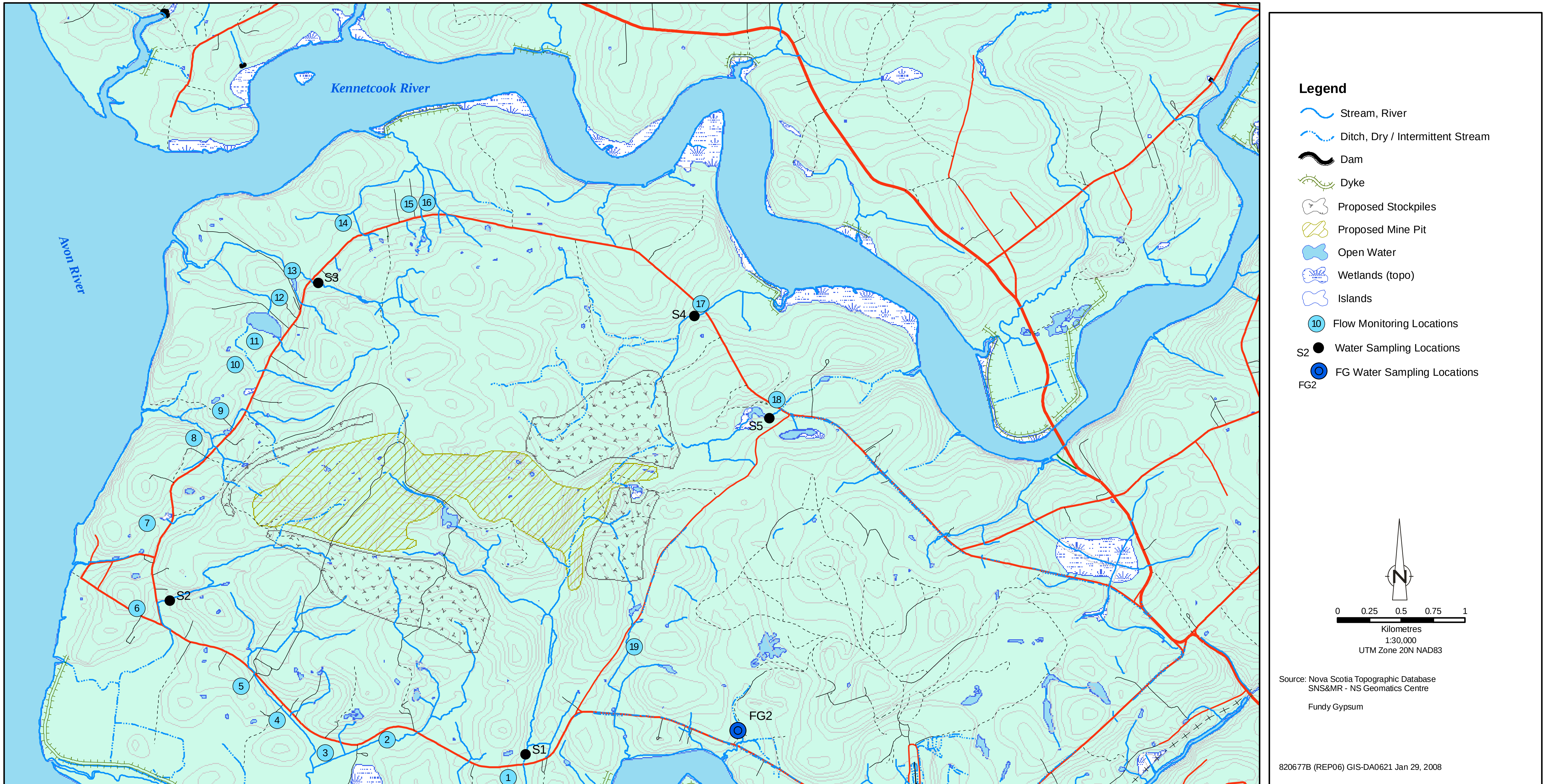


Figure 6.2-1
WATERCOURSES, POOLS & PONDS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

TABLE 6.2-1: STREAM CHARACTERISTICS AND FLOW SUMMARY

Stream Number[1]	Stream Name	Channel Characteristics[2]	Measured Stream Flow Range (L/s)
1	Shaw Brook	- Flows through agricultural area on either side of road - Channel is about 1 m wide by 0.5 m deep - 2 m wide by 1.2 m high wood box culvert under road - Additional CSP culverts upstream and downstream of box culvert for fording creek	6.2 - 326.5
2	Unnamed	- Small channel flowing below road through 1.2 m diameter CSP culvert - Ponded area at culvert outlet	0 - 134.0
3	Unnamed	- Small creek flows through 30" concrete culvert	0 - 6.0
4	Unnamed	- Small creek, channel about 1.2 m wide - Flows through 30" concrete culvert	0 - 8.3
5	Unnamed	- Small creek flows along road ditch prior to entering arched CSP culvert 1.4 m wide by 0.95 m high - Bends to left under driveway downstream of road	0 - 18.4
6	Unnamed	- Stream flows from east through treed area and then flows south along ditch, and through 0.9 m concrete culvert below driveway and continues south toward intersection, through field/pond and then under road via 0.9 m concrete culvert - Another twin culvert alongside also that likely takes drainage from ditch from east along road - Creek is about 3 m wide (top bank to top bank), ditch about 2 m wide	0 - 61.8
7	Unnamed	- Small stream flowing through 24" concrete culvert below road - Stream flows southwest along dirt road	0 - 10.7
8	Unnamed	- Small stream about 0.5 m wide - Flows through 24" concrete culvert below road	0 - 6.5
9	Unnamed	- Small stream about 0.5 m wide - Flows through 30" CSP culvert below road	0 - 21.1
10	Unnamed	- Small stream about 0.6 m wide - Flows through 24" CSP culvert below road	0 - 18.8
11	Unnamed	- Small stream - Flows through culvert below road near pond	0
12	Unnamed	- Very small stream/ditch	0 - 2.1
13	Unnamed	- Gravel/cobble bed stream, about 1.5 – 2 m wide - Flows west through 1.0 m diam. CSP culvert below road	0 - 36.9
14	Unnamed	- Small stream, likely mostly ditch drainage, some agricultural drainage - Flows through concrete culvert below road	0
15	Unnamed	- Small stream - Flow north through 24" CSP culvert	0 - 5.5
16	Unnamed	- Small stream, about 0.5 m wide - Flows through concrete culvert below road	0
17	Fish Brook	- Upstream section is narrow, through flat, open floodplain area - 1.45 m wide by 1.5 m high wood box culvert under road - Pool downstream at culvert outlet – appears to be backwatered by ford further downstream - Shallow, weedy downstream	0 - 125.0
18	Unnamed	- Small stream, about 1 – 1.5 m wide - Forested area upstream - Flows east through 30" concrete culvert below road	0 - 80.8
19	Unnamed	- Small stream, draining pond - Flows through ~24" PVC culvert below road	0 - 6.1

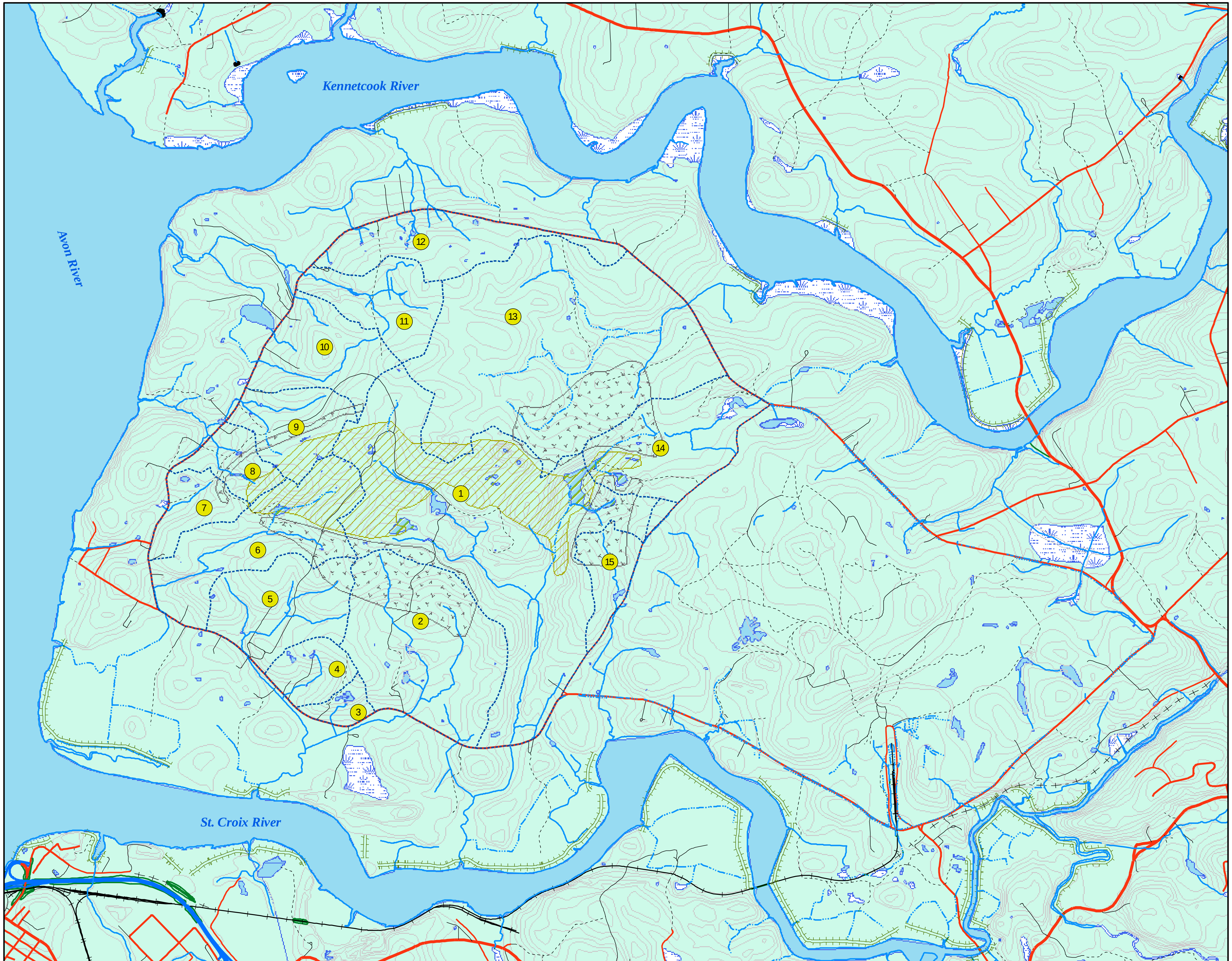
Notes: 1. Refer to Figure 6.2-1 for Stream Locations.
2. Characteristics observed near road crossing location.

The two most significant drainage channels in terms of length and catchment area that drain the peninsula are Shaw Brook and Fish Brook (monitoring locations No. 1 and 17, respectively, on Figure 6.2-1). Shaw Brook flows southeast from the centre of the peninsula and then southward draining into the St. Croix River. The stream drains a catchment area of approximately 318 ha. Photos 6.7-2 and 6.7-3 (see Section 6.7) show views of the creek upstream and downstream of the Avondale Road crossing, respectively. The headwaters of Fish Brook originate on the northern portion of the peninsula and flow northeast draining into the Kennetcook River. The brook drains a catchment area of approximately 303 ha. Photo 6.2-1 shows an upstream view along the brook from the Belmont Road crossing. Additional information on these watercourses is provided in the fish habitat description in Section 6.7.

Photo 6.2-1: View upstream along Fish Brook from Belmont Road crossing.

Figure 6.2-2 shows the subcatchment delineations for the major drainage courses and provides an accompanying table of catchment areas. Note that separate catchments were only delineated for the larger watercourses, as shown in Figure 6.2-2. Smaller creeks and ditches have been grouped together in catchments adjacent to the main catchments.

Several small ponds are also scattered across the peninsula, with most appearing to be either sinkholes that have developed as a result of the underlying geology or are remnants of historic small quarries and pits. Some of the ponds are tied into the drainage network of streams described above, while others are isolated and have no obvious inflow or outflow channels.



Legend

Proposed Mine Pit

Proposed Stockpiles

Wetland Area

Catchments

Catchment No.	Area (ha)
1	318.5
2	143.8
3	12.7
4	27.8
5	74.7
6	100.8
7	29.3
8	27.4
9	48.7
10	64.2
11	53.7
12	67.5
13	303.1
14	86.7
15	28.2

0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
Fundy Gypsum

820677B (REP06) GIS-DA0622 Feb. 14, 2008

Figure 6.2-2
CATCHMENT AREAS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

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Vernal pools are small pools which are filled with water from snow melt and surface runoff in early spring. As they do not have a regular supply of surface water, nor are they connected to a groundwater supply, these pools are usually not permanent. Because vernal pools often dry up by summer's end, they do not provide suitable habitat for breeding populations of fish, or for amphibian species with multi-season larval stage. Because of the lack of fish predation, these pools provide habitat for species whose larvae would otherwise be consumed by fish. Such obligate vernal pools species include mole salamanders (such as the yellow- and blue-spotted salamanders), spring peepers and wood frogs. These species have short larval development stages which can be completed within the relatively short time frame in which the vernal pools contain water.

During the wetland surveys in May and June 2007, forty-one small vernal pools were located on the study site within the proposed footprint of the Project. The karst topography of this area has resulted in sinkhole depressions which collect runoff and function as vernal pools. These pools contained less than 50 cm of water in May, and were considerably shallower in June. Most were situated in sinkhole depressions less than two metres deep. Vegetation was usually limited to sedges and ferns ringing the perimeter of the pool. No rare species of flora or fauna were detected in any vernal pools, nor was any true aquatic vegetation observed. In June, many vernal pools contained yellow-spotted salamander eggs masses and/or spring peeper and wood frog tadpoles. Adult wood frogs were also frequently encountered near the edges of these pools. As sinkholes are very common on the Avon Peninsula, similar vernal pools are located in areas off the project site.

One of the identified uses of the surface water supply on the peninsula is for agricultural purposes (*e.g.* livestock watering, irrigation). There are no known water withdrawal approvals or permits in place for any agricultural users. Water withdrawal permits and approvals are generally issued by NSEL for large quantity users. It appears that water use for agriculture is limited to the larger streams such as Shaw Brook, where catchment areas are large enough to provide sufficient and regular (*i.e.* non-ephemeral) runoff volumes. Water has been historically withdrawn by agricultural users on an as needed basis.

Water for processing operations at the mine is not required, as the processing involves dry crushing only. Water for dust suppression may be required during drier periods of the year. During initial mine development, water for dust suppression would be sourced from the existing Bailey Quarry, and later would be sourced from a sump developed in the extension area pit or other on-site settling ponds.

Hydrology

As outlined in the climate description for the area in Section 6.8 of this document, the peninsula receives abundant precipitation throughout the year (over 1000 mm). Much of the annual precipitation is converted to runoff drained by the many watercourses and ditches.

A hydrologic budget was completed for the area to determine average trends in the various water budget components and monthly water surplus available for runoff. The budget was compiled using a simple hydrologic budget model. The model is operated by Meteorological Services Canada (MSC) and is based on the Thornthwaite and Mather water balance procedure (Johnstone and Louie 1983). The procedure accounts for temperature, precipitation, snow storage and melt, evapotranspiration, and soil water holding capacity for a given area. Model input consists of mean daily temperature and precipitation data for the station and period of interest, station latitude, and site soil and vegetation cover information (used to estimate soil water holding capacity). The model was run using the Summerville climate station data (MSC ID# 8205650) for the period 1966 to 2003 as input, along with assumed soil water holding capacities of 75 mm (agricultural land) to 225 mm (forested land). The Summerville data was used because of its length of record, geographic location and proximity to the site.

Figure 6.2-3 summarizes the model output for average monthly conditions. The figure plots the total precipitation, available free water each month (*i.e.* sum of rainfall and snowmelt), evapotranspiration loss for each month (*i.e.* amount of water evaporated or transpired from a vegetated surface), and the net water surplus (*i.e.* excess water remaining after evapotranspiration demands have been met and soil storage is returned to its water holding capacity level). The figure indicates that the amount of available free water is highest in March, which corresponds to the spring melt period. Available water then levels off over the summer months, corresponding to a decrease in rainfall and increased evapotranspiration. Evapotranspiration losses steadily increase during the spring as temperatures rise and days lengthen, to a peak of 120 mm in the month of July. As indicated in Figure 6.2-3, evapotranspiration losses exceed available water (*i.e.* rainfall) between June and August. In these months moisture is drawn from soil storage to satisfy demand. The overall effect of the moisture gains and losses is shown in Figure 6.2-3 as the net water surplus for each month. As would be expected, water surplus is relatively high in the fall, winter and spring, given the abundant precipitation in the region. Surplus falls in the summer as evaporative demands increase, to a minimum surplus of 10 mm over the region in July.

Based on the water surplus predicted from the water budget model, average monthly runoff rates can be determined. Runoff can also be estimated from nearby gauged streams, by prorating the gauged values based on contributing catchment area size of the gauge versus the catchment area of the stream in question. Two Water Survey of Canada (WSC) stream gauges with historic data are located near the peninsula. The St. Croix River at Hartville (Sta. No. 01DE002) is located approximately 10 km southeast of the site, with a period of record from 1915 to 1934. The North Brook at Sheffield Mills (Sta. No. 01DD005) is located approximately 35 km northwest of the site, with a period of record from 2000 to 2005. Flow data was obtained for both gauges and used to estimate runoff for the various catchment areas delineated. The runoff estimates from both the hydrologic budget calculations and the prorating of the gauge data are presented in Table 6.2-2.

TABLE 6.2-2: SUMMARY OF RUN-OFF ESTIMATES

Catchment No.[1]	**Area**		**Average Monthly Discharge Estimates**					
			Hydrologic Budget[2]		**Pro-rated - St. Croix R.**[3]		**Pro-rated - North Bk.**[4]	
	(ha)	**(acre)**	**(m^3/d)**	**(Igpm)**	**(m^3/d)**	**(Igpm)**	**(m^3/d)**	**(Igpm)**
1	318.5	787.0	4,730	722	6,149	939	6,095	931
2	143.8	355.3	2,135	326	2,776	424	2,752	420
3	12.7	31.4	189	29	245	37	243	37
4	27.8	68.7	413	63	537	82	532	81
5	74.7	184.6	1,109	169	1,442	220	1,430	218
6	100.8	249.1	1,497	229	1,946	297	1,929	295
7	29.3	72.4	435	66	566	86	561	86
8	27.4	67.7	407	62	529	81	524	80
9	48.7	120.3	723	110	940	144	932	142
10	64.2	158.6	953	146	1,240	189	1,229	188
11	53.7	132.7	797	122	1,037	158	1,028	157
12	67.5	166.8	1,002	153	1,303	199	1,292	197
13	303.1	749.0	4,501	688	5,852	894	5,801	886
14	86.7	214.2	1,287	197	1,674	256	1,659	253
15	28.2	69.7	419	64	544	83	540	82
Total	1,387	3,428						

Notes:
1. Refer to Figure 6.2-2 for catchment delineations
2. Based on results of hydrologic budget model (based on assumed uniform soil water holding capacity of 150 mm)
3. Based on data from St. Croix River at Hartville (WSC Sta. No. 01DE002)
4. Based on data from North Brook at Sheffield Mills (WSC Sta. No. 01DD005)

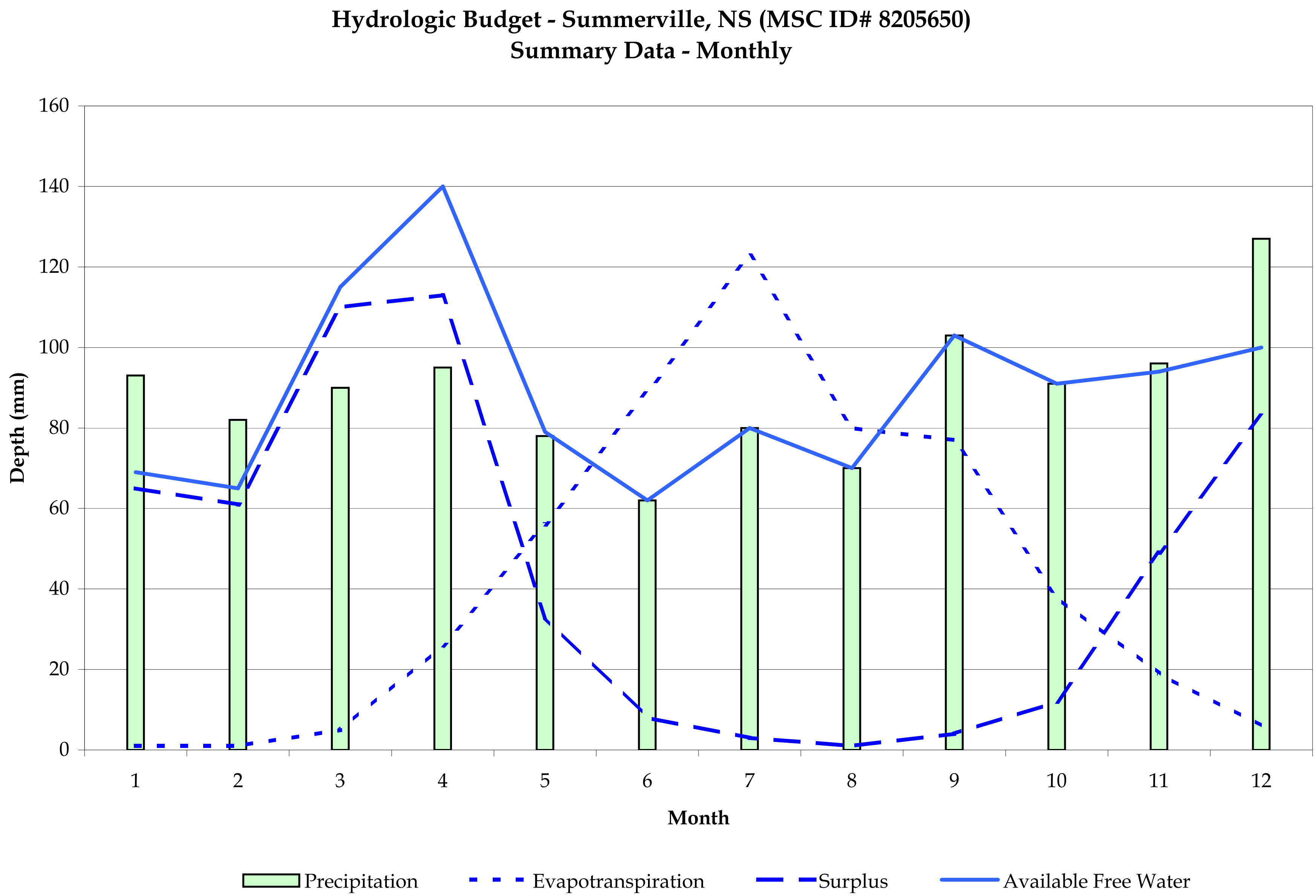

Figure 6.2-3
SUMMARY OF HYDROLOGIC BUDGET DATA
Miller's Creek Extension Project
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Hants County, Nova Scotia

Several of the streams identified on the mapping were also monitored over the course of several months to assess baseline discharge/runoff information. Figure 6.2-1 indicates which streams were chosen for monitoring. A total of 19 monitoring locations were established, to ensure full coverage of the area, and given the small size and ephemeral nature of many of the streams. Flows were measured in each creek on a monthly basis, if flow was present in the creek and if ice/snow cover was absent. Appendix B.1 presents a summary of the baseline discharge information collected. The information will serve as a basis for comparing flows during monitoring activities during mine operation.

Water Quality

FG has collected monthly surface water samples at five locations (S1-S5) around the peninsula since November 2004 (Figure 6.2-1). A sixth location (S6) was added in November 2005. These samples are analysed for general inorganic chemistry, nutrients, suspended solids, and metals. Monthly environmental compliance monitoring (in accordance with the Industrial Approval 91-041 issued by NSEL) is also conducted at the discharge outlets of the existing Miller's Creek Quarry and Bailey Quarry settling ponds (Figure 6.2-1). These samples are analysed for pH, suspended solids, ammonia, oil and grease and acute toxicity. Appendix B.2 provides the data for each sampling station. All concentrations are total values for unfiltered samples.

Four inorganic nutrients were measured: ammonia, nitrite, nitrate and phosphate. Nitrate and ammonia did not exceed the CCME guidelines (0.57 to 1.86 mg/L depending on temperature and pH) for Freshwater Aquatic Life (FWAL) at sampling stations S1-S5. The average phosphorus concentration at S1, S2 and S3 are extremely high on occasion at levels of 100 to 1200 µg/L in 2006 and at 200 and 400 µg/L at S1 in 2005. However, the lab detection limit is too high to adequately determine nutrient loading. It is likely that phosphorus limits are at eutrophic levels. The source of this nutrient loading is agricultural related. The sampling locations are downstream of local livestock farms and fields. Total ammonia in the final discharge effluent from the Bailey Quarry and Miller Creek Quarry settling ponds exceeded the CCME guideline for FWAL on six occasions (average exceedance by 0.66 mg/L) and 13 occasions (average exceedance by 1.2 mg/L, excluding the 24 mg/L value), respectively over 10 years of monthly monitoring. The concentration of nitrate is well below the CCME livestock water level of 100 mg/L. However, for the existing quarries, the CCME FWAL does not apply as the discharges flow along drainage channels that are not considered fish habitats. The Bailey Quarry discharge channel is along an old roadway and the Miller Creek discharge channel is a ditch along the railyard. Both conduit channels flow into the St. Croix River which is estuarine/marine. CCME does not have nitrogen/ammonia guidelines for marine waters. Due to occurrence and the infrequent nature of the exceedances at the non-operating Miller Creek Quarry and the location of the storage facility, ammonium nitrate handling is the most likely cause.

Conductivity, total dissolved solids, major anions (sodium, calcium, magnesium and potassium) and major cations (sulfate and chloride) concentrations are high due to dissolved minerals in the area geology rendering the water very hard. Dissolved ions are derived from the weathering of rocks and from precipitation. Conductivity concentration ranges extensively in the 1000s and 100s range. Cation concentrations reflect the presence of gypsum (calcium sulphate dihydrate) and dolomite (calcium magnesium carbonate) in the elevated levels of magnesium and calcium. Sampling locations S1, S2 and S3 have the highest calcium concentrations, followed by S4 and S5 which had calcium levels one order of magnitude less, but still elevated above typical Nova Scotia concentrations for watercourses in igneous or metamorphic geology. Sodium and chloride are elevated at S2 and highest at S5 which may indicate effects of road salt, tidal influence and or sea spray. Average magnesium concentrations are relatively consistent, with SW1 having the highest levels above the other sampling locations. Sulfate concentrations range in the high 100's at S1 and S2 due to the gypsum.

Despite the watersheds having been logged and farmed, turbidity and total suspended solids are low despite the high silt content in the surficial soils and erosion in the woods and fields. The concentration of total suspended solids (TSS) (and turbidity) were above provincial guidelines of 50 mg/L for a single grab sample in April of 2006 and March 2007 at all sampling locations. The highest levels were at S1, S2 and S3.

Alkalinity is very high at all stations, the limestone/dolomite is comprised of carbonate. This significant buffering capacity of the geology is also reflected in the pH levels, which ranges from 7.0 to 8.2 over all sampling locations.

The majority of metal levels are below detectable levels. Aluminium and iron exceed the Canadian Council of Ministers of the Environment Fresh Water Aquatic Life (CCME FWAL) at all stations, a feature of Nova Scotia surface waters. The presence of heavy metals above detectable limits is not frequent. Some concentrations of zinc are questionable considering its non-detection for most months at all stations and when present in single digit levels. A lab or transcription error might be the cause of the outlier high values. The higher than typical levels of strontium is likely due to the proximity of the water sampling location to seawater and its presence in dolomite and limestone.

The routine compliance monitoring at the two mine settling ponds show only a few exceedences since 2000. Ammonia exceeds the FWAL guideline six times at Miller's Creek Quarry settling pond and once in the Bailey Quarry settling pond. Exceedences of provincial guideline for a single grab sample for total suspended solids occurred seven times at Miller's Creek Quarry in seven years and all except one appear to be related to rainfall or snowmelt. Six exceedances in TSS occurred at Bailey Quarry settling pond over the seven years, of which three were related to rainfall or snowmelt. In both ponds, the pH levels are consistent, all acute toxicity tests received pass results and there is no presence of oil and grease.

FG has also been conducting long-term monitoring of their discharge from the settling ponds in the existing Miller's Creek and Bailey Quarries. Data for these two sites are provided in Appendix B.3. The data provides an indication of water quality levels attainable from the operating mine.

6.2.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP MONITORING

The potential effects of the Project activities on the surface water resource VEC include the following:

- Reduction in flow rates and overall runoff volumes for individual catchment areas/streams due to interception of rainfall and surface runoff by the mine pit and stockpiles;
- Potential localized increase in runoff due to removal of soils and forest cover leading to reduced evapotranspiration rates, and reduced interception and infiltration rates;
- Reduction in stream base flows due to change in groundwater table elevation or flow regime as a result of pit development;
- Reduced water quality due to introduction of contaminants during operation, such as nitrates/ammonia from blasting and petroleum hydrocarbons from refueling or accidents, and;
- Increased sedimentation in streams and higher sediment loads due to increase in sediment laden runoff during development and operation.

The spatial boundary associated with this VEC encompasses the Project site located within the Avondale-Belmont-Ferry Roads loop, and extends to the ultimate discharge of the water courses into the St. Croix, Avon and Kennetcook Rivers. Refer to the mapping on Figures 6.2-1 and 6.2-2 and a discussion of the existing environment above. Based on mapping and baseline data collection, it is assumed that the relative magnitude of flow in the watercourses in comparison to the receiving waters is too negligible to warrant the need to consider impacts in the receiving waters themselves or further downstream. The Project will directly interact with this VEC in all areas of disturbance in or near a watercourse, such as the mine and stockpile footprints, roads, and site drainage controls such as berms, ditches, etc.

The temporal boundary will extend over the life of the Project, which is expected to operate continuously over 35 to 50 years. It should be noted however, that the mining and reclamation plans are progressive, so that not all components *(i.e.* streams) in the VEC will be affected at the same time.

A significant adverse effect with respect to surface water resources would include the following:

- Decrease in runoff volume or flow rate from an otherwise adequate (*i.e.* non-ephemeral) stream to the point where supply is inadequate for present use (*i.e.* farming)
- Discharge of effluent or stormwater runoff to a receiving stream with TSS concentration greater than that stipulated by any IA (50 mg/L grab sample; 25 mg/L monthly average)
- Discharge of a toxic substance to a watercourse which could impact downstream users *(e.g.* livestock watering), existing aquatic species in the watercourse, or fish habitat in downstream receiving waters.

6.2.3 DEVELOPMENT AND OPERATION

One of the main potential impacts of the proposed mine development on surface hydrology will be the loss of runoff quantity in some of the drainage channels due to the influence of the mine footprint on drainage patterns. As the excavation of the pit progresses, rainfall, snow and snowmelt occurring over the pit footprint will be captured within the pit and collected in the pit bottom, rather than flow overland as runoff as the surplus water does at present. In addition, portions of a creek's contributing catchment area that do not lie within the pit footprint, but are cutoff from the lower portions of the catchment by the pit will essentially drain into the pit rather than the downstream channel. Thus, the portion of a stream's contributing catchment area that the pit footprint covers and any headwater areas above the pit will no longer contribute directly to stream runoff. Material stockpiles will also act to intercept rain and snowfall; however, runoff quantities should not be affected significantly as infiltration and surface runoff will still occur over these areas as long as they are contoured appropriately.

The proposed pit footprint and overburden and waste rock stockpile locations are shown superimposed on the catchment area delineated in Figure 6.2-2. Much of the pit footprint lies within the contributing catchment area for Shaw Brook, which is Catchment 1. Surface drainage normally directed to the brook in this portion of the catchment would now be captured by the pit itself. In addition, drainage from the portions of the catchment area to the north and east of the pit will also be intercepted by the pit. Based on the mapping, the total portion of the Shaw Brook catchment area covered by the pit footprint is approximately 108 ha. The areas of the catchment to the north and east of the pit total approximately 51 ha. Thus, the total potential lost area contributing to runoff to Shaw Brook would be approximately 160 ha, or just over 50% of the total catchment area for the brook of 318 ha. It should be noted however, that progressive sequencing of the pit development and reclamation will mean that the full extent of the pit footprint will not be impacting the catchment at one time. Therefore, the 50% noted above would represent a worst case scenario. Table 6.2-3 summarizes the percentage of impacted areas for each catchment. Besides Shaw Brook, the pit and stockpile footprints will also encroach on some of the other catchment areas delineated in Figure 6.2-2 to a lesser degree. Catchment 6 would have approximately 30% of its catchment area lost to the pit and a maximum of 12% covered by stockpiling, while Catchment 13 would see a maximum of 15% covered by stockpiling.

TABLE 6.2-3: PERCENTAGE OF CATCHMENT AREA IMPACT

Catchment ID	Catchment Area (ha)	Area Disturbed (ha)	Percent Disturbed
1	318.5	169.6	53.2%
2	143.8	0.0	0.0%
3	12.7	0.9	6.9%
4	27.8	0.0	0.0%
5	74.7	6.0	8.0%
6	100.8	43.0	42.6%
7	29.3	1.2	4.3%
8	27.4	6.1	22.4%
9	48.7	14.2	29.2%
10	64.2	0.4	0.6%
11	53.7	0.0	0.0%
12	67.5	0.0	0.0%
13	303.1	53.4	17.6%
14	86.7	21.2	24.4%
15	28.2	11.0	39.2%

The pit and stockpiles will also alter the natural hydrologic cycle in the project vicinity to some extent, which will impact the longer-term water balance for some of the catchment areas. Clearing of trees, other vegetation and soil for the pit development will act to reduce rain and snowfall interception and infiltration and also reduce evapotranspiration rates. In the short term (*i.e.* during/after a rain event) this would act to increase runoff quantity and peak flow rates. This would be more evident for areas covered by stockpiling, as pit areas would see flow collecting in the pit rather than running off. For stockpile areas however, the increased infiltration and attenuation effects through the stockpile would act to offset the potential increases in peak flow rate. Over the longer term water balance, there would also likely be a slight increase in water surplus due to less uptake of water by the lost vegetation and reduced evapotranspiration. However, higher evaporation rates for pooled surface water in the pit (mainly during the summer months) would act to offset some of the increase in the overall water balance. For stockpile areas, the net effect will depend on existing vegetation cover type and extent in the footprint area and the type of material being stockpiled.

Another consideration in the hydrologic balance is the impact of the pit excavation on local groundwater elevations and flow patterns. Flow patterns will likely be altered in the area of the pit, which may reduce base flows to some headwater streams near the pit. The pit and stockpiles may also have an impact on local groundwater recharge from surface water percolation, again potentially impacting base flows. Further details on groundwater and potential impacts are discussed in Section 6.3.

Based on the above discussion it may be concluded that qualitatively, the Project impacts on some local surface watercourses would result in a net decrease in surface water quantity, in particular to Shaw Brook. Exact quantitative amounts are difficult to predict, however they would likely parallel the percentage losses in contributing catchment area lost to the pit.

Avoidance of watercourses and other wet areas (*e.g.* wetlands) will be the first mitigative measure employed, where at all possible. However, complete avoidance will not always be possible. In order to minimize and mitigate the losses in runoff quantity, the stockpile areas will have perimeter ditches to collect runoff (Figure 5.6-6) which would be re-directed to a settling pond to ensure settling of sediments before sufficient vegetation is established on the stockpiles. Runoff collected and treated in the settling ponds would then be discharged back to the downstream catchment area to ensure flow quantity is maintained in the lower reaches of the impacted streams. Similarly, the mine will also have storm water ponds incorporated into its design, to ensure proper settling of fines generated during mining operations within the pit and to collect intercepted rainfall and runoff for discharge back to the impacted catchment area (namely, Shaw Brook). This will ensure a continual supply of treated water to downstream watercourses similar to current runoff and base flow rates. Additional information on settling ponds and their current use in the existing Miller's Creek and Bailey's Quarries can be found in Section 6.7. The baseline flow data collected for the various streams in the area will provide a basis for supply estimates and monitoring of impacts to water quantity.

With respect to water quality, standard precautions and best practices will be adopted during both the development and operation phases of the Project. Examples include secondary containment measures for fuels and oils, locating refuelling areas away from watercourses, and ensuring vehicles are maintained regularly to prevent unnecessary leakage of fuel or oil. Contingency plans and emergency response procedures will be developed during the IA process, prior to construction or operation activities. The discharge channels for the mine have not been determined at this stage. Shaw Brook, which may receive much of the settling pond water, is not fish habitat due to the obstructions and destruction of habitat it has been subjected to. Therefore, the fish habitat occurs in the St. Croix and Kennetcook Rivers which are estuarine and marine. However, this situation does not permit untreated discharges or disregard for guidelines and the aquatic environment. Nitrate/ammonia levels in the site discharge water will be monitored for the mine extension area as required now for the existing operations. Improvement will be made in storage and handling controls in transfer and loading practices to reduce and minimize dispersion of ANFO compounds at the storage area. Recommendations are provided in Gordon Reevey's 1996 paper *Practical Methods to Reduce Ammonia and Nitrate Levels in Mine Water*. Such controls have been shown to reduce ammonia levels in mine water by up to 50%.

During development and operation, a stormwater management plan will be in place to ensure runoff from all disturbed areas is properly treated by utilizing both short term (*e.g.* silt fencing, diversion ditching, temporary check dams) and long term (*e.g.* permanent ditching, storm water ponds, buffer zones) stormwater and best management practices. Temporary controls may be required during initial mine development to ensure that discharge quality limits are met before the pit is able to function as a settling pond itself. Comprehensive sediment and erosion control for all project phases and stormwater management plans would be developed during the industrial approvals process, which would conform to all NSEL guidelines and requirements, such as the NSEL Erosion and Sediment Control Handbook for Construction Sites. Monitoring of off-site discharges will be carried out by FG on a continuous basis during both development and operation, according to NSEL requirements for frequency and parameters.

A comprehensive monitoring program would be developed during the IA stage, to monitor water quantity and quality at key locations and identified source water streams. The monitoring program would help guide protective measures developed for quality and quantity control. For example, discharge from settling ponds back to streams would be monitored to ensure baseline flow levels are maintained, particularly at drier periods during the year. Individual monitoring programs for known (non-regulated) users may be required to ensure continued quantity supply. These would be addressed during the IA approval stage as required. It is FG's intent to work with local surface water users to help maintain existing uses.

Reclamation

Reclamation will proceed incrementally as the mining operations continue and move from east to west. The ultimate reclaimed area will likely feature at least three separate small lakes within the pit footprint, and complete revegetation of all stockpiles and disturbed areas. The lakes would serve multiple purposes, including recreation, habitat and as a continued supply of water to downstream areas as required. Monitoring of water quality would continue as required by NSEL.

6.2.4 SUMMARY

The proposed mine footprint and stockpiles will have an impact on surface water drainage patterns and runoff distribution over the life of the project. Minor changes to the overall hydrologic budget for the area are also expected. The majority of impacts to water quantity would be for the Shaw Brook catchment, within which the majority of the pit development will take place. In order to ensure continued water supply to the downstream reaches of impacted catchments, rainfall and runoff intercepted by the pit and stockpile areas will be collected and treated in storm water ponds followed by controlled release back to the watershed. Following reclamation, a system of lakes in the headwaters of the peninsula would ensure continued supply of water downstream. Proper storm water management and other mine management best practices will also be employed to protect water quality for all discharges from the site. As a result, there are no cumulative or adverse effects anticipated to surface water resources on the peninsula as a result of the project.

6.3 GROUNDWATER

Groundwater is considered a VEC because of its importance as a water supply, as well as in the hydrologic cycle and ecological function. Groundwater originates from percolation of precipitation and surface water into the ground where it fills voids between individual grains in unconsolidated materials and fractures in consolidated materials. The upper surface of the saturated zone is known as the water table. Groundwater generally flows underground from areas of high elevation to areas of low elevation and where the water table intersects the surface springs, lakes and streams occur. There is a dynamic interaction between groundwater and surface water resources. Groundwater generally sustains the base flow of springs, streams and wetlands during the drier periods of the year.

6.3.1 EXISTING ENVIRONMENT

Groundwater yield to dug or drilled wells can vary greatly, depending on the hydraulic properties of the aquifer. An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well.

The following discussion is based on information gathered from existing study information, completion of a domestic well survey within the study area and installation and monitoring of a series of groundwater monitoring wells, including sampling and groundwater depth measurements. Groundwater samples were collected in accordance to industry standard protocol (Appendix B.4).

The Project site is irregular in shape and is located in an area with undulating topography that generally slopes downward on the north, south and west sides. The groundwater study area for this Project is within the area bounded by the St. Croix, Avon and Kennetcook Rivers and the Ferry Road. Due to its location, the project is expected to lay within groundwater recharge areas. Inference of groundwater flow direction has been made based on topography of the peninsula and varies across the project site, but overall flow direction is away from the proposed Project area to the north, south and west.

The local hydrogeology consists of a fractured bedrock aquifer system which is overlain by a thin aquifer in the till. The bedrock aquifer ranges from low hydraulic conductivity to high depending on the degree of fracture and presence of solution channels. The overburden consists mainly of silts, clays and muds with some cobbles and sandy areas and therefore, the hydraulic conductivity is low with some localized areas of higher hydraulic conductivity. Thus, the bedrock sequence and part of the overlying tills will be saturated with groundwater under ambient conditions.

The geochemical composition of the aquifer materials through which groundwater passes directly influences groundwater quality. Water quality in the Windsor Formation strata is poor with elevated metals, sulphate, hardness and chlorides creating a situation where some residences which are underlain by this material will rely on shallow (less than six metres) dug wells for potable water. These wells are installed by hand digging or using an excavator/backhoe and typically have a series of concrete crocks (approximately one metre in diameter and length) which extend from surface to total depth with a granular backfill around the bottom two or three crocks. When properly located and constructed this type of system will supply water of adequate quality and quantity with the possibility of some difficulties in the summer months during period of decreased groundwater levels. Some residences will have both a dug well and a drilled well to address quantity issues during the summer. To further compensate for water shortages during the drier months some houses are equipped with cisterns to increase water storage.

Salty groundwater can be a problem in flat lowland areas where the freshwater lens is relatively thin or in drilled wells close to the sea. Elsewhere, salty water is generally not a problem because the land and water table rise rapidly away from the sea and the majority of wells are dug and produce only a few litres of water per minute. The majority of domestic water wells located within the study area are dug wells. The depth and elevation of these wells does not make them vulnerable to saltwater intrusion should that begin to occur, however unlikely, within the study area. Drilled wells, because of their depth are more at risk of being affected by saltwater should intrusion begin to occur.

As described in Section 5.6.2, the mine will be developed to a maximum depth of 70 metres below ground surface with the average depth being 50 metres below surface. At maximum depth the pit floor will be approximately 10 metres below sea level.

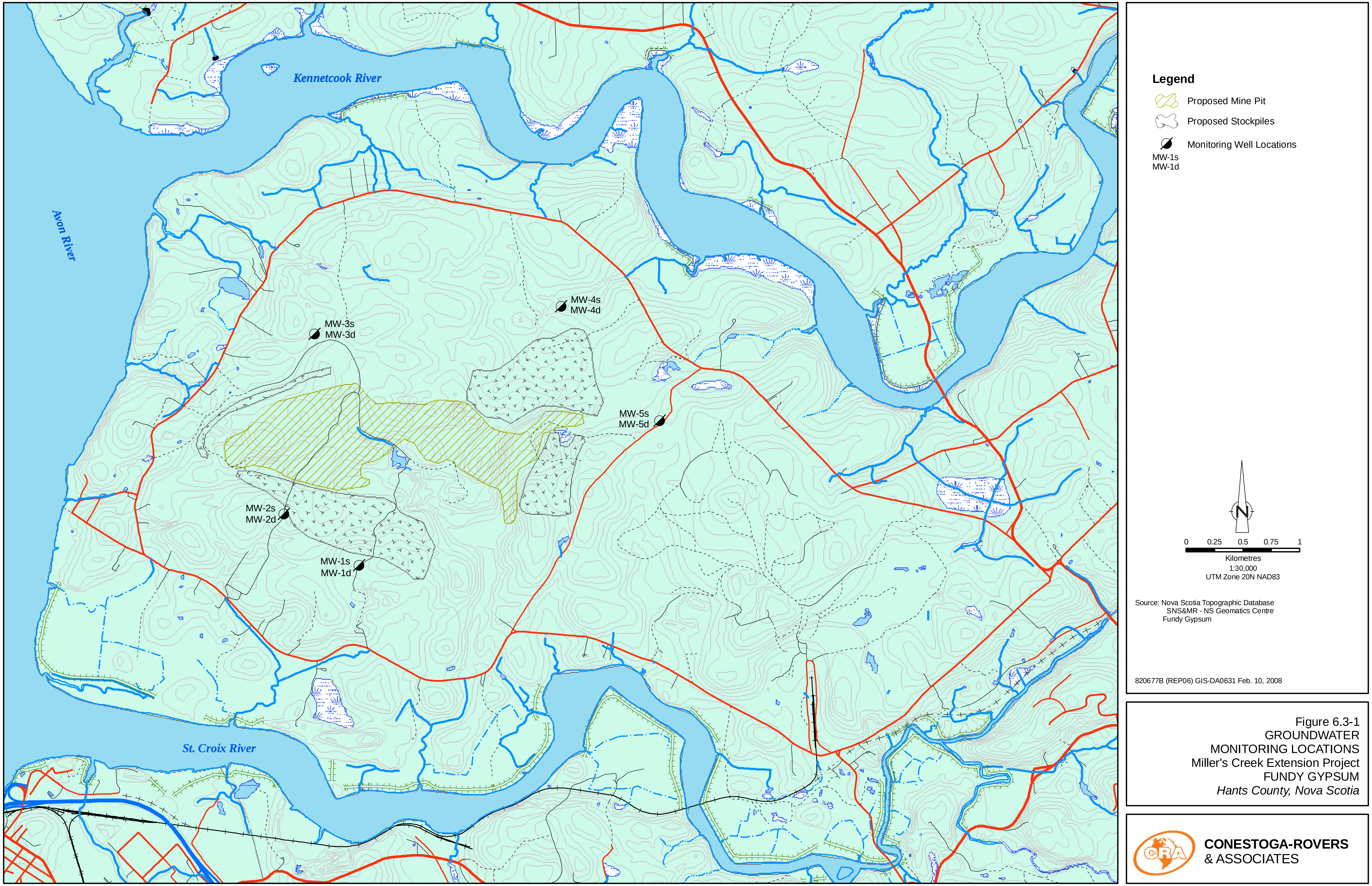

Figure 6.3-1
GROUNDWATER
MONITORING LOCATIONS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

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Groundwater Monitoring

A drilling program consisting of a total of five groundwater monitoring well nests of two wells each, for a total of 10 wells was completed in 2006. Each nest consisted of one overburden well (to top of bedrock), and one bedrock well to an approximate depth of 10 metres below mean sea level which was calculated to be a depth of between 40 metres and 60 metres. (See Figure 6.3-1 for well locations). Two of the wells drilled are dry (MW-1S and MW-2D). Well MW-5D is an artesian well.

The five wells were sampled for general chemistry and metals content (August 2006) as well as bacteria (March 2007). The sample results are contained in Table 6.3-1 and indicate high levels of calcium, sulphate, manganese which are typical of groundwater in this area.

Seven wells were equipped with data loggers to record hourly water levels and water temperature. The daily static water level averages are contained in Appendix C.

Bail tests were performed on each well to determine the approximate hydraulic conductivity for each well. The results are contained in Table 6.3-2.

TABLE 6.3-2 – HYDRAULIC CONDUCTIVITY

Well ID	Location		Elevation (m)	Depth (m)	Hydraulic Conductivity (cm/sec)
MW-1S	4986479	5531632	20.73	6.2	DRY
MW-1D	4986479	5531632	20.73	33.3	Artesian
MW-2S	4986862	5530938	61.4	15.5	too low to calculate, greater than 10^{-7}
MW-2D	4986862	5530938	61.4	44.3	DRY
MW-3S	4988441	5531322	62.51	6.3	2.12E-05
MW-3D	4988441	5531322	62.51	34.3	2.63E-05
MW-4S	4988773	5533420	25.11	6.1	5.35E-05
MW-4D	4988773	5533420	25.11	36.5	1.96E-06
MW-5S	4987799	5534280	38.86	9.8	1.20E-05
MW-5D	4987799	5534280	38.86	37.2	1.38E-05

The results of the bail tests indicate a very low hydraulic conductivity for the well sites. This is consistent with findings of the domestic well survey described below. Low hydraulic conductivity in the host bedrock and overburden is advantageous because groundwater flow into the active mine area will be less than if the areas were of high hydraulic conductivity. It also indicates that the cone of depression from pit dewatering will not extend as far from pit boundaries.

Domestic Well Survey

A domestic well survey was conducted for the homes within the study area in August and September 2006. Of the 128 residences in the area, 69 chose to participate in the study. Water quantity and quality problems were cited as issues for those with dug wells. Often a single residence had more than one water supply or bought water to supplement during dry periods. Drilled wells had fewer quantity problems, but water quality was still poor. All individual results were shared with the homeowners.

A total of 83 water samples were collected during the course of the domestic well survey. The chemical parameters and number of samples which demonstrated exceedences included colour (6), pH (1), sulphate (9), total dissolved solids (TDS) (24), aluminum (10), arsenic (2), cadmium (1), copper (1), iron (35), lead (9), manganese (47), zinc (1) and sodium (7). The guideline limits for most of these parameters have been established based on aesthetic considerations such as taste, visual appearance and their potential to stain plumbing fixtures and clothing during washing and not health related concerns. The health-based parameters included aluminum, arsenic, cadmium and lead. Exceedences of some parameters, including colour, in all probability related to the entrance of surface water into the well from low lying or swampy areas which contain tannic acids. Exceedences related to TDS, zinc and sulphate are considered naturally occurring, in that these parameters are generally associated with underlying geological materials which consist of Windsor Formation gypsum, limestone and anhydrite. Lead can also be naturally occurring, but is sometimes associated with old household plumbing systems containing lead pipes, solders or service connections to homes. Likewise, the most common source of copper in drinking water is corrosion of copper pipes in the home. Sodium exceedances are usually from salt-water intrusion, road salt, geological formations or water softeners. Exceedances of iron and manganese are common in Nova Scotia, both in dug and drilled wells and in this case are most likely due to the corrosive action of high sulphate waters on well casings and plumbing fixtures.

With respect to the bacteriological analyses, of the 83 wells sampled, 81 wells were sampled for bacteria and of those, 55 wells contained total coliform and 29 contained *Escherichia coli* (*E.coli*). The presence of total coliform is not necessarily a health hazard but indicates that the well is subject to surface water infiltration. The presence of *E.coli*, which originates from the feces of warm blooded animals, is a health hazard and again, indicates that the well is poorly constructed. The source of *E.coli* may be related to the nearby presence of livestock, domestic pets or malfunctioning septic systems.

6.3.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP MONITORING

Spatial boundaries for assessment of groundwater resources are based on a combination of aquifer hydraulic properties, expected groundwater flow directions and the distance between the future extent of the fully developed subject property and wells or potential ecological receptors.

The potential for contamination of groundwater from project related activities such as petroleum hydrocarbon spills from machinery or blasting chemicals such as nitrate exists but it is small. Potential effects are considered for all wells downgradient of the proposed mine and include all wells to the north, south and west on the Avon Peninsula. Most potential hazards should be contained within the mine dewatering system.

Drilled and dug wells have the potential to incur vibration damage, but this is dependent on the distance between the well and the blasting as well as the seismic properties of the aquifer materials. Overburden wells and wells constructed within soft bedrock such as that in the study area, are less likely to sustain damage than wells in fractured bedrock. The risk from blasting is greatest closest to the excavation and becomes moderate at greater than 50 metre distance and minimal greater than 200 metre distance. Domestic wells are currently at a minimum distance of 500 metres from proposed blasting activity. The exception is at the western end of the proposed pit area where the distance to the nearest domestic well is approximately 300 metres. The potential for vibration damage to existing domestic wells is therefore minimal.

The potential environmental effects from a mining operation on surrounding groundwater resources can include: lowering of the groundwater table in the area of the pit and subsequent decrease in well yield; depressurization of down-gradient springs due to reduction of recharge, siltation of nearby wells due to blasting or vibration caused by heavy equipment; and possible water quality deterioration at down-gradient wells from accidental spills of deleterious substances.

The potential for these impacts to affect down-gradient wells is dependent on distance and location with respect to groundwater flow directions, well construction methods and depth, intensity and frequency of blasting and the location.

Potential Effects to Groundwater

As the depth of the mine increases and the water table is intercepted, there is the potential to impact the quantity of groundwater available to water users. If extraction occurs below the water table then dewatering of the pit will be necessary. This could cause a lowering of the water table in the vicinity of the pit. This effect can be increased by fewer recharge areas being available to sustain the aquifer. The floor elevation and the amount of water encountered will determine the rate at which dewatering occurs and the resulting effect on the surrounding aquifer.

Potential changes in water quality include: well collapses from blasting; nitrate from blasting; and accidental petroleum hydrocarbon from spills or other chemical releases within the mine. The potential for acid production and drainage in this area is low, but it is possible within mineralized zones.

Significant adverse impacts on groundwater in dug wells are not anticipated due to the distance they are from the proposed mine and because the localized areas of groundwater recharge for these wells is generally within the area immediately surrounding the well. The majority of domestic wells in the study area are dug wells. Drilled wells may be more susceptible to dewatering of the mine. Mitigation of changes in water quality due to Project activities, such as siltation, would involve supplying bottled water to residents or provision of water treatment equipment. In the event of long term quality degradation or a loss of quantity, the proponent would replace or repair the water supply. Acid generating rock is not expected, but should it be encountered, the rock will be tested for acid generating potential and, if determined to be acid generating, will be handled appropriately.

The previously mentioned groundwater monitoring wells installed by CRA for FG will continue to be monitored throughout the life of the Project and will act as early warning indicators of changes in the water table and migration of any offsite contamination. Groundwater chemistry will also be monitored regularly. Additional details of the monitoring program, including frequency of monitoring and the need for installation of additional wells, will be developed in consultation with NSEL. The program will be developed such that measures can be taken to mitigate potential adverse effects to local groundwater supplies.

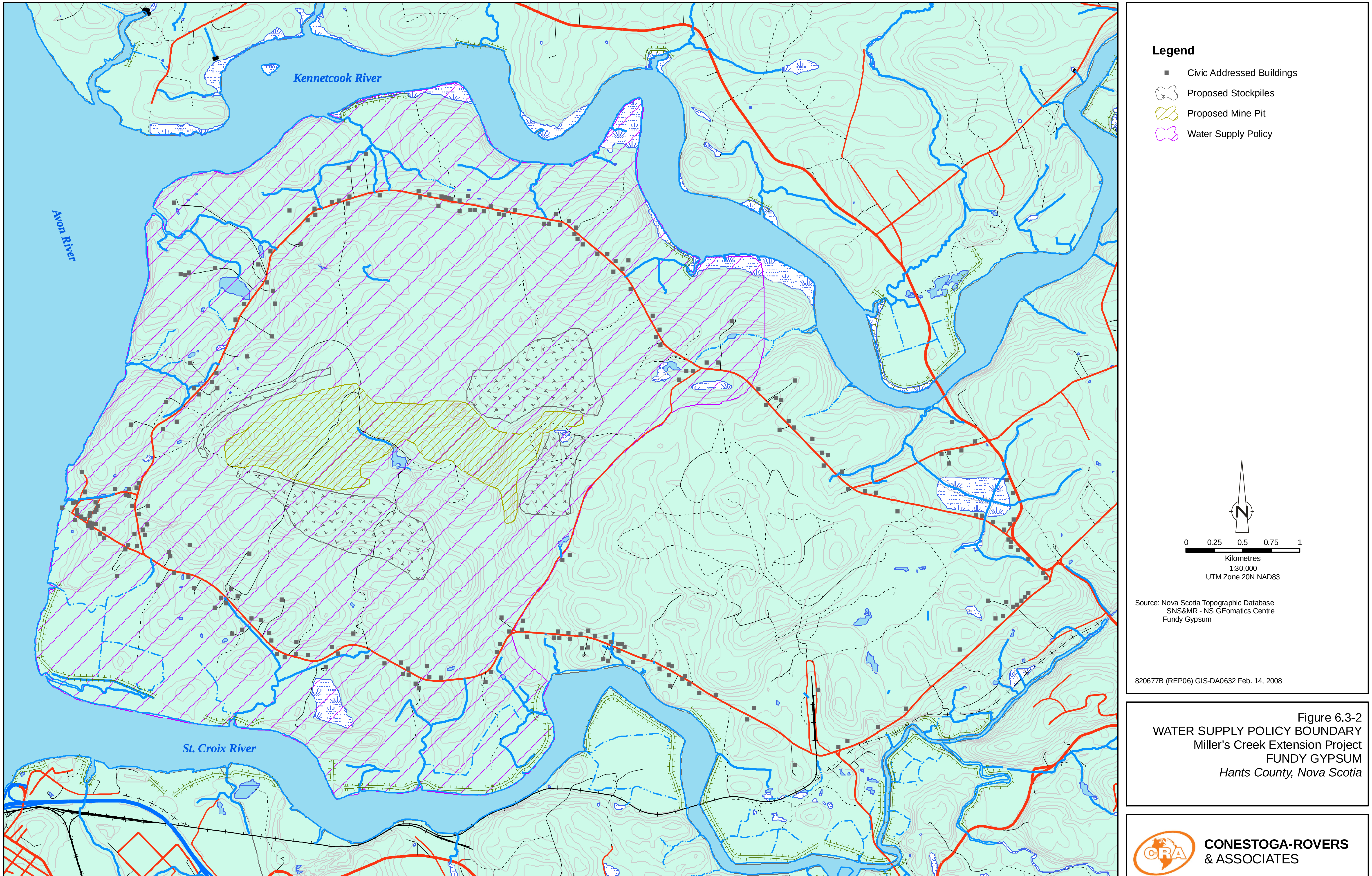


Figure 6.3-2
WATER SUPPLY POLICY BOUNDARY
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

For areas where groundwater use for domestic purposes occurs there is a need for a contingency plan. FG proposes a Water Supply Policy as outlined on Figure 6.3-2. This policy area includes all of the approximately 128 residences located in the area surrounding the proposed mine site. This area was chosen because it the absolute furthest extent to which any effect from mine operations would occur and is designed as a “worst case” zone of influence with respect to domestic water supply. FG will develop site specific plans for commercial users that will be in place prior to the IA application.

Complaints of loss of quantity or degradation in the quality of water in a well may be directed to FG’s local manager. While emergency matters can be reported verbally, when time permits, a written summary can be helpful to all parties and is preferable and will need to be prepared.

Upon receipt of the complaint within the area described above, FG will investigate in a timely manner and supply potable water as necessary. As part of the actions to be undertaken by FG, the company will arrange and pay for, as needed, an independent third party to investigate the matter promptly. The resident will be advised in writing of the results of the investigation and provided a copy of all relevant information from the investigation such as water chemistry results.

If the loss of water quantity or quality is determined to be due to FG's mining activities, FG will:

a. continue to supply potable water to the residence until the matter has been resolved;
b. agree in writing with the resident on a mutually acceptable solution;
c. in the event that a mutually agreeable solution cannot be concluded, then an independent arbitrator, agreeable to both parties, will be appointed to review the matter and the arbitrator's decision will be binding, without appeal, on both resident and FG;
d. if the resident and FG cannot agree on the name of an arbitrator, then each will appoint another party as the third arbitrator and as the Chairman of the Arbitration Board. The majority decision of the Arbitration Board will be binding without appeal on both the resident and FG.

6.3.3 SUMMARY

In summary, significant adverse Project-related effects on groundwater quality resources from the area are not likely to occur. There is some potential to cause loss of groundwater quantity in the areas immediately surrounding the active mine areas but efforts will be made to minimize this effect.

6.4 WETLANDS

Wetlands have been selected as a VEC because of potential interactions between the proposed Project and the physical environment. Wetlands can have many functions, known as wetland functional attributes, which play important roles in natural ecosystems. Wetlands can minimize erosion and control flooding, and can reduce contaminant loads. Wetlands may also be closely linked to local hydrogeology, in that they may be groundwater recharge and discharge areas. They also perform various important biological functions, such as providing habitat for wetland species, as well as for upland species which require wetland habitat at some point in their life history. Humans also utilize wetlands for various recreational activities such as bird watching, hunting, and harvesting of wild plants, as well as commercial operations such as cranberry production and peat harvesting. In Nova Scotia, wetlands are protected under the provincial *Environment Act* and an approval is required for their alteration.

6.4.1 EXISTING ENVIRONMENT

The study area for the evaluation of wetlands encompassed the footprint of the proposed mine and stockpile areas.

Air photo interpretation, a review of NSDNR's Wetland Database, and field surveys revealed a total of 16 wetlands on the site within or adjacent to the proposed mine and stockpile areas. The NSDNR Wetlands Database lists two wetlands on the Project site.

The wetland surveys were conducted in May, June and August 2007. Field surveys by CRA terrestrial ecologists determined that one of the NSDNR wetlands is not in fact a wetland. Locations of the sixteen wetlands are depicted in Figure 6.4-1. Wetlands were described according to the Canadian Wetland Classification System (National Wetlands Working Group 1997). As per NSEL regulations, a Wetland Report has been prepared for each wetland to be impacted by the proposed Project, and is provided in Appendix D. A listing of each wetland is provided in Table 6.4-1.

These wetlands can be grouped according to wetland types. Three types of wetlands are located within the study site; basin marsh, basin swamp, and shallow water wetland. Most of these wetlands are small (< 1 ha) and are composed of a single type of wetland, although the larger wetlands are complexes containing more than one type of wetland.

TABLE 6.4-1 SUMMARY OF WETLANDS PRESENT ON OR ADJACENT TO PROJECT SITE

Wetland No.	Wetland Classification*	Size (ha)	Area Lost to Development (ha)
1	Wetland complex composed of Mixedwood Treed Basin Swamp and Basin Marsh.	4.22	4.22
2	Deciduous Treed Basin Swamp	0.12	0.12
3	Isolated basin marsh	0.03	0.03
4	Wetland complex composed of Basin Marsh and Deciduous Treed Basin Swamp	0.34	0.34
5	Isolated Basin Marsh	0.10	0.10
6	Isolated Basin Marsh	0.19	0.19
7	Isolated Basin Marsh	0.10	0.10
8	Isolated Basin Marsh	0.06	0.06
9	Isolated Basin Marsh	0.09	0.09
10	Mixedwood Treed Basin Swamp	0.72	0.72
11	Isolated Basin Marsh	0.04	0.04
12	Mixedwood Treed Basin Swamp	1.53	~0.75
13	Isolated Basin Marsh	0.25	0
14	Isolated Basin Marsh	0.05	0
15	Shallow Water Wetland	0.60	0
16	Mixedwood Treed Basin Swamp	0.86	0
	TOTAL AREA	9.30	6.01

*** National Wetlands Working Group 1997**

MARSHES

Marshes are wetlands which contain shallow water and have levels which may fluctuate daily, seasonally or annually due to flooding, evopotranspiration, groundwater recharge or seepage losses (National Wetlands Working Group 1997). Marshes may experience decreases in water levels which may expose sediments. They receive their water supply from surface runoff, stream inflow, precipitation and groundwater discharge. One type of marsh, isolated basin marsh, occurs on the Project site.

Basin Marshes

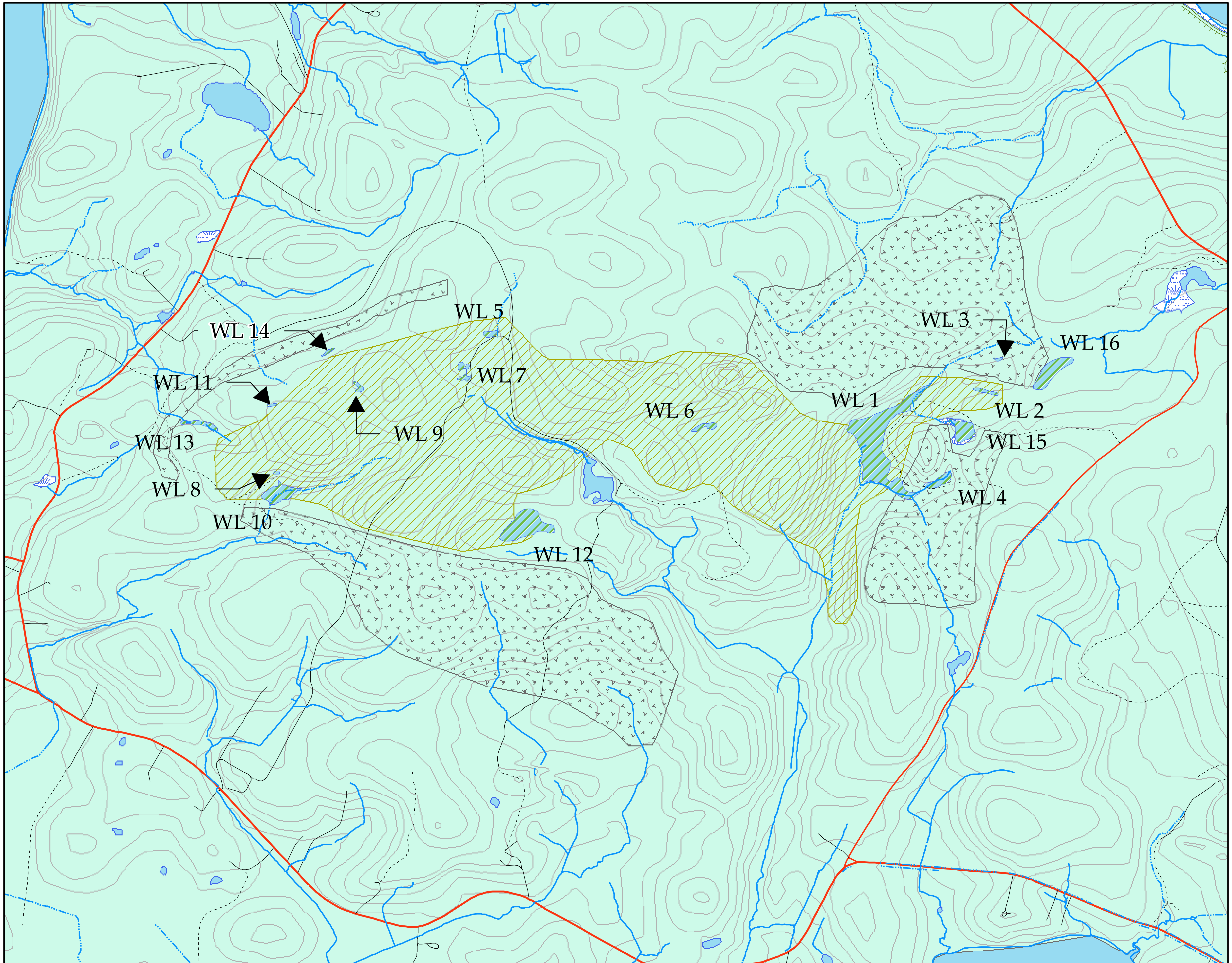
Basin marshes are situated in well-defined basins and depressions in inland regions outside the influence of sea waters and sea spray. They receive waters from groundwater discharge, surface runoff, and stream and river inflow (National Wetlands Working Group 1997). The basin marshes present on the site are isolated from streams in the area and receive their water through surface runoff. They likely do not have any groundwater inflow. Most of the isolated basin marshes are sinkholes which are sufficiently deep and situated properly to collect enough water to maintain water levels year-round despite losses through evaporation. The isolated basin marshes were generally ringed by trees such as red maple (*Acer rubrum*), balsam fir (*Abies balsamea*) and red spruce (*Picea rubens*), while shrubs consisted of narrow-leaved meadowsweet (*Spiraea alba*), black holly (*Ilex verticillata*) and speckled alder (*Alnus incana*), and ground vegetation included cinnamon fern (*Osmunda cinnemome*a), sensitive fern (*Onoclea sensibilis*), and sedges such as little prickly sedge (*Carex echinata*), shallow sedge (*C. lurida*) and hop sedge (*C. lupulina*). The open water portion of the wetlands often contain floating lesser duckweed (*Lemna minor*), and submerged hemlock water-parsnip (*Sium suave*). Broad-leaved cattail (*Typha latifolia*) is often present in sunny areas. Floating moss-covered deadwood is also often present in the isolated basin marshes.

SWAMPS

Swamps are tree or tall shrub dominated wetlands which are influenced by groundwater (National Wetlands Working Group 1997). The water table may be at or below most of the ground surface. Water may move from the margins of the swamp or from other sources of groundwater. Vegetation usually consists of a dense cover of trees or shrubs, herbaceous plants and some mosses. Basin swamps occur in topographically defined basins where water is derived locally but additional input may be provided by runoff from the rest of the watershed (National Wetlands Working Group 1997). Two types of basin swamp are present on the study site, deciduous treed basin swamp and mixedwood treed basin swamp.

Deciduous Treed Basin Swamp

Deciduous treed basin swamps are characterized by a tree canopy dominated by red maple and white ash (*Fraxinus americana*) and may contain some white birch (*Betula papyrifera*). A small proportion of coniferous trees may also be present. Typical shrub species are black holly and speckled alder. Ground vegetation consists of cinnamon fern, purple avens (*Geum rivale*) and bristly crowfoot (*Ranunculus gmelini*), with abundant *Sphagnum* moss.



Legend

- Proposed Mine Pit
- Proposed Stockpiles
- WL3 Wetland Area

Water Features

- Stream; River
- Ditch, Dry / Intermittent Stream
- Dam
- Dyke
- Lakes; Rivers
- Swamp (topo)
- Islands

0 0.1 0.2 0.3 0.4 0.5
Kilometres
1:15,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre

820677B (REP06) GIS-DA0641 Feb. 15, 2008

Figure 6.4-1

WETLAND AREAS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

Mixedwood Treed Basin Swamp

Mixedwood treed basin swamps in the area consist of a treed layer containing several species such as balsam fir, red spruce, red maple, and birches. Shrub species consist of black holly, mountain holly (*Nemopanthes mucronata*), and speckled alder. Ground vegetation is similar to that observed in deciduous treed basin swamps.

SHALLOW WATER WETLANDS

Shallow water wetlands have water less than two metres deep in mid-summer, and may be referred to as ponds or shallow lakes (National Wetlands Working Group 1997). Water levels may be stable, or they may decrease during droughts or periods of low flow. To be classified as a shallow water wetland, pen shallow water must cover more than 75% of the surface area of the wetland (National Wetlands Working Group 1997).

The rest of the shallow water area may be occupied by rooted emergent vegetation, including inundated trees. One type of shallow water wetland, linked basin water wetland, is present on the study site.

Linked Basin Water Wetland

Linked basin water wetlands may be found in high or intermediate topographic positions of the landscape and consist of open basins with inflowing and outflowing streams (National Wetlands Working Group 1997). The linked basin water wetland on the study site was ringed by a low ridge, and emergent vegetation was present around portions of the perimeter. A beaver dam blocking the intermittent outflow stream likely increased the water levels in this wetland. Vegetation around the open water in this wetland consisted of broad-leaved cattails and sedges such as little prickly sedge and shallow sedge. Rushes such as knotted rush (*Juncus nodosus*) and cottongrass bulrush (*Scirpus cyperinus)* were also present.

RARE WETLAND PLANTS

Two plant species listed by NSDNR occur in or near wetlands on the Project site. A population of ram's head lady's-slipper (*Cypripedium arietinum*), a red-listed species now protected under the NSESA, is known to occur on the northern slope of the basin containing Wetland 12. A yellow-listed species, black ash (*Fraxinus nigra*) occurs in Wetlands 1, 2, 7, 10, 12, and 16. Both these species are discussed in further detail under Section 6.5.

6.4.2 POTENTIAL EFFECTS, PROPOSED MITIGATION, AND FOLLOW-UP MONITORING

Potential Project-related effects on wetlands include:

- Loss of wetland habitat by creation of the mine, access roads, and placement of stockpiles;
- Decrease in wetland functional attributes, such as flood and erosion control;
- Increase in sedimentation in wetlands due to development and operation activities;
- Disruption of surface water supply to wetlands.

Impacts to flora and fauna inhabiting wetlands are discussed in Section 6.5.

The physical boundaries of the effects of the mine and stockpiles will be limited to the areas over which these features are positioned. On a temporal scale, the mine will be in operation continuously for 35 to 50 years. However, as the mine progresses from east to west and as progressive reclamation occurs, not all wetlands will be affected at once and over that time period.

A significant adverse effect occurs when there is a net loss of wetland functions in a wetland which has been determined to be of significant value. Some important wetland functions include provision of flora and fauna habitat, shoreline and stream bank stabilization (and therefore erosion and sedimentation control), flood control and streamflow maintenance, water quality maintenance, suspended sediment removal, moderation of local climactic conditions, and carbon storage.

Development and Operation

Removal of the wetlands will occur over several decades, not all at once, and thus removal of some non-critical flora and fauna habitat will occur gradually. Wetlands listed in Table 6.4-1, with the exception of Wetlands 13, 14, 15 and 16, will be affected by the project. The stockpile locations have been adjusted to avoid Wetlands 15 and 16. Twelve wetlands will be completely removed by the project. Wetlands 13 and 14 are located between the proposed mine and stockpiles. The surface water runoff to these wetlands, received from current runoff patterns, will be affected, but it is anticipated that the runoff received from the proposed stockpile area to the north will compensate for losses. Approximately half of Wetland 12 lies within the planned mine. The local topography indicates that runoff feeding this wetland flows from the north and east, so excavation of the western and southern portion of this wetland will not have a significant effect on the remaining portion of this wetland. Wetland 11 lies very close to the planned mine outline at the base of a hill. When this hill is excavated, Wetland 11 will likely lose its surface water supply. Small portions of Wetlands 1 and 10 lie outside of the planned mine and stockpile footprints, however the majority of these wetlands will be removed and the remainder will likely be impacted by changes in surface hydrology.

Development activities such as clearing and grubbing, and removal of overburden could result in increased sediment deposition in portions of wetlands receiving surface runoff from these areas. Such an increase could lead to increased fertility of the wetlands, leading to changes in plant communities. However, much of the site is already fertile, and species typical of nutrient-rich areas, such as cattails, are already established in most wetlands.

None of these effects are likely to be significant. No wetlands on site provide habitat to rare species of fauna or lichens. None of the wetland areas to be impacted provide habitat for any red-listed species. While one red-listed plant, ram's head lady's-slipper, is present in Wetland 12, the portion of wetland containing this species is not expected to be affected. Impacts to one yellow-listed species, black ash, in Wetlands 1, 2, 7, 10, and 12 are not considered to be significant, and are discussed in detail under Section 6.5. Additional black ash specimens are present in Wetland 16, which will not be affected, and are likely present elsewhere on the Avon Peninsula.

Wetland 13 lies between the proposed pit and the westernmost stockpile. Creation of the pit will remove a small portion of this wetland's contributing catchment area for surface water runoff input. This should not have a significant effect on this wetland since surface runoff from areas outside of the pit will continue. The proposed footprint of the stockpile will also act to redirect some surface runoff from north and south of the wetland toward the wetland. The placement of the stockpile across the stream draining this wetland could lead to increased water levels in the wetland, potentially increasing the overall size of this wetland. This potential impact can be mitigated by the placement of a rock drainage channel or overflow culvert through the base of this narrow stockpile.

Wetland 14 also lies between the proposed pit and the westernmost stockpile. Some runoff to this wetland may be lost by the creation of the pit to the southeast. Runoff will continue to be supplied to this wetland via the stockpile, which can be graded to maximize runoff to this wetland to compensate for the loss of runoff from the southeast.

Wetland 15 will lose some of its contributing catchment area to the north as a result of the pit creation. It will still receive runoff from the south of the stockpile, and in fact the creation of the stockpile over the catchment area boundary will increase the size of this wetland's catchment area (via grading) to the south and increase the amount of runoff reaching this wetland from this direction. This should compensate for the loss of some runoff from the north and ensure this wetland's water supply is not reduced significantly.

Wetland 16 is located south of a proposed stockpile. This wetland will not lose any of its catchment area due to pit construction and its water supply should be unaffected with proper stockpile grading. A suitable buffer area will further ensure this wetland is unaffected by project activities.

Wetland functional attributes will not be significantly affected in the long term, as wetland recreation will occur in previously mined areas as the mine moves westward. There are no local citizens dependent on any wetlands as a source of water. None of the wetlands are large enough to play significant roles in wetland functioning, especially local erosion or flood control, on the Avon Peninsula. Most of the wetlands are tiny isolated basin marshes and thus have minimal roles in shoreline and stream bank stabilization, flood control, streamflow maintenance, water quality maintenance, or suspended sediment removal in surface waters in the local area. They are much too small to play any significant role in local climate control or carbon storage. There are other wetlands of a similar nature remaining in the local area. Creation of compensatory wetlands (see Reclamation section) will restore wetland functioning and habitat in the local area.

Reclamation

The reclamation phase of the project will restore wetland habitat and functional attributes to the Project site. FG will work with NSDNR and NSEL to develop the required mitigation measures including wetland compensation at a ratio agreed upon with NSDNR and NSDEL. Wherever feasible, proposed stockpile locations were adjusted by FG to avoid placement atop wetlands. It is more difficult to avoid wetlands within the planned mine, as the resource is fixed in nature and a substantial portion of the resource has already been set aside by FG to allow the development of the Conservation Area. FG is considering various approaches to the wetland compensation issue. The first approach, preferred by NSDNR, is to create wetland habitat within the same watershed as the wetland that is to be altered. FG plans to recreate wetland habitat onsite once mine operations are completed by ensuring that the three planned ponds have sufficiently shallow edges to support large marsh-type wetlands. If this is not possible, the proponent will consider a wetland enhancement or creation project outside of the local watershed. Contribution to wetland education and/or protection programs may also be considered. Creation of compensatory wetlands will restore wetland functional attributes and wetland habitat to the Avon Peninsula.

6.4.3 SUMMARY

The proposed mine footprint and stockpiles will have an impact on wetlands and wetland functional attributes over the life of the project. These impacts are not considered to be significant. None of the wetlands are large enough to play significant roles in any wetland functions on the Avon Peninsula. Impacts to rare species of flora in or near the wetlands to be impacted are discussed in Section 6.5.

In summary, given appropriate wetland compensation, significant long-term adverse or cumulative impacts on wetlands on the study site are not likely to occur. Some wetland habitat and functioning will be impacted in the short term, however the creation of compensatory wetlands will restore wetland habitat and functional attributes on the study site in the long term.

6.5 FLORA SPECIES AND HABITAT

Flora (vascular plants and cyanolichens) and flora habitat is considered a VEC because of its contribution to regional biodiversity and potential interactions between project activities and the physical terrestrial environment. In this document, the term flora will refer to both vascular plants and cyanolichens. Cyanolichens (lichens which contain cyanobacteria) and their habitat have also been identified as a VEC because of potential interactions between Project activities and air quality on the site. The presence of rare flora may be indicative of rare habitats which may support unusual assemblages of plants and animals. Protecting rare plants is beneficial to ecosystems in that it results in simultaneously protecting rare habitats and the associated species of flora and fauna. Flora is considered rare in Nova Scotia if it has been listed as a rare species by the Province (NSDNR General Status Ranks or the Nova Scotia Endangered Species Act (NS*ESA*)), is listed as rare or extremely rare by the Atlantic Canada Conservation Data Council (ACCDC), or if it has been listed rare nationally by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2006). The VEC for rare vascular plants and cyanolichens in this document considers any species of vascular plant listed as rare in any of the above lists. Additional information on global and national species status ranks were obtained from the NatureServe Canada website (www.natureserve.org).

6.5.1 EXISTING ENVIRONMENT

Flora species and flora habitat were surveyed in August 2005; May, June and July 2006, and May, June and August 2007. Descriptions are based on NSDNR air photo interpretation and field surveys in 2005, 2006, and 2007 on the Project site. The study area for flora and flora habitat encompasses much of the peninsula, in particular inside the area bounded by Belmont, Ferry and Avondale Roads. A significant portion of the vegetation in this area has been disturbed historically through forestry, agriculture, mining, and road building.

6.5.1.1 VASCULAR PLANTS

The existing forest is a mosaic of different types and ages. Some areas are dominated by young second-growth hardwoods, typically trembling and large-tooth aspen (*Populus tremuloides* and *P. grandidentata*), while other areas, particularly the hills, are dominated by large, mature conifers such as red spruce, balsam fir, and some eastern hemlock (*Tsuga canadensis*).

Coniferous Forest

Areas dominated by red spruce and balsam fir border farmland throughout the study area. Trees are typically not mature. Understory/ground cover varies from open to denser ferns and shrubs.

Mixed Forest

The majority of the forest present within the study area is mixed deciduous and coniferous trees. Hardwoods are typically immature red maple, white birch, large-tooth aspen, trembling aspen and white ash, but include occasional mature yellow birch (*Betula alleghaniensis*), red oak (*Quercus rubra*), beech (*Fagus americana*) and hophornbeam (*Ostyra virginiana*). Conifers are typically immature to mature red spruce and balsam fir, but eastern hemlock and white pine (*Pinus strobus*) are also present. The understory is typically fairly open and ground vegetation is somewhat sparse in dry areas, although yellow lady's-slippers (*Cypripedium parviflorum*) are rather abundant in gypsum outcrop areas.

Deciduous

Small areas of hardwood forest occur throughout the study area. Hardwood stands are generally not mature and are dominated by red maple, trembling aspen, large-tooth aspen, white birch and white ash. There is also scattered American elm (*Ulnus americana*), beech and hophornbeam. Such areas include older regenerating forest harvest areas. Understory/ground vegetation is similar to mixed forest areas.

Agricultural Fields

The perimeter of the Avon Peninsula is dominated by agricultural fields. These areas are predominately cleared and in grass/pasture. Small areas of row crops, orchards and vineyards are also present.

Karst-related Microhabitat Features

The site displays karst features such as sinkholes and calcareous outcrops. Most of these features occur within the central study area, where the main gypsum deposit is located. Sinkholes in particular are very common on the site. The abundance of gypsum on the site permits the presence of many calcium-loving plants.

Disturbed Areas

A variety of disturbed or cutover habitats are present within the study area. Tree removal has occurred as a result of forestry operations throughout the area. Recent forest harvest areas were noted as extensive during field surveys. Smaller cleared areas are associated with old gypsum pits and extensive access roads and all-terrain vehicle (ATV) trails.

Wetlands

Sixteen small wetlands are located within the study area. Most of these are small sedge-dominated basin marshes which have developed in depressions created by sinkholes, however, treed swamps and a shallow water wetland are also present. See Section 6.4 for further discussion of wetlands on the Project site.

Watercourses and Riparian Habitat

Several intermittent to small watercourses and ponds are located within the study area. The largest of these watercourses is Shaw Brook, flowing from the central area southward. This watercourse has a fairly broad floodplain with potential for a variety of rare plants and has the closest to intervale-type habitat.

The headwaters of Fish Brook, another significant watercourse, flows from the central area northward and has a much smaller less diverse floodplain. Most of the other watercourses within the study area either flow through agricultural fields or are intermittent. Several ponds have been created through flooding of historic quarries, and through beaver activity. The prevalence of sinkholes has also resulted in abundant small vernal pools.

Significant Habitats

A review of the NSDNR Significant Habitats Database revealed three areas described as potentially Significant Habitats or habitats of concern. The Poplar Grove habitat of concern is an area of karst topography known for rare plants which require calcareous soils, such as ram's head lady's-slipper (*Cypripedium arietinum*), yellow lady's-slipper, and eastern leatherwood (*Dirca palustris*). This area is located south of the Project site and will not be affected by the Project.

An area east of Ferry Road was identified in the Significant Habitats Database as having historical records of a rare plant, the Canada Violet (*Viola canadensis*). This plant was listed as extirpated in Nova Scotia by NSDNR in 2003 (pers. com. Mark Elderkin).

The tributaries of the Avon to Kennetcook Rivers are identified as at-risk habitat due to potential for shoreline rare plants such as maidenhair fern (*Adiantum pedatum*), yellow Canada lily (*Lilium canadense*) and hemlock parsley (*Conioselinum chinense)*.

Flora Species Of Special Status

Information on species at risk and species of concern from the Atlantic Canada Conservation Data Centre (ACCDC), the Nova Scotia Museum (NSM) and the NSDNR General Status Ranks of Wild Species in Nova Scotia and Significant Habitats and Species Databases were included in this desktop review.

A review of the ACCDC database and NSM records for rare plant species records resulted in a list of 33 red-listed and 55 yellow-listed species that had potential to occur on the site. A large proportion of the plants with potential to occur in the area are plants of calcareous soils, which thrive in the gypsum-rich soils of the Project site. Table 6.5-1 lists all rare or sensitive flora reported in the ACCDC (100 km radius) and NSM (about a

10 km radius) database near the study site which have potential, based on habitat preferences, to be present on the Project site. The ACCDC database compiles locality data on very rare to uncommon species in Atlantic Canada, with a rarity rank and legal status for each. The complete list of all rare plants recorded within 100 km of the Project site in the ACCDC database may be found in Appendix E.1, while the NSM screening is provided in Appendix E.1.

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Adiantum pedatum	Northern maidenhair-fern	Red	Fertile or alkaline soils. Under oak-birch-sugar maple-elm trees.	Possible	ACCDC, NSM
Allium tricoccum	Small white leek	Red	Rich deciduous forests and intervals	Possible	ACCDC
Alnus serrulata	Brook-side alder	Yellow	Lakeshores	Possible	ACCDC
Alopecurus aequalis	Short-awn foxtail	Yellow	Muddy margins of rivers and shallow ponds, and gravel margins where competitor species are few	Possible	ACCDC
Anemone canadensis	Canada anemone	Yellow	Damp thickets, meadows and gravelly shores, on calcareous or alluvial soils.	Possible	ACCDC
Anemone quinquefolia	Wood anemone	Yellow	Wooded riverbanks and shaded intervales.	Possible	ACCDC
Anemone virginiana	Virginia anemone	Yellow	Intervales and stream sides. Calcareous and slaty ledges, shores and thickets.	Possible	ACCDC
Anemone virginiana var. alba	River anemone	Yellow	Intervales and streamsides. Calcareous and slaty ledges, shores and thickets.	Possible	ACCDC
Arabis drummondii	Drummond rockcress	Yellow	Usually on dry slopes and talus, but occasionally in more fertile locations at lower elevations.	Possible	ACCDC
Arabis drummondii	Drummond rockcress	Yellow	Usually on dry slopes and talus, but occasionally in more fertile locations at lower elevations.	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Arabis hirsuta var. pycnocarpa	Hairy rock-cress	Red	Dry cliffs, crevices, ledges, talus slopes, and gravels	Possible	ACCDC
Arenari groenlandica	Mountain sandwort	Yellow	Loose calcareous ledges, rocky granite areas	Possible	ACCDC
Asplenium trichomanesramosusm	Green spleenwort	Yellow	Shaded cliff along stream on basic rock/limestone	Possible	ACCDC
Bidens connata	Purple-stem swamp beggar-ticks	Yellow	Boggy swales, and the borders of ponds, thickets and in ditches behind brackish shores	Possible	ACCDC, NSM
Botrychium lanceolatum	Triangle grape-fern	Yellow	Rich, wooded hillsides	Possible	ACCDC
Botrychium lunaria	Moonwort grape-fern	Red	Open, turfy or gravelly slopes, shores, and meadows. Usually on basic soils	Possible	ACCDC
Botrychium simplex	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.	Possible	ACCDC, NSM
Campanula aparinoides	Marsh bellflower	Yellow	Meadow, ditch, riverbank	Possible	ACCDC, NSM
Cardamine parviflora	Small-flower bitter-cress	Yellow	Dry woods, shaded or exposed ledges, and in sandy soils	Possible	ACCDC
Cardamine maxima	Large toothwort	Red	Dry woods, shaded or exposed ledge and in sandy soils.	Possible	ACCDC
Carex eburnea	Ebony sedge	Yellow	Cliffs and talus slopes, under conifers , particularly on Calcareous substrates	Possible	ACCDC
Carex garberi	Elk sedge	Red	Alkaline regions, in fields and intervales, often on slopes	Possible	ACCDC
Carex granularis	Meadow sedge	Red	Alkaline regions, in fields and intervales, often on slopes	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Carex hirtifolia	Pubescent sedge	Red	Calcareous regions, in meadows and thickets, forest slopes.	Possible	ACCDC
Carex livida var. radicaulis	Livid sedge	Red	Calcareous bogs and meadows.	Possible	ACCDC
Carex prairea	Prairie sedge	Red	Cattail swamp	Possible	ACCDC
Carex tuckermanii	Tuckerman sedge	Red	Swale	Possible	ACCDC, NSM
Caulophyllum thalictroides	Blue cohosh	Red	Deciduous and intervale forest	Possible	ACCDC, NSM
Clematis occidentalis	Purple clematis	Red	Rocky calcareous slope, open woods	Possible	ACCDC
Clethra alnifolia	Coast pepper-bush	Red	The shores of lake headwaters, swamps, damp thickets, and sandy woods	Possible	ACCDC
Coeloglossum viride var. virescens	Long-bract green orchis	Red	Boggy spots, damp mature woods, and fir or floodplain forests	Possible	ACCDC
Conioselinum chinense	Hemlock parsley	Yellow	Swamps, mossy coniferous woods or swales, and seepy slopes near the coast	Possible	ACCDC
Cryptogramma stelleri	Fragile rockbrake	Yellow	Shaded limestone cliffs, and shaded crevices in conglomerate cliff-face.	Possible	ACCDC, NSM
Crataegus flabellata	A hawthorn	Yellow		Possible	NSM
Cynoglossum virginianum var. boreale	Northern wild comfrey	Red	Open beech woods, on dryish soils or on gypsum. Woods and thickets	Possible	ACCDC, NSM
Cypripedium arietinum	Ram's head lady's-slipper	Red	The rough country of gypsum sinkholes	Possible	ACCDC, NSM
Cypripedium parviflorum	Small yellow lady's-slipper	Yellow	Most often associated with gypsum or open calcareous soils	Possible	ACCDC, NSM
Cypripedium parviflorum var. pubescens	Large yellow lady's-slipper	Yellow	On calcareous soils, often near outcrops of gypsum, or limestone. Occasionally in deciduous forests.	Possible	ACCDC, NSM
Cypripedium reginae	Showy lady's-slipper	Red	Alkaline swamps and bogs.	Possible	ACCDC, NSM
Decodon verticillatus	Hairy swamp loosestrife	Yellow	Quaking margins of ponds or lakes	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Desmodium canadense	Showy tick-trefoil	Red	Open woods and river banks	Possible	ACCDC
Desmodium glutinosum	Large tick-trefoil	Red	Open woods and river banks	Possible	ACCDC
Dichanthelium/Panicum linearifolium	Slim-leaf witchgrass	Yellow	Dry sandy soils.	Possible	ACCDC, NSM
Dirca palustris	Eastern leatherwood	Red	Rich deciduous or mixed woods	Possible	ACCDC, NSM
Draba arabisans	Rock whitlow-grass	Yellow	Muddy soils or on calcareous rocks, in cliff crevices and ledges.	Possible	ACCDC
Draba glabella	Rock whitlow-grass	Red	crevices of cliff edges, and on talus slopes	Possible	ACCDC
Dryopteris fragrans var. remotiuscula	Fragrant fern	Yellow	Dry, overhanging cliffs, and in cliff crevices along streams or near waterfalls.	Possible	ACCDC
Elymus wiegandii	Wiegand's wild rye	Red	Rich stream banks and meadows	Possible	ACCDC
Epilobium coloratum	Purple-leaf willow-herb	Yellow	Low-lying ground, springy slopes and similar locations.	Possible	ACCDC
Epilobium strictum	Downy willow-herb	Yellow	Boggy areas and meadows	Possible	ACCDC
Equisetum pratense	Meadow horsetail	Yellow	Rich wooded bank, mossy slopes, typically alkaline soil	Possible	ACCDC
Erigeron hyssopifolius	Daisy fleabane	Yellow	Exposed gypsum outcrops, damp stream banks between flood levels, banks ledges and cliffs. Calcareous and low competition	Possible	ACCDC
Festuca subverticillata	Nodding fescue	Red	Rich deciduous forested slopes and alluvial woods	Possible	ACCDC
Floerkea proserpinacoides	False mermaid-weed	Yellow	Deciduous ravine slopes, river margins, and intervale forests.	Possible	ACCDC
Fraxinus nigra	Black ash	Yellow	Low ground, damp woods and swamps.	Possible	ACCDC, NSM
Goodyera pubescens	Downy rattlesnake-plantain		Woodlands and thickets	Possible	ACCDC
Gratiola neglecta	Clammy hedge-hyssop	Yellow	Usually in wet or muddy places	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Helianthemum canadense	Canada frostweed	Red	Sandy plains, barrens, dry clearings, dry mixed woods	Possible	ACCDC
Hepatica nobilis	Round-lobe hepatica	Red	Dry, usually mixed deciduous forest	Possible	ACCDC, NSM
Hudsonia ericoides	Golden-heather	Yellow	Dry, rocky, and sandy barrens. Recently disturbed areas or on open sandy soils	Possible	ACCDC
Hystrix patula/Elymus hystrix	Bottle-brush grass	Red	Wooded bottomlands	Possible	ACCDC, NSM
Impatiens pallida	Pale jewel-weed	Yellow	Rich alluvial soils, damp thickets, and along intervales	Possible	ACCDC
Isoetes acadiensis	Acadian quillwort	Yellow	Water up to 1 m deep, bordering lakes or ponds, and occasionally along rivers.	Possible	ACCDC
Juncus marginatus	Grassleaf rush	Yellow	Clayey roadsides, damp fields, and brooksides	Possible	ACCDC
Lilium canadense	Canada lily	Yellow	Rich river or stream intervale meadows and forest	Possible	ACCDC
Lindernia dubia	Yellow-seed false-pimpernel	Yellow	Wet areas and the muddy edges of streams. Drained Millponds and gravel pits	Possible	ACCDC
Lophiola aurea	Golden crest	Red	Lakeshores, wet savannas, sphagnous swales	Possible	ACCDC
Malaxis brachypoda	White adder's-mouth	Red	Moss cushions and wet, mossy cliff-edges, where there is little competition from other plant species.	Possible	ACCDC
Megalodonta beckii	Beck water-marigold	Yellow	Shallow, quiet waters, slow-moving streams, and ponds	Possible	ACCDC
Montia fontana	Fountain miner's-lettuce	Yellow	Springy or seepy slopes, wet shores and brackish spots, coastal	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Dichanthelium/ Panicum xanthophysum	Slender dichanthelium	Red	Open thickets in dry, sandy or rocky soils.	Possible	ACCDC
Pilea pumila	Canada clearweed	Yellow	Moist rich deciduous or mixed woods along streams to often intermittent water courses, seepage slopes rich calcareous basin marsh/swaps with summer draw down	Possible	ACCDC
Platanthera orbiculata	Large round-leaved orchid	Yellow	Damp woods in deep shade.	Possible	ACCDC
Poa glauca	White bluegrass	Yellow	Cliff crevices, on shelves, and talus slopes.	Possible	ACCDC
Rhamnus alnifolia	Alderleaf buckthorn	Yellow	Calcareous bogs , swamps, swampy woods and meadows, marl bogs in rich alluvial soils	Possible	ACCDC, NSM
Rudbeckia laciniata var. gaspereauensis	Cut-leaved coneflower	Yellow	Swales, the edges of swamps, or in gullies - in small colonies	Possible	ACCDC
Salix sericea	Silky willow	Yellow	Low thickets and stream banks	Possible	ACCDC
Sanicula odorata (syn. gregaria)	Black snake-root	Red	Rich, alluvial woods and along intervales.	Possible	ACCDC, NSM
Saxifraga paniculata ssp. Neogaea	A White Mountain Saxifrage	Red	Pockets in cliffs, mossy hillsides, dripping cliffs, and limestone ledges	Possible	ACCDC
Senecio (syn. Packera) pauperculus	Balsam groundsel	Yellow	Gypsum outcrops, dry talus slope	Possible	ACCDC, NSM
Shepherdia canadensis	Canada buffalo-berry	Yellow	Gypsum or talus slopes and along the coast within reach of salt spray.	Possible	ACCDC, NSM
Sphenopholis intermedia	Slender wedge grass	Yellow	Calcareous ledges and shores	Possible	ACCDC
Stellaria longifolia	Longleaf stitchwort	Yellow	Damp or wet grassy places, in sandy or mucky soils	Possible	ACCDC
Symphyotrichum undulatum	Wavy-leaf American-aster	Yellow	Old fields and the edges of thickets	Possible	ACCDC

TABLE 6.5-1: RARE VASCULAR PLANTS WITH POTENTIAL TO OCCUR ON THE PROJECT SITE

Binomial	Common Name	NSDNR Status	Habitat (Zinck 1998)	Likely on Site	Source of Record
Tiarella cordifolia	Heart-leaved foam-flower	Yellow	Rich deciduous and mixed woods	Possible	ACCDC
Triosteum aurantiacum	Coffee tinker's-weed	Red	Rich soils of river intervales, or rich forest on limestone	Possible	ACCDC, NSM
Viola sagittata	Arrow-leaved violet	Yellow	Dry sterile woods, clearings and fields	Possible	ACCDC
Zizia aurea	Common alexanders	Yellow	Meadows, shores, damp thickets and wet woods. Generally in relatively rich sites	Possible	ACCDC

Seven of these species were detected on the project site during botany surveys in August 2005, May, June, and July 2006, and June and August 2007. Ram's head lady's-slipper, round-lobed hepatica (*Hepatica nobilis*), black ash, eastern leatherwood, yellow lady's-slipper, thimbleweed (*Anemone quinquefolia*) and Canada buffalo-berry (*Shepherdia canadensis*) were all found on the project site. None are listed under the Committee on the Status of Endangered Wildlife (COSEWIC) or the *Species at Rick Act (SARA).* A provincial status report was prepared for the ram's head ladyslipper in 2007 and this species was listed as endangered under the *NSESA* on Oct 10, 2007. The status and habitat requirements of each of these species are described in the following sections. Coordinates of the rare species locations will be provided only to NSDNR to ensure protection of these species.

Habitat for the ram's head lady's-slipper is described in Roland's Flora of Nova Scotia (Zinck 1998) as the rough country of gypsum sinkholes, and in Native Orchids of Nova Scotia (Munden 1999) as in and around gypsum sinkholes in a cool shaded environment. Ram's head lady's-slippers are known in Nova Scotia from scattered locations throughout the St. Croix to Brooklyn area in Hants County (Zinck 1998). This species has also recently been detected in Cumberland County (Sean Blaney, pers. comm. 2006). This species was detected at nine locations (four main areas) within the study area, for a total of 138 plants. Eight of these locations are within the proposed Conservation Area, while the ninth occurs on privately-owned land. The Project footprint has been adjusted by FG to avoid this species.

This plant is found from Nova Scotia to Saskatchewan, south to New York and Minnesota. In Canada, this species is listed as rare in Nova Scotia (red and S1), Ontario (S3), Quebec (S2) Manitoba (S2) and Saskatchewan (S1). This species is not protected under the federal *SARA*, but is listed as endangered under the *NSESA*. Globally, this species is listed as G3 and N3 nationally (vulnerable), due to restricted range or localness.

At the request of NSDNR, additional surveys were conducted in 2006 at other local areas to determine the local abundance of this plant. Five additional areas having ram's head lady's-slipper, totaling over 400 plants, were detected outside of the study area. Locality data has been provided to NSDNR, and information gathered from the survey has been included in the status report discussed above.

Eastern leatherwood, also a provincial red-listed species, was discovered on several locations on the study site. This shrubby plant of rich deciduous or mixed woods is one of the least frequent shrubs in Nova Scotia (Zinck 1998). This species occurs in calcareous areas and is very slow-growing. NSDNR notes that several additional locations have been identified recently (Mark Elderkin, pers. comm., 2006), and it is wide-ranging elsewhere (westward to Ontario and Minnesota and south to Florida). This species is listed globally as G4, and in Nova Scotia as S1. Eastern leatherwood is also known from a several acre area of mixed hardwoods east of Milford Station and from the St. Croix Area near Newport. A small number (approximately 25) of leatherwood specimens were found in three small areas within the study area. Two of these locations are within the Conservation Area, while the third, which contains only a single specimen, lies within the proposed mine footprint. In addition, approximately 100 leatherwood specimens, ranging from those with trunks five centimetres in diameter to small saplings, were also discovered in the northern portion of the peninsula, during a stream survey in November 2006. All coordinates will be provided to NSDNR.

Round-lobed hepatica is rare and local in Nova Scotia with approximately ten known existing locations. This plant ranges from Nova Scotia to southern Manitoba. It is listed globally as G5 (common with secure population) and in Nova Scotia as S1 and is red-listed by NSDNR. This species has been in decline in the province for largely unknown reasons over the past several decades (Marian Munro, NSM, pers. comm, 2006). Habitat for this species is typically dry mixed hardwood forest (Zinck, 1998). In 2006, this plant was found to be common at one site in the study area, which is within the proposed Conservation Area. Over 100 round-lobed hepatica specimens were found at this location. Coordinates will be provided to NSDNR.

In Nova Scotia, black ash is found from Digby and central Lunenburg counties to northern Cape Breton, scattered throughout the northern portion of the mainland, and rare elsewhere (Zinck 1998). This small tree species prefers damp woods, low ground, and swamps (Zinck 1998). This species is yellow-listed by NSDNR and is of particular importance to Nova Scotia's First Nations communities due to its use in basket weaving.

Black ash's subnational rank in Nova Scotia, Manitoba, and Newfoundland is S3 (sensitive), while it is S2 (may be at risk) in Prince Edward Island. Nationally, due to large and secure populations of this species in Ontario, New Brunswick and Quebec, this plant is listed as secure. Globally this species is listed as G5, or common with secure populations. A single mature black ash, 24 saplings and four seedlings were detected on the site in 2007 in several wetlands. An additional seven saplings were detected in a wetland outside of the Project footprint. It is likely that additional specimens are present on the Avon Peninsula outside of the survey area. Coordinates of this species on the Project site will be provided to NSDNR. FG is working with the Confederacy of Mainland Mi'kmaq (CMM) to develop a monitoring program for this species at the site. The program will involve monitoring for general health, possible seed harvesting and more detailed survey work in the general area for additional specimens.

Yellow lady's-slipper was found to be very common within the study area and appears to be associated with previously disturbed, more open areas, particularly along trails, abandoned rail lines and old roads near areas of historic mining activity. Over 1700 yellow lady's-slipper plants were detected on the site during surveys in 2005, 2006, and 2007. Many of these are within the proposed mine and stockpile footprints, however, large numbers, including a patch of over 500 specimens, occur within the proposed Conservation Area. This species, formerly known as *C. calceoleus*, ranges from Newfoundland to British Columbia. In Nova Scotia, yellow lady's-slippers are known to occur in the Windsor Brook area of Hants County, Kings County and in parts of Cape Breton (Zinck 1998). This species is yellow-listed by NSDNR. The global status of this plant is G5, and its sub-national status is S3 (sensitive). Two varieties of this plant occur on the study site. The large variety (var. *pubescens*) is listed globally as G5T5 (apparently secure to secure) and sub nationally as S2 (may be at risk). The small variety, (var. *makasin*, formerly var. *parviflorum* in Nova Scotia) is ranked similarly.

Zinck (1998) notes that *C. parviflorum var. parviflorum* (now known as var. *makasin*) is generally the most common form, except at Sweet's Corner (a community very close to the study site), where the large variety (*C. parviflorum var. pubescens)* is more prevalent. The large variety (*C. parviflorum* var. *pubescens*) was the most frequently observed in the study area, with one area having over 500 plants within a 50 metre radius. The small-flowered form (var. *makasin*) with its smaller flowers and dark twisted sepals, was only occasionally observed in small numbers, particularly near the Poplar Grove area. It is important to note that extreme variation and hybridization within this species does not always allow accurate identification to variety in the field especially of the blooming period.

The Canada buffalo-berry was detected at three general areas in the central portion of the study area and was abundant where observed. Over 100 specimens are estimated to occur within the study site. This plant is yellow-listed by NSDNR and S2 subnationally, and is listed globally as G5, common globally with secure population. This plant requires calcareous soil, and has a very localized distribution in Nova Scotia, with abundant plants in the Windsor to Brooklyn area and some in northern Cape Breton. Additional botany surveys in 2006 and 2007 found that this plant was common to abundant in the centre of the study area, particularly along trails and in previously disturbed areas. Coordinates will be provided to NSDNR.

Thimbleweed was also located on the study site. This species is known from the Meander River area in Hants County, occasionally in Colchester and Pictou Counties, and from scattered locations in northern Cape Breton. It is listed globally as G5, common with a secure population, and in Nova Scotia as S1/S2. Preferred habitat for this species is in intervales and along streams along calcareous and slate ledges, shores and thickets (Zinck 1998). One large patch of this plant, totaling approximately 30 specimens, was found in the study area in 2006. Coordinates will be provided to NSDNR.

At the request of NSDNR, additional surveys were conducted in 2006 by botanist Tom Neily in the area of the historic Canada violet record to determine if this species might still be present. The Canada violet or any evidence thereof was not found.

6.5.1.2 CYANOLICHENS

Lichens are mutualistic organisms composed of a fungal partner (the mycobiont) and a photosynthesizing partner (the photobiont). Currently only the group known as cyanolichens, which contain a cyanobacterium as the photobiont, have been given status rankings by NSDNR. This group of lichens will be discussed in this document.

The study area for cyanolichens and their habitat encompasses much of the Avon Peninsula, in particular inside the area bounded by Belmont, Ferry and Avondale Roads. Cyanolichens can be particularly abundant in mature humid forests (Nash 1986). Many of these cyanolichens are epiphytic, and forestry practices which result in loss of mature trees and the accompanying changes in environmental conditions are a main cause of habitat destruction (Maas and Yetman 2002). Cyanolichen abundance also tends to be greater in mature and old-growth forests than in regrowth or immature forests. A significant portion of the forested land on the Project site has been clear-cut in recent years, and is therefore, poor-quality epiphytic cyanolichen habitat. No listed epiphytic cyanolichen species were observed on the site during the botany surveys by Tom Neily, an experienced botanist and lichenologist, in 2005 and 2006.

Similar to vascular plants, the Avon Peninsula is home to a variety of cyanolichen species which prefer calcareous substrates. The karst topography of the site has resulted in soils which are less acidic than in most of Nova Scotia. In addition, rock outcroppings in this area are of gypsum, and thus have more buffering capacity than do most other rock outcrops in the province. Thus an assemblage of cyanolichen species which prefer higher pH environments than are typically found in much of Nova Scotia is present. Unfortunately, there is only limited information available regarding cyanolichen species present in calcareous areas of Nova Scotia (Frances Anderson, NSM, pers. com., 2007). Cyanolichen observations were noted during botany surveys by Tom Neily in 2005 and 2006. Five uncommon to rare cyanolichen species were found on the Avon Peninsula. Four of these species are on the study site. None of these species are listed under COSEWIC or *NSESA*, and only one has been given a status ranking by NSDNR. Individual cyanolichens were described by the surveyor as abundant or not uncommon.

One red-listed cyanolichen, *Solorina saccata*, was detected on the site at four locations. One of these locations is within the Conservation Area, while the other three are within the planned mine footprint. *S. saccata* grows on calcareous soil or rock, and in moist situations on tundra (Nearing 1947, Brodo *et al.* 2001). Thomson (1984) states that this calciphile species grows best in very moist places such as in spray from waterfalls, in moist microhabitats as hummock sides, sides of animal burrows, seepages and moist shaded cliff sides. Lichenologist Dr. David Richardson of Saint Mary's University states that this species is usually on mossy ledges on limestone outcrops, cliffs or rocks, in his experience. In his text on Arctic macrolichens, Thomson (1984) states that this is a circumpolar, arctic, and boreal species, which in North America ranges south to Vermont, Wisconsin, South Dakota, Alberta and British Columbia. Seward (1977) states that this cyanolichen is very tolerant of a wide range of temperatures, but is very specific to calcareous substrates. This species was described as not uncommon by the surveyor in the areas. NSDNR has only one record of this species in Nova Scotia (Nova Scotia Cyanolichen Status List, 2007), however the lack of field biologists skilled in identifying cyanolichens and the paucity of field surveys are likely the reason. There have been recent reliable reports of this species from other locations in Nova Scotia (Frances Anderson, NSM, pers. comm. 2007). The distribution map for this species in Brodo *et al*.'s Lichens of North America (2001) depicts *S. saccat*a as occurring in Nova Scotia near the New Brunswick border.

A species of cyanolichen identified as *Collema cristatum var. cristatum* was found growing on exposed gypsum outcrops at three locations on the study site. Two of these locations are within the Conservation Area, while the third is in the planned mine area. One of these locations is within the Conservation Area, the second is on privately-owned land, and the third is in the planned mine footprint. Each patch of *C. cristatum* was found within an approximately 1m^2 area. This species was described by the surveyor as not uncommon at these locations. This species is not listed by NSDNR This species is known from Ontario and Manitoba, and British Columbia (Brodo *et al*. 2001, NatureServe Canada (www.natureserve.org)) and is depicted in Brodo *et al.* (2001) as occurring in New Brunswick near the Nova Scotia border. It is listed globally as G3G5, meaning it ranges from being at moderate risk of extinction to secure (NatureServe Canada (www.natureserve.org)). Habitat for this species is calcareous rock, and sometimes on limy soil or among mosses (Brodo *et al*. 2001). Degelius (1954) states this species is mainly saxicolous (living on rock) but practically restricted to calciferous rocks which are periodically wetted. It generally grows on the bare rock, at times among mosses. It may also occur on periodically wet soil, especially var. *cristatum*, sometimes bare soil (even fine sand and gypsum), but usually among other plants. Occasionally, it has been found on lignum and bark. Degelius (1954) also states that this species prefers rather sunny exposures.

The third species of cyanolichen was *Peltigera lepidophora*. This was detected in an area well north of the planned project footprint. This cyanolichen is tolerant of dry habitats. It is most common along road cuts and other dry habitats (Goffinet and Hastings 1994). It can grow on mosses over soil, on sandy soil, and on quartzitic sandstone boulders, from open grasslands, aspen, poplar and pine forests, on dunes, to exposed, rocky alpine tundra. It is occasionally found on peat (Goffinet and Hastings 1994). Vitikainen (1994) describes this species as terricolous (living on soil), on slightly calcareous substrates, especially in Northern Europe; and as somewhat nitrogen-loving and tolerant of warm dry areas. This species is not listed by NSDNR. It is a distinctive species and has recently been found in a few areas of the Province (Frances Anderson, NSM, pers. com., 2007). It is listed on NatureServe (www.natureserve.org) as occurring in Alberta, Manitoba, Ontario, Quebec and Saskatchewan, although with a caution that distribution data for Canadian provinces is known to be incomplete or has not been reviewed. It is also known to occur in the Pacific Northwest (Northwest Lichenologists (www.nwlichens.org)). Globally this species is ranked G4, apparently secure. A specimen of this cyanolichen will be collected and deposited in the NSM.

Two species of *Leptogium* were detected on the study site. The genus *Leptogium* contains several tiny, inconspicuous species which are easily overlooked (Martin *et al.* 2002). Distributions for tiny *Leptogium* species have not been published and are poorly understood (Martin *et al*. 2002). *L. lichenoides* was found to be quite abundant at five locations on the study site. Two of these are in the Conservation Area, while two occur on privately owned land and one is located well north of the Project footprint. Most specimens were growing on rock, while one was growing on the bark of an apple tree. Brodo *et al.* (2001) lists the habitat for this species as mossy calcareous rock or rarely on the bases of trees having basic bark. This species commonly grows on rocks, usually calcareous, and generally among mosses (Sierk 1964). It is very widespread in North America, excluding the south (Sierk 1964). Nearing (1947) states this species is more tolerant of exposed conditions than are other *Leptogium* species. This species is not listed by NSDNR. This species has been detected recently in Nova Scotia(Frances Anderson, NSM, pers. com., 2007), and the distribution map for this species in Brodo *et al.* (2001) includes NS. This species has been collected in four counties in New Brunswick (New Brunswick Museum online database). The NatureServe website (www.natureserve.org) lists this species as being present in Ontario, Quebec, Manitoba and Saskatchewan, and provides a global rank of G5 (Secure).

The second *Leptogium* species detected on the site has been tentatively identified as *L. teretiusculum*. This species was found to be abundant at one location on the study site within the planned mine footprint. Sierk (1964) states that this species is generally northern in distribution and had until 1964 been little collected in North America, undoubtedly because of its small size and inconspicuous appearance. *L. teretiusculum* is listed on NatureServe Canada as being present in Alberta, Ontario and Quebec, and is listed globally as G4-G5 (apparently secure to secure). This species has recently been confirmed to be much more common in the Pacific Northwest than has been previously recognized (Martin *et al.*, 2002). This species is not listed by NSDNR. There have been recent reliable reports of this species in Nova Scotia (Frances Anderson, NSM, pers. comm. 2007). The New Brunswick Museum is also home to two cyanolichen specimens identified as *L. teretiusculum* which were collected in Inverness (1977) and Annapolis (2005) counties in NS. This species prefers basic rock or trees, and is often found near the coast. Sierk (1964) states that all North American specimens seen grew on bark, but the species is reported to grow also on rock in Europe in calcareous areas. A specimen of this cyanolichen will be collected for confirmation of identity and will be deposited in the NSM.

As with vascular plants, the calcareous areas support a distinct cyanolichen community not found in areas which do not contain gypsum. Some environmental factors associated with a gypsum–rich landscape offer certain advantages to cyanolichen species. The prevalence of gypsum outcrops provides suitable substrate for acid-sensitive saxicolous (rock-dwelling) species, while the dissolution of gypsum has led to a decrease in the acidity of the surrounding soils, permitting acid-sensitive terricoulous (soil-dwelling) species to exist. The somewhat porous nature of gypsum, an easily eroded form of rock, may also allow cyanolichens dwelling on such substrates to remain moist for a longer time after rainfall than if they were inhabiting faster-drying rock, thereby allowing them to continue photosynthesizing for a longer period (lichens can only photosynthesize when they are moist and the temperature is above freezing). Some cyanolichen species have also been shown to actually impede the dissolution of gypsum substrates beneath them, leading to the formation of elevated lichen-covered mounds on otherwise flat gypsum outcrops (Mottershead and Lucas 2000). Little detailed information regarding the specific habitat requirements (*i.e.* light levels, humidity levels, rainfall requirements, to name a few) of these species of interest is available, other than the fact that most of them prefer calcareous soil or rock substrates.

The lack of biologists skilled in identifying lichens in Nova Scotia, and the paucity of comprehensive lichen surveys throughout the province has resulted in gaps in knowledge of the cyanolichen species of NS. Considerable new information on species presence and distribution has been gathered in just the last few years. For example, a recent study by McMullin (2007) found 135 lichen species in 51 mature forest plots in southern Nova Scotia. Of these, 26 species (19%) were new records for Nova Scotia, while three were likely new to science, and one appears to represent a new genus. Lichen species of calcareous areas in particular are especially poorly known (Frances Anderson, NSM, pers. comm. 2007). Pictou County, with its significant calcareous areas, is particularly lacking in lichen species reports (Frances Anderson, NSM, pers. comm. 2007). It is likely that as additional knowledge of cyanolichens of calcareous areas is obtained, these species, and perhaps additional ones, will be detected in other calcareous areas of the province.

6.5.2 POTENTIAL EFFECTS, PROPOSED MITIGATION, AND FOLLOW-UP MONITORING

Potential Project-related effects on terrestrial flora , including rare species, and habitat include:

- Loss of rare vascular plants, rare cyanolichens, and habitat by creation of the mine, and placement of stockpiles;
- Loss of rare species of flora and critical habitat for these species, if present;
- Smothering of vegetation from dust accumulation on flora;
- Decreased gene flow between populations of rare flora.
- Exposure to gasesous pollutants generated by mine activities and vehicles.

The spatial boundaries of the effects of the mine and stockpiles will be limited to the areas over which these features are positioned. On a temporal scale, the mine will be in operation continuously for 35 to 50 years. However, as the mine progresses from east to west and as progressive reclamation occurs, not all vegetation will be affected at once and over that time period. The mine will be developed in about 10 to 15 year sections.

A significant adverse effect on vascular plants or cyanolichens is one that results in a decline in the population of a listed species such that natural recruitment would not return the population(s), or any populations to their former level within several generations.

6.5.2.1 DEVELOPMENT AND OPERATION

Some loss of common flora habitat will occur through site development and clearing activities. Structural complexity is decreased by the removal of forests and associated vegetation, and the habitats associated with these species are lost, resulting in lower species diversity in the area. This habitat loss will not occur all at once, but will extend westward from Ferry Road as the mine extends over the next 35 to 50 years. Large amounts of similar forest habitat, including mature hemlock areas, are present in the study area outside of the proposed mine footprint. The Project may also initially disrupt distribution of flora on the Avon Peninsula. Habitat loss will be mitigated initially by the designation of the Conservation Area near the middle of the site, and by the progressive reclamation plan to be enacted during the reclamation phase of the Project.

Cumulative habitat losses on the Avon Peninsula have already been significant. Historical and ongoing agriculture has had significant adverse effects on the vascular flora of the study site, in that extensive areas of mature forest habitat have been permanently removed and replaced with monocultures of non-native agricultural crops and/or pasture, which provides little if any suitable habitat for the original species of flora. Historical and ongoing forestry has also had significant effects on the vascular flora of the study site, in that extensive areas of mature forest habitat have been removed and are now in varying stages of regrowth. Road construction and historic mining activities have also had significant impacts, leading to the complete loss of forest habitats in some areas. Creation of roads has also led to increased penetration of interior forests by humans with ATVs, and has decreased the amount of undisturbed interior forest. It is unlikely that the impacts from the mine could exceed the impacts of agriculture, road development, and forestry on the flora of the Avon Peninsula, none of which has likely been compensated for.

Most of the rare plants that have been found on the study site are species which require calcareous soils. Calcareous soils have considerable buffering capacity and thus, the pH of these soils ranges from neutral to basic, allowing species intolerant of acidic soils to thrive. A number of rare or unusual plants also survive in gypsum areas because of the comparative lack of competition (Davis and Johnson 1996). Calcareous soils are not uncommon in Nova Scotia. The Windsor Group formation contains sedimentary deposits of gypsum and anhydrite and is found throughout central Nova Scotia and in parts of Cape Breton. Typical species, such as yellow lady's-slipper, are often found associated with these deposits.

Some specimens of yellow lady's-slipper exist in the planned mine footprint. This species is very common throughout the centre of the study area, and is most common in areas which have been disturbed. While this species is yellow-listed in Nova Scotia, it can be very abundant when habitat conditions are suitable, such as on calcareous soils near gypsum or limestone outcrops. The high abundance of yellow lady's-slippers on the site, coupled with the fact that suitable habitat for this species will be recreated (as evidenced by its current high abundance in areas historically disturbed by mining activities), should not result in long-term adverse impacts on the population of this species in Nova Scotia.

Twenty-four specimens of black ash are also present within the planned mine footprint. There was no sign of any black ash seedlings or saplings within 500 m of the single mature specimen to indicate this tree has been reproducing. Eighteen saplings and five seedlings were found over 500 metres from the mature specimen. Representatives of the CMM went to inspect this tree in July 2007 and will continue to monitor it for seedling harvesting and relocating. The mine is not expected to reach the area where the mature black ash is located for at least 15 years. Loss of these 24 black ash specimens, which is a yellow-listed species, will not have a significant negative effect on the black ash population in Nova Scotia. FG has adjusted the proposed mine and stockpile locations to avoid an additional thirteen black ash specimens located near the perimeter of the Project footprint.

Loss of habitat is the main potential adverse impact of the proposed Project on cyanolichen species in the area. Cyanolichens can be particularly abundant in mature humid forests (Nash 1986). Forestry practices which result in the loss of mature trees and the accompanying changes in environmental conditions are a main cause of cyanolichen habitat destruction (Maas and Yetman 2002). Thus clearing of mature forested areas for Project activities may result in loss of habitat for epiphytic cyanolichens. No listed epiphytic cyanolichens have been observed in mature forests on the site to date. Significant forest habitat will still exist around the perimeter of the

Project footprint, and only a small portion of the mine will be actively mined at any one point in time, with reclamation restoring forest habitat in the path of the mine activity. The Conservation Area will protect a large parcel (30+ ha) of forest which will provide suitable habitat for a variety of epiphytic cyanolichen species.

The area also contains suitable habitat for cyanolichens which grow on soil or rock, particularly species which prefer basic substrates such as calcareous soils or outcrops. Some of these soils and outcrops will be excavated during mine development, or covered by stockpiles. Thus species which grow on calcareous soils or rock outcrops will also lose some habitat. The area around the perimeter of the footprint will still contain significant habitat for rock and soil-dwelling cyanolichens, and the stockpiles may provide suitable new habitat for some cyanolichen species to colonize.

To minimize impacts to rare species of flora which require calcareous soils on the site, FG proposes to put aside a large piece of land as a Conservation Area. The Conservation Area will protect a large parcel (30+ ha) of forest which contains a considerable amount of gypsum outcrops and calcareous soils which will provide suitable habitat for a variety of vascular plant and cyanolichen species requiring habitat rich in calcium. These calcareous areas support vascular plant and cyanolichen assemblages which are not found in areas which do not contain gypsum. The creation of this Conservation Area will ensure that the red-listed vascular plants and their habitat remain undisturbed. The majority of the red-listed vascular plant specimens occur within the Conservation Area. Small numbers of ram's head lady's-slipper and a larger number of eastern leatherwood specimens occur on privately-owned lands around the Project footprint. Only a single known red-listed plant, a small specimen of eastern leatherwood, is located within the proposed mine and stockpile footprints. Significant numbers of all the yellow-listed vascular plant species known from the site also occur within the Conservation Area.

The rarest vascular plant found on the site, ram's head lady's-slipper, will be unaffected by the Project. Populations of this species will be untouched and will be protected within the Conservation Area. There exists in Hants County a strong local desire to preserve this species. A local citizen has recently signed a Conservation Easement with the Nova Scotia Nature Trust to protect an eight hectare piece of land which supports an estimated 200 ram's head lady's-slipper plants, thereby ensuring this land can never be logged or developed. FG has also funded a survey of several local areas having historic records of this species, and has found considerable populations at several off-site locations within Hants County. This information has been sent to NSDNR and was utilized in the preparation of the Status Report for this species which resulted in this species recently being listed as endangered under the *NSESA.* The complete avoidance of this plant and it's habitat through the designation of the Conservation Area will ensure this Project does not cause significant adverse effects on this species' population.

A portion of a population of a rare species of cyanolichen will be lost from the study site due to the proposed mine extension project. The red-listed species known from the site, *S. saccata*, is known from 3 areas within the planned mine and one area within the Conservation Area. This species is known from at least two other locations in the Province (Frances Anderson, NSM, pers. com., 2007). The Project may result in the loss of a significant portion of the known population of this species on the study site. The loss of part of the population of *S. saccata* might be mitigated by experimentally transplanting pieces of the substrate on which the cyanolichen is growing to an area which will not be disturbed, such as the Conservation Area, if feasible. This species is already present with the Conservation Area and the transplanted specimens would be moved to similar habitat as the existing specimens. The *S. saccata* specimens could then be monitored to determine how successful the move was. An analysis of the factors affecting distribution of this species could predict whether moving the cyanolichen and its substrate is feasible.

FG has had discussions with NSDNR on the areal extent, boundaries and access aspects of the Conservation Area concept. It is FG’s intention to continue these so as to have a program acceptable to NSDNR that would be fully described as a Condition of Environmental Assessment Approval that may be granted for the Project.

The development of a mine on the Avon Peninsula, an area characterized by karst topography with its associated springs and intermittent streams, could lead to changes in surface hydrology and subsequent adverse effects on terrestrial flora. The presence of springs and intermittent streams which disappear underground can lead to patterns in surface water flow which might not be expected based on rainfall runoff patterns. It is possible that some plant species, particularly those preferring moist soils, could be adversely affected by changes in hydrology. Two of the rare plants known from the site are considered predominately wetland species. Black ash is considered a facultative wetland (FACW) species, meaning it occurs in wetlands 67% - 99% of the time, but is occasionally found in non-wetlands, while ram’s head lady’s-slipper is a FACW+ species, indicating it tends to occur in wetlands more frequently than a FACW species, but still may be found in non-wetland habitat (United States Fish and Wildlife Service 1996). There are no obligate (*i.e.* occurring in wetlands > (99 % of the time) wetland species of concern known from the site. Possible changes in surface hydrology patterns are irrelevant with respect to the black ash present on the site, as these specimens will eventually be removed by the gradual development of the mine. However, the monitoring and seed harvesting program developed by CMM, plus the recreation of wetland habitat lost to development will mitigate the loss of these specimens and habitat.

There is no effect of changes in surface hydrology predicted on the approximately 42 ram's head lady's-slippers in wetland 12. While a portion of this wetland will be removed by pit development, there are no springs or groundwater sources known to feed this wetland, and surface drainage patterns to the remaining wetland habitat are expected to be unaffected. Thus the portion of wetland containing this species should not be affected by changes in water supply. The remainder of the ram's head lady slippers are located in the proposed Conservation Area. While some of the catchment area for Shaw Brook, which runs through the Conservation Area, will be lost to mine development, the volume of water in Shaw Brook will be actively maintained by diversion of mine pit water. Thus the surface water supply to the ram's head lady slippers growing along Shaw Brook should be unaffected. Ram's head lady slippers growing in areas away from Shaw Brook (but still within the Conservation Area) tend to be found growing at the bases of hills or ridges, most of which will be undisturbed. Thus local surface water supply to these specimens should not be affected. Changes in soil moisture levels due to effects on surface watercourses, springs and or intermittent streams will not have significant adverse effects at the population level on any species of flora known from the site.

The extension of the mine on the Avon Peninsula could potentially lead to increased levels of airborne particulates due to gypsum mining activities. Physical effects could include interference with photosynthesis of vascular plants and cyanolichens under high levels of dust accumulation. Particulates can also have negative effects on cyanolichens due to the fact that cyanolichens are known to accumulate metals by trapping insoluble particulates containing metals. Cyanolichens can also take up dissolved metal ions through ion exchange. Deposition of particulates containing metals can lead to increased concentrations of these metals in the cyanolichen thallus, which can cause negative impacts on the cyanolichen.

Gypsum dust is inert and of sufficient particle size that it settles close to the disturbance and thus will not cause negative effects on flora. This dust is composed predominately of calcium, sulphur, and oxygen and the gypsum present on the site does not contain significant amounts of any metals.   The existing Miller's Creek site has been operating for decades and dust levels are generally not an issue. Dust from blasting activities will be well contained within the mine and is not expected to extend beyond the Project footprint. Further detail on dust due to blasting activities is provided in Section 6.8. The dense forest surrounding the site and the relatively high humidity due to the proximity to the Avon and Kennetcook rivers will also help to minimize penetration of airborne particulates into forested areas. In addition, dampening waste piles with water during dry periods will minimize particle resuspension (which is generally not an issue).

Dust levels at the existing mine tend to be low, and recent monitoring of dust levels has revealed that existing dust levels are well below the Nova Scotia Ambient Air Guidelines for Quarries for particulates. Dust levels are not predicted to increase at the proposed mine extension. Emissions from the proposed Project must meet requirements for particulate air emissions, thus air quality monitoring should be conducted on site and measures enacted to ensure these guidelines are met. The proposed Project will not lead to significant adverse effects on vascular plants or cyanolichens due to airborne particulates. Accumulation of metals in cyanolichens on the Project site will not occur. Photos 6.5-1 to 6.5-2, taken in July 2007, show how the nearby vegetation to the existing operations is not smothered in dust.

Photo 6.5-1 View of vegetation surrounding existing operations

Photo 6.5-2 Additional view of vegetation surrounding existing operations

The potential for decrease in gene flow between isolated populations of rare (red-listed) plants has been suggested. The populations of rare plants which exist on the study site already exist as small isolated populations which are unlikely to have significant gene exchange with other populations due to limits on pollination by wind or insects due to the distances involved. The Conservation Area will contain the majority of specimens of rare flora, and there are no existing populations of red-listed species in the Project footprint. Thus, no existing populations with which rare plants in the conservation area might cross-pollinate will be removed. The Project will not cause a decrease in gene flow between isolated populations of rare plants.

Fuel and blasting materials are required for mining operations. Gypsum would be crushed to the size required at the existing mill facility. There is no chemical process only a physical process. Relatively small amounts of fuel and blasting materials will be stored on site and if an accidental spill were to occur, the effects would be very small and localized. Use of fuels and blasting compounds on mine sites is strictly controlled and regulated and emergency contingency plans are and will be in place. These are discussed elsewhere in this document. No significant adverse effects on flora and habitat due to accidental spills of chemical compounds at the site are predicted.

Small amounts of gaseous pollutants will be produced on the site via combustion of fossil fuels (diesel) in mine vehicles. Sulphur dioxide is a component of vehicle exhaust which is capable of having adverse effects on cyanolichens. This soluble gas combines with water to form acid rain when it is emitted high into the atmosphere, where it is oxidized and falls as sulphuric acid. Cyanolichens rely primarily on air and rain-borne nutrients and thus, are susceptible to air pollution, particularly acidifying or fertilizing sulphur and nitrogen-based pollutants, especially acid rain. Unlike vascular plants, cyanolichens do not have a cuticle layer to protect them (Richardson 1988) and many have been shown to accumulate pollutants, including tiny particulates (Richardson 1992). The main impact of acid rain on cyanolichens is to acidify their environment, causing leaching of important nutrients or changes in the buffering capacity of bark and soil (Richardson 1992). A combination of acid rain and habitat destruction is considered responsible for the loss of the boreal felt lichen (*Erioderma pedicellatum*) from Europe, New Brunswick, and most of Nova Scotia (Maas and Yetman 2002).

However, vehicle emissions on the site will be emitted at ground level where the sulphur dioxide will not be oxidized and will not aid in the creation of acid rain. Exposure to high levels of sulphur dioxide itself has the potential to disrupt metabolic processes in cyanolichens, including photosynthesis, respiration and nitrogen fixation (Richardson 1992), causing negative impacts on growth. Acid-sensitive cyanolichens may thrive on substrates with a high pH which can buffer acid rain, such as the bark of certain deciduous trees or calcareous outcrops. As low pH increases the toxicity of sulphur dioxide action (Farmer *et al*. 1992), cyanolichens growing on the relatively high-pH study site have considerably more buffering capacity in their environment due to the prevalence of calcareous soils and rock, and are not expected to be adversely affected by sulphur dioxide emissions. In addition, fuels used on the site will be regulated clean-burning low-sulphur diesel fuels which will result in a minimum of sulphur dioxide being released. Project air-related emissions are not expected to cause significant adverse effects on cyanolichens or their habitat.

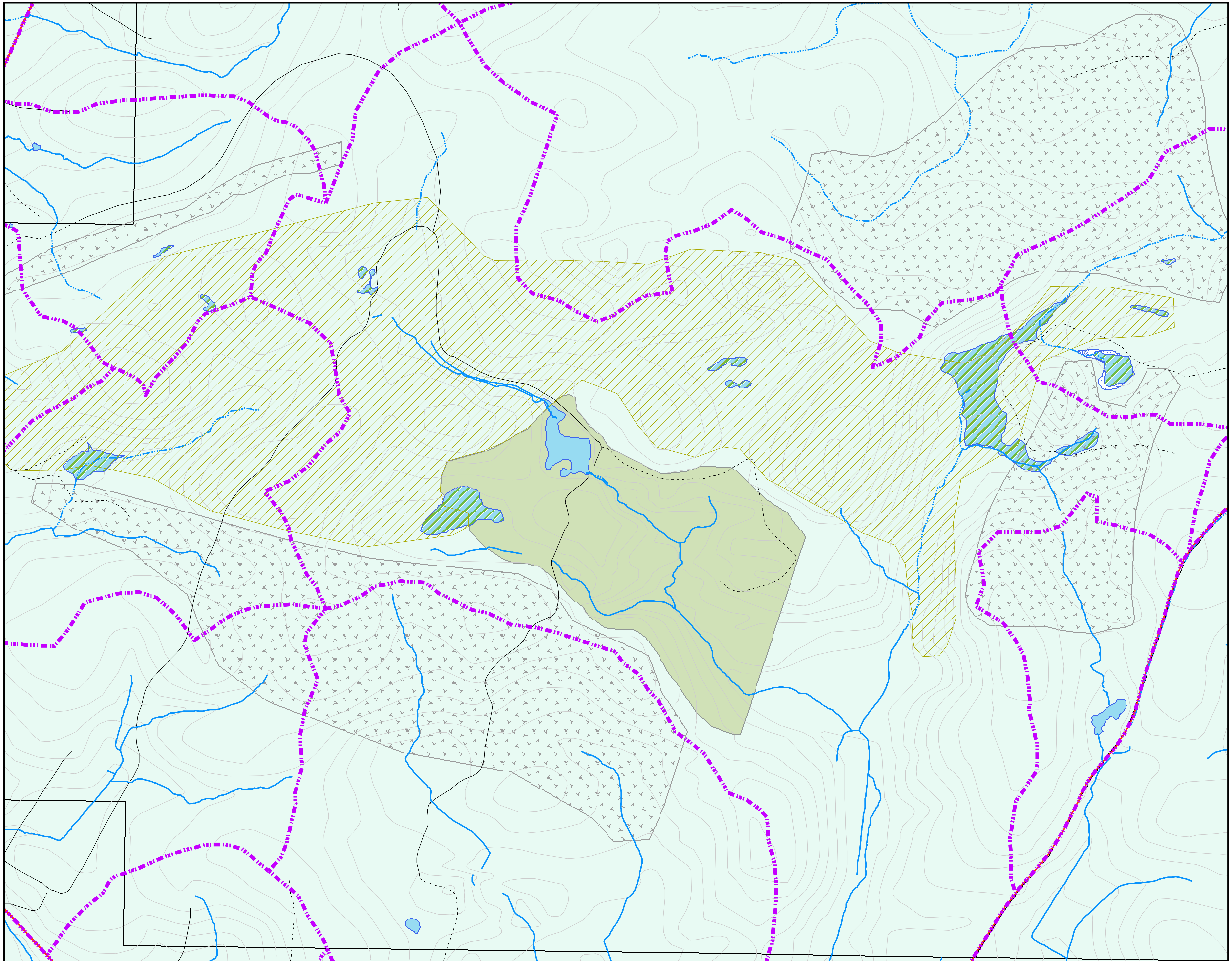
6.5.2.2 PROPOSED CONSERVATION AREA

FG recognizes that the mine development is in close proximity to an important population of a provincially red-listed species (ram's head lady's-slipper). This species is important locally as the emblem for the Municipality and is a widely recognized and treasured species by local residents. FG is committed to, and has communicated via newsletter and the public information sessions, to protecting mineable land for this species; as well as several other provincially important species that are found there, as outlined in this EARD. The Conservation Area (Figure 6.5-1) concept was presented at the Public Information Sessions and in a newsletter that went to the local residents. FG is firmly committed to advancing the concept and feels strongly that it is a project benefit. Long term research on plant species and protection of the area is an integral part of the proposed project. FG recognizes that additional work will be needed with NSDNR, local interests groups and landowners, the CLC and NSEL to determine the most appropriate boundaries, marking of the area and access restrictions. We feel the proposed Conservation Area and the commitments noted below will aid greatly in determining the deficiencies in the knowledge base for these species through research, monitoring and linkages with academia. We understand that it will be important to fully detail how FG will increase the available knowledge on aspects of habitat and plant information that aid to enhance long term improvements to the species population and distribution. In order to do this, it is critical to determine performance indicators that are measurable and demonstrative. FG will work with the aforementioned groups to develop this program and will identify the long term plan in the application for the Industrial Approval when the Extension Project receives Environmental Assessment Approval.

Key Aspects of FG's Commitment to the Proposed Conservation Area include:

- Set aside approximately 40 ha of mineable land which is host to an important assemblage of provincially and locally important plant species;
- Liaison with NSDNR, local interest groups, CLC and NSEL and other groups identified by NSDNR;
- Determine clear boundaries that are based on ecological, legal and technically suitable considerations;
- Conduct long term research on plant species within the Conservation Area that is developed with academia and co-sponsored by FG, that is specifically aimed at benefiting those species by providing information on habitat requirements and plant reproduction

The Conservation Area requires connectivity with undisturbed areas around it. The proposed area was chosen because it represents a cross section of the rare or endangered species found in the project area. FG is open to discussing changes to the boundaries that are beneficial to the species and don't affect project viability. The proposed boundaries are defined on the east by Fundy's property line with its neighbour. Species of concern may cross this boundary, but FG has no control over their current or future status. The southern boundary is controlled partly by the Shaw Brook watershed boundary and the extent of the stockpile that is being created through mine development. The north and west boundaries of the proposed Conservation Area are controlled by the mine boundaries that were chosen to provide a considerable ecological buffer around the aerial extent of the ram's head lady's-slipper.



Legend

- Catchments
- Proposed Mine Pit
- Proposed Stockpiles
- Wetlands
- Proposed Conservation Area

0 100 200 300 400
Metres
1:10,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
Nova Scotia Property Database
SNS&MR - NS Geomatics Centre
Fundy Gypsum
Field Surveys: CRA, Dillon

820677B (REP06) GIS-DA0651 Jan. 29, 2008

Figure 6.5-1

PROPOSED CONSERVATION AREA
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

The lands surrounding the Minas Basin are some of the oldest inhabited lands in the province. A critical review of the history of the area and the role of human interaction with the land that may have affected species over the years will be conducted. Detailed studies of the habitat supporting these species may reveal what combination of biogeoclimatic parameters are required to enable these particular plants to grow where they do. Monitoring of the area's hydrology will also be required to note changes in the fundamental building blocks of the Conservation Area. Water chemistry and flow data that has been collected since 2004 in the area will continue to be collected. A refined consultation program with the aforementioned groups will be undertaken to maximize benefits. Other data collection programs may be required. FG recognizes the importance of developing a comprehensive program that is technically feasible, does not affect project viability, can be scientifically defensible and provides long term benefit to the plant species involved.

6.5.2.3 BLACK ASH (WISQOQ) MONITORING PLAN

FG recognizes the importance of black ash to the Province and Mi'kmaq and has developed a monitoring program to provide benefit to the species. Some black ash, or Wisqoq, will be removed as part of the mine development's 50 year life and FG has sought to develop a program that gains as much information on the species as possible prior to each individual trees removal. We have also provided information on what may be done with individuals at the time of removal. FG recognizes the need to continue to work with NSDNR and the Confederacy of Mainland Mi'kmaq (CMM) to finalize a program that is beneficial to all. The program described here provides detail that is intended to meet the EA needs. FG recognizes that, should the project receive approval, additional detail and discussions may need to occur as part of the application for an Industrial approval.

The following section provides a monitoring plan for the management of black ash within the Miller's Creek Mine Extension Project. In Nova Scotia, black ash (or Wisqoq) is distributed from Digby to central Lunenburg counties to northern Cape Breton, scattered throughout the northern portions of the mainland, and limited elsewhere. This species prefers damp woods, low ground, and swamps. Black ash is yellow-listed by NSDNR and is of particular importance to Nova Scotia's Mi'kmaq communities due to its many cultural uses such as basket weaving. Black ash's sub-national rank in Nova Scotia in S3 (sensitive), while nationally is listed as secure based on large populations in Ontario, New Brunswick and Quebec. Globally this species is listed as G5, or common with secure populations.

From environmental baseline data collected for the EARD for the Miller's Creek Mine Extension, black ash was identified in several wetlands in and around the Project area. Within the Project area, a single mature black ash, 24 saplings and four seedlings were detected in the summer of 2007. An additional seven saplings were identified outside the Project footprint and measures to avoid disturbance to these individual specimens were addressed in the EARD. The avoidance measures have resulted in roughly 25% of the specimens found being in areas where the mine development will not disturb them.

The proposed plan involves the black ash being assessed yearly to obtain information on populations within the Miller's Creek Mine Extension Project area. Based on conversations with CMM, baseline assessments, monitoring, and management options for healthy trees impacted by the project will be evaluated. Field studies will commence in mid- to late summer when potential seed sources are present.

Baseline Assessment

Baseline information is critical to the management of black ash within the Project area. A significant amount of baseline information on locations and health of individuals are known. This information will be upgraded and the additional assessments will include:

- Further searching and investigations for additional black ash in the area surrounding existing populations.
- Documenting the existing geological and hydrogeological conditions for each area where black ash are located.
- Identification of wildlife attributes associated with black ash.
- Assessing soil and wetland characteristics at black ash locations.

Monitoring

Appropriate monitoring strategies are imperative to the understanding of black ash population and habitat requirements of black ash in Nova Scotia. Monitoring of black ash will include:

- Each black ash specimen will be marked with a unique identification code and monitored yearly.
- Complete yearly data collection on each black ash specimen will be collected based on a field checklist provided by CMM (see Table below).
- Identification of seed sources. Good seed crops occur at irregular intervals and up to 7 years apart. Due to the biology of the species, seeds will be collected when possible.

Management Options

FG will provide advice and guidance on management options for healthy trees to be impacted by the project. Management options include:

- Determine suitable locations for black ash transplantations in the surrounding landscape or Mi'kmaq communities for trees scheduled to be removed by the Project development.
- FG will coordinate with CMM to determine the appropriate course of action for any trees that can not be transplanted.

Wisqoq Research Field Sheet		
Site:		Date:
GPS Location:		
Data Collector(s):		
1. Macrotopography		
2. Tree Number		
3. DBH (Diameter at Breast Height)		
4. Height		
5. Dominance (D,C,I, or S)		
6. Tree Type		
7. Basket Quality		
8. Stem Form (0,2,3,4,5)		
9. Main Stem Bending (1 to 5)		
10. Dieback (%)		
11. Anthracnose (diseases of hardwood trees)		
12. Stem Fungus (1 to 5)		
13. Leaf Insect Damage (%)		
14. Woody Tissue Damage	Type	
	Location	
	Level	
15. Soil Drainage Class	Terrain Position	
	Horizon depth, colour and texture	
16. Wildlife Attributes		
17. Associated Soils		
18. Associated Vegetation		

6.5.2.4 RECLAMATION

Reclamation of land disturbed from past or ongoing surface mining is an essential component of mitigating impacts to flora. Where reclamation is not complete and a landscape remains disturbed, terrestrial habitat is impacted in the long term. Long-term impacts of deforestation can be mitigated via progressive reclamation of the site. As the mine progresses westward over the next several decades, the previously mined area will be reclaimed. Topsoil and root mat from the site will be stockpiled during the development period for use in reclamation. These materials will act as a source of seeds and propagules of existing species and will aid greatly in re-establishment of these species. The existing scrub plant material and debris will also be re-used in the reclamation as a growing medium placed as the final layer on top of the contoured lands. Some of the stockpiled material will be redistributed, seeded with native grasses and wildflowers and planted with a mix of deciduous and hardwood trees. As the reclaimed and reforested areas mature, much of this structural complexity of the original forest will be regained and additional flora habitat will be created. Thus, natural revegetation processes combined with an active reclamation plan should result in the reclamation period being significantly shorter than it would be if left to nature alone.

6.5.3 SUMMARY

The proposed mine footprint and stockpiles will have an impact on flora and flora habitat over the life of the Project and slightly beyond. These impacts are not considered to be significant. Populations of red-listed flora species will be avoided altogether by the Project footprint, and considerable habitat and a buffer zone will be left undisturbed for these species via the creation of the Conservation Area. No known critical habitat for any rare plant species will be disturbed. The creation of the Conservation Area will benefit the ram's head lady's-slipper, eastern leatherwood, and round-lobed hepatica, thimbleweed, Canada buffalo-berry, and yellow-lady's-slipper by preserving and protecting habitat for these species. The loss of some specimens of yellow-listed vascular plants and a single red-listed vascular plant will not have significant long-term effects on these species' viability in NS. Significant adverse impacts on rare cyanolichens due to the Project are possible for one listed species of cyanolichen due to habitat loss and removal of specimens. FG will consult with NSDNR to determine appropriate mitigation for this loss. A monitoring program to determine the habitat requirements of the one cyanolichen species which may be significantly affected by the Project may be established. Project emissions are not predicted to have significant adverse effects on cyanolichen species in the study area. Progressive reclamation and revegetation of the site will mitigate the long-term effects of deforestation on the Project site and restore non-critical habitat for flora.

6.6 FAUNA SPECIES AND HABITATS

Fauna are considered a VEC due to their role in biodiversity and ecological integrity. Many faunal species are protected under the Nova Scotia *Wildlife Act* (1989) or the *Migratory Bird Convention Act* (*MBCA*) (1994). In Nova Scotia, a species is considered rare when it is listed as rare or sensitive to anthropogenic disturbance by the Province (Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks of Wild Species or the *Endangered Species Act* (2003) of Nova Scotia), listed as rare or extremely rare by the Atlantic Canada Conservation Data Council (ACCDC), or listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

6.6.1 EXISTING ENVIRONMENT

Birds

In Nova Scotia, legislation protecting birds includes the *MBCA* and the Nova Scotia *Wildlife Act*. The *MBCA* protects migratory birds and their nests. Most bird species present in Nova Scotia are listed under the *MBCA*; however it does not include avian predators such as raptors and introduced species such as European Starlings (*Sturnus vulgaris*). The Nova Scotia *Wildlife Act* specifically protects raptors including eagles, ospreys, falcons, hawks and owls.

A significant area for migrating shorebirds occurs downstream of the Project site, in the Southern Bight of the Minas Basin. This portion of the Minas Basin, that includes the Avon River, is a large tidal estuary with extensive intertidal mudflats. These mudflats are recognized as a National Wildlife Area and provide important staging areas for millions of shorebirds. In addition, the mudflats have been identified as areas of International Significance (RAMSAR site) and contain a portion of the Western Hemisphere Shorebird Reserve Network. Shorebirds, including 95% of the world's Semipalmated Sandpipers (*Calidris pusilla*, a green-listed species in Nova Scotia), feed on the mudflat shrimp in later July and early August on their fall migration to South America. Nearby fields and dykeland may also be used during spring tides for roosting.

To obtain information on bird species possibly present on the study site, desktop reviews were conducted, as well as a breeding bird survey on the site. The Atlas of Breeding Birds of the Maritime Provinces (Erskine 1992) provided information on bird species detected in the atlas square in which the study site is located. Table 6.6-1 lists the breeding status of birds reported from the 10 x 10 km atlas square (20MQ18) in which the Project site is located. A total of 81 species were recorded from the square. Of these, 51 species are confirmed to breed in the area, while 24 species are probable breeders and 6 species are considered to be possibly breeding in the area (see Erskine 1992 for indicators of breeding evidence). An additional 6 species are confirmed, probable, or possible breeders in the atlas squares immediately surrounding the Project site.

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
Pied-Billed Grebe	*Podilymbus podiceps*	Confirmed	Fertile wetlands, impoundments	Moderate	Green
Wood Duck	*Anas spinosa*	Possible	Cavities near fertile wetlands/water	Moderate	Green
Green -winged Teal	*Anas crecca*	Probable	Forested areas, brackish marsh near coast	Moderate	Green
American Black Duck	*Anas rubripes*	Confirmed	on ground near water/wetland	High	Green
Blue-winged Teal	*Anas discors*	Confirmed	Open fertile marsh including estuary	Moderate	Green
American Wigeon	*Anas americana*	Confirmed	Marshes, estuaries	Moderate	Green
Ring-necked Duck	*Athytha collaris*	Confirmed	Lakes, ponds, and still waters, marsh, clumps pf sedge, sweetgale or leatherleaf	Moderate	Green
Northern Harrier	*Circus cyaneus*	Probable	Open marshes, meadows	Low-Moderate	Green
Sharp-shinned Hawk	*Accipiter striatus*	Possible	Conifer and mixed forests, spruce trees	High	Green
Northern Goshawk	*Accipiter gentilis*	Not within 10 km but within 20 km	Mature forest	Low-Moderate	Yellow
Red-tailed Hawk	*Buteo jamaicensis*	Confirmed	Woodlands, forage in openings and cutovers	High	Green

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
American Kestrel	*Falco sparverius*	Confirmed	Cavity nester	Moderate	Green
Gray Partridge	*Perid perdix*	Confirmed	Open lands, farmlands	Moderate	Introduced
Ring-necked Pheasant	*Phasianus colchicus*	Confirmed	Farmland, suburban areas	Moderate	Introduced
Ruffed Grouse	*Bonasa umbellus*	Confirmed	Hardwood, mixed forest	High	Green
Sora	*porzana carolina*	Probable	Fertile marshes	Moderate	Green
Common Moorhen	*Gallinula chloropus*	Probable	Fertile wetlands	Moderate	Green
Killdeer	*Charadrius vociferous*	Confirmed	clear-cuts, farmlands, gravel pits	High	Green
Willet	*Catoptrophorus semilpalmatus*	Possible	fields and open areas near salt marshes	Moderate	Green
Spotted Sandpiper	*Actitis macularai*	Confirmed	Near watercourse, coast	Low	Green
Upland Sandpiper	*bartramia longicauda*	Probable	Open grassy areas	Low	Green
Common Snipe	*Gallinago gallinago*	Probable	Shallow marsh/bog with grasses/sedges low shrubs	High	Green
Rock Pigeon	*Columba livia*	Confirmed	Associated with buildings, agriculture	Moderate	Introduced
Black-billed Cuckoo	*coccyzus erythropthalmus*	Possible	Open woods, edges, nest in small trees/shrubs	Moderate	Green
Barred Owl	*Strix varia*	Confirmed	Cavities in hardwood or mixed forests	Moderate	Green
Long-Eared Owl	*Asio otus*	Not within 10 km but within 20 km	Woodlands	Low	Green

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
Short-eared Owl	*Asio flammeus*	Not within 10 km but within 20 km	Coastal marsh, open meadows	Low	Yellow (COSEWIC Special Concern)
Chimney Swift	*Chaetura pelagiaca*	Confirmed	Structures, hollow trees	Low	Yellow
Belted Kingfisher	*Ceryle alcyon*	Confirmed	Tree, cliff near water	Moderate	Green
Downy Woodpecker	*Picoides pubescens*	Confirmed	Hardwood, mixed forest	High	Green
Hairy Woodpecker	*Picoides villosus*	Confirmed	Cavity, open woods	High	Green
Northern Flicker	*Colaptes auratus*	Confirmed	Open woods	High	Green
Pileated Woodpecker	*Dryocopus pileatus*	Possible	Cavity in old large hardwoods	Moderate	Green
Olive-sided Flycatcher	*Contopus borealis*	Probable	Dense secondary growth	High	Yellow
Eastern Wood-pewee	*Contopus virens*	Probable	Hardwood and mixed forest	High	Green
Alder Flycatcher	*Empidonax alnprum*	Probable	Low in shrubbery	High	Green
Least Flycatcher	*Empidonax minimus*	Probable	Broad leafed woods	Low-Moderate	Green
Eastern Kingbird	*Tyrannus tyrannus*	Confirmed	Open areas	Moderate	Green
Tree Swallow	*Tachycineta bicolor*	Confirmed	Cavities, nest boxes	Moderate	Green
Bank Swallow	*Riparia riparia*	Confirmed	Banks and cliffs	Moderate	Green
Cliff Swallow	*Hirundo pyrrhonata*	Confirmed	Cliffs, structures	Moderate	Green
Barn Swallow	*Hirundo rustica*	Confirmed	Buildings, caves, cliffs	Moderate	Yellow

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
Blue Jay	*Cyanocitta cristata*	Probable	Trees	High	Green
American Crow	*Corvus brachyrhynchos*	Confirmed	Trees	High	Green
Common Raven	*Corvus corax*	Confirmed	Large trees, cliffs, old buildings	High	Green
Black-capped Chickadee	*Poecile atricapilla*	Confirmed	Cavities in coniferous forests	High	Green
Red-breasted Nuthatch	*Sitta canadensis*	Confirmed	Cavity in coniferous forest	High	Green
White-breasted Nuthatch	*Sitta carolinensis*	Confirmed	Cavity in open woodlands, urban areas	Moderate	Green
Golden-crowned Kinglet	*Regulus satrapus*	Probable	Coniferous forests	Moderate	Green
Ruby-crowned Kinglet	*Regulus calendula*	Probable	Conifers	High	Green
Eastern Bluebird	*Sialis sialis*	Not within 10 km but within 20 km	Woodpecker cavities	Low	Yellow
Veery	*Catharus fuscescens*	Probable	Broadleaf forest	Moderate	Green
Hermit Thrush	*Catharus guttatus*	Confirmed	Open woods	high	Green
Gray Catbird	*Dumetella carolinensis*	Confirmed	Hardwood forest	Moderate	Green
American Robin	*Turdus migratorius*	Confirmed	Wide range of habitats	High	Green
Northern Mockingbird	*Mimus polyglottos*	Confirmed	Urban areas	Low	Green
Cedar Waxwing	*Bombycilla cedrorum*	Confirmed	Edge, open woods	Moderate	Green
European Starling	*Sturnus vulgaris*	Confirmed	Cavities, enclosed spaces	Moderate	Introduced

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
Red-eyed Vireo	*Sturnus vulgaris*	Confirmed	Forest	High	Green
Northern Parula	*Parula americana*	Probable	Bearded lichens in conifers	Moderate	Green
Yellow Warbler	*Dendroica petechia*	Confirmed	Shrubs, urban areas	Moderate	Green
Chestnut-sided Warbler	*Dendroica pensylvanica*	Probable	Low shrubs	Moderate	Green
Yellow-rumped Warbler	*Dendroica coronata*	Possible	Forest with some confers	Moderate	Green
Black-throated Green Warbler	*Dendroica virens*	Probable	mixed or coniferous forests	High	Green
Black-and-white Warbler	*Mniotilta varia*	Confirmed	Forests with some hardwoods	Moderate	Green
American Redstart	*Setophaga ruticilla*	Confirmed	Small trees	Moderate	Green
Ovenbird	*Seiurus aurocapillus*	Confirmed	On ground in mixedwoods	Moderate	Green
Northern Waterthrush	*Seiurus noveboracensis*	Probable	Wet mixed woods near the ground	Moderate	Green
Common Yellowthroat	*Geothlypis trichas*	Confirmed	Brushy areas	Moderate	Green
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Probable	Coniferous forests	Low	Green
Evening Grosbeak	*Coccothraustes vespertinusq*	Probable	Coniferous forest, spruce trees	High	Green
Chipping Sparrow	*Spizella passerina*	Confirmed	Edge, open woods	Moderate	Green
Vesper Sparrow	*Proecetes gramineus*	Not within 10 km but within 20 km	Short grass, low shrubs	Low	Yellow
Savannah Sparrow	*Passerculus sandwichensis*	Confirmed	Grasses, sedges	Moderate	Green

TABLE 6.6-1: BREEDING STATUS OF BIRDS WITHIN THE 10 x 10 Km ATLAS SQUARE ENCOMPASSING THE PROJECT SITE[1]

Common Name	Binomial	Breeding Status in Atlas Square[1]	Preferred Nesting Habitat[1]	Potential Presence on Site	NSDNR Status[2]
Song Sparrow	*Melospiza melodia*	Confirmed	Shrubs	Moderate	Green
White-throated Sparrow	*Zonotrichia albicollis*	Confirmed	On ground at forest edge	High	Green
Dark-eyed Junco	*Junco hyemalis*	Confirmed	Forest edge	High	Green
Bobolink	*Dolichonyx oryzivorus*	Confirmed	Lush meadows	Low	Yellow
Red-winged Blackbird	*Agelaius phoeniceus*	Confirmed	Marshes with cattails and shrubs	High	Green
Eastern Meadowlark	*Sturnella magna*	Not within 10 km but within 20 km	Grasslands	Low	Green
Common Grackle	*Quiscalus quiscula*	Confirmed	Open areas	Moderate	Green
Brown-headed Cowbird	*Molothrus ater*	Probable	Parasite farm areas	Low	Green
Baltimore Oriole	*Icterus galbula*	Confirmed	Open woods, scattered tress in farmlands	Low-Moderate	Green
Purple Finch	*Carpodacus purpureus*	Probable	Conifers	Moderate	Green
Pine Siskin	*Carduelis pinus*	Probable	Conifers	Low	Green
American Goldfinch	*Carduelis tristis*	Probable	Open areas	High	Green
House Sparrow	*Passer domesticus*	Confirmed	Settled areas, buildings	Low	Introduced

[1] Erskine (1992) and Sibley (2000).
[2] Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks of Wild Species in Nova Scotia (http://www.gov.ns.ca/natr/wildlife/genstatus/ranks.asp).

A breeding bird survey was undertaken in June 2005 to provide a baseline data on breeding birds on the Project site and to identify potential species-at-risk. The area surveyed included all of the Project footprint area found within the property. Surveys were conducted as listening posts (5 min point counts) at representative locations within major habitat types in the study area. Birds were identified by an experienced birder based on song and visual observations following the Environment Canada protocol. A total of 263 birds representing 51 species were recorded during the breeding bird survey. A list of bird data recorded at each survey point is provided in Table 6.6-2. Breeding birds were present in all habitat types. Descriptions of each bird survey point are provided in Appendix E.3. Potential nesting habitat for species detected covered a full range of nesting types from typical tree and shrub nesting species to cavity and ground nesting species. The most abundant species in descending order of abundance were American Robin (*Turdus migratorius*; 6.5%), Common Yellowthroat (*Geothlypis trichas;* 4.2%), Cedar Waxwing (*Bombycilla cedrorum;* 3.8%), and Eastern Wood-pewee (*Contopus virens;* 3.8%). All of the species heard were presumed to be attempting to breed within or in the vicinity of the Project site. Two species recently listed as sensitive to anthropogenic disturbance (yellow-listed) by the NSDNR was detected during the breeding bird survey. Three Olive-sided Flycatchers (*Contopus borealis*) and one Barn Swallow (*Hirundo rustica*) were heard singing during the breeding bird survey in 2005. Olive-sided Flycatchers prefer open woodlands and Barn Swallows prefer open areas near human structures, caves and cliffs. Olive-sided Flycatcher has only recently (November 2007) been listed as threatened by COSEWIC.

Birds of Concern in Nova Scotia

Additional information regarding use of the area by rare and endangered birds was derived from a review of ACCDC database and Nova Scotia Museum (NSM) environmental screening (Appendix E.1) and used to develop a rare bird modelling exercise. Lists of provincially rare or sensitive birds were derived from NSDNR while nationally rare species were derived from the COSEWIC list. Results of these reviews are described in the following sections.

A review of the ACCDC database of rare bird species records revealed 17 listed species in the region (Appendix E.1). Four red-listed and 13 yellow-listed bird species were listed within 100 km by the ACCDC search. No currently listed rare bird species were identified in the NSM environmental screening. Each species' habitat preference was determined based on Erskine (1992), and the likelihood of their presence on site was determined based on the habitat types present on site. The results of the rare bird habitat modeling are presented in Table 6.6-3. None of the four red-listed species, Peregrine Falcon (*Falco peregrinus*), Piping Plover (*Charadrius melodus*), Roseate Tern (*Sterna dougallii*), or Purple Martin (*Progne subis*), are expected to be present on the Project site due to the lack of suitable habitat (Table 6.6-3).

TABLE 6.6-2: BREEDING BIRDS OBSERVED DURING THE 2005 BREEDING BIRD SURVEY

Common Name	*Binomial*	NSDNR Status	Preferred Nesting Habitat	Nesting Period	Survey Station																										Total # of Individuals
					B1	B1-eve	B1-2	B2	B2-3	B3	B3-4	B4	B4-5	B5	B5-6	B6	B6-7	B7	B7-8	B8	B8-9	B9	B10	B11	B12	B12b	B13	B14	B15	B16	
Ring-neck Duck	*Aytha collaris*	Green	Ground in thick grass and weeds	May-June												1															1
Red-tailed Hawk	*Buteo jamaicensis*	Green	Woodland trees or cliff	Apr-June												1															1
Ring-necked Pheasant	*Phasianus colchicus*	Green	Farm, suburban areas	May-mid July									2							1				1							4
American Woodcock	*Scolopax minor*	Green	Broad-leafed forests, in dense tree or shrub cover, near swamps	Mid Apr- late May	2																							1			3
Mourning Dove	*Zenaida macroura*	Green	Open areas, nest in trees	Early Apr- mid Sept			1														1										2
Barred Owl	*Strix varia*	Green	Hardwood and mixed forest, large hollow tree or nest box	Early Apr- late June																										2 pair	0
Downy Woodpecker	*Picoides pubescens*	Green	Cavities in dead trees	Early May- July																						1					1
Hairy Woodpecker	*Picoides villosus*	Green	Live poplar cavities	Early May- early July	1	1											1				1		1	1				1	2		9
Northern Flicker	*Colaptex auratus*	Green	Tree or post cavities	Early May- early Aug				1			1			2		2				1	1							1			9
Olive-sided Flycatcher	*Cantopus borealis*	Yellow	Forest edge	Mid June- mid Aug	1																	1							1		3
Eastern Wood-Pewee	*Contopus virens*	Green	Open forest	Early June, early Sept				2		2	1	3					1			1											10
Yellow-bellied Flycatcher	*Empidanax flaviventris*	Green	Ground in conifer moss	Mid June, early Aug																						1					1
Least Flycatcher	*Empidanax minimus*	Green	Broad- leaved woods	Early June, mid Aug	4							1						2											2		9
Tree Swallow	*Tachycineta bicolor*	Green	Cavities near lakes	May-June															1			1							1		3
Bank Swallow	*Ripara ripara*	Green	Banks, cliffs	May-July				1		2		1		1		1															6
Barn Swallow	*Hirundo rustica*	Yellow	Structures, cliffs	Late May- July																1											1
Blue Jay	*Cyanocitta cristata*	Green	Conifers	Early May- mid July						1		1																			2
American Crow	*Corvus brachyrhynchos*	Green	Tall trees	April-July		2		1				1				1	1	1	1		1				1						10
Common Raven	*Corvus corax*	Green	Trees, cliffs, old buildings	Mar-June										1													2				3
Black-capped Chickadee	*Parus atricapillus*	Green	Nest cavities in rotted tree stumps	Early May- mid Aug				1				3				2					1		1								8
Red-breasted Nuthatch	*Sitta Canadensis*	Green	Excavated from dead trees	Mid May- late June										2			1														3

TABLE 6.6-2: BREEDING BIRDS OBSERVED DURING THE 2005 BREEDING BIRD SURVEY

Common Name	*Binomial*	NSDNR Status	Preferred Nesting Habitat	Nesting Period	Survey Station																										Total # of Individuals
					B1	B1-eve	B1-2	B2	B2-3	B3	B3-4	B4	B4-5	B5	B5-6	B6	B6-7	B7	B7-8	B8	B8-9	B9	B10	B11	B12	B12b	B13	B14	B15	B16	
Brown Creeper	*Certhia Americana*	Green	Stumps or low trees in coniferous forests	Mid May- early July				1						2			1						1								5
Winter Wren	*Troglodytes troglodytes*	Green	Damp coniferous forest	Mid May- late July																			1			1					2
Veery	*Catharus fuscescens*	Green	Broad-leafed forest	Late May- late July																						1		1	1		3
Swainson's Thrush	*Catharus ustulatus*	Green	Low conifers	Late May- late July		1			1													1						1			4
Hermit Thrush	*Catharus guttatus*	Green	Ground	Mid May-late Aug	1				1			1																	1		4
American Robin	*Turdus migratorius*	Green	Tree crotches	Late April- mid Sept		2					1							1			1		1	1	2		3	3	2		17
Cedar Waxwing	*Bombycilla cedrorum*	Green	Open woods	Mid June- early Sept			2							1				1	1		1	3						1			10
Solitary Vireo (Blue Headed)	*Vireo solitarius*	Green	Low conifers	Late May- late July						1		1				1													1		4
Red-eyes Viero	*Vireo olivaceus*	Green	Maple, Apple and Elm	Early June- early Aug			1							1																	2
Northern Parula	*Parula Americana*	Green	Bearded lichen in conifer	Late May- early Aug						1											1	4					1				7
Yellow Warbler	*Dendroica petechia*	Green	Edges and disturbed areas	Late May- July	1		1													1			1								4
Chestnut-sided Warbler	*Dendroica pennsylvanica*	Green	Low shrubs, raspberry canes	June-July				2		1	1			1		1					1	1			1						9
Magnolia Warbler	*Dendroica magnolia*	Green	Conifers	Early June- late July				1		1								2		1								1			6
Black-throated Green Warbler	*Dendroica virens*	Green	Mixed or coniferous forests	Early June- mid July	2		1														1										4
Blackburnian Warbler	*Dendroica fusca*	Green	Conifers	Mid June- late July			1																			1					2
Bay-breasted Warbler	*Dendroica castanea*	Green	Conifers	June- July							1						1							1							3
Black-and-White Warbler	*Mniotilta varia*	Green	Ground, among tree roots	Early June- mid July			1	1					1					1		1					1						6
American Redstart	*Setophaga ruticilla*	Green	Small trees	Late May- late July																								6			6
Ovenbird	*Seiurus aurocaptilus*	Green	Ground	Late May- late July	4			1												1				1							7
Northern Waterthrush	*Seiurus noveboracensis*	Green	Mixed woods	May- July			1																		2			1			4
Common Yellowthroat	*Geothlypis trichar*	Green	Brushy areas	Late May- late July	2			1		1						4		1									1	1			11
Rose-Breasted Grossbeak	*Pheucticus ludovicianus*	Green	Mixed and broad leafed woods	June- July																						1					1
Savannah Sparrow	*Passerculus sandwichensis*	Green	Open vegetated areas, ground	Mid May- August																1	1			1							3

TABLE 6.6-2: BREEDING BIRDS OBSERVED DURING THE 2005 BREEDING BIRD SURVEY

Common Name	*Binomial*	NSDNR Status	Preferred Nesting Habitat	Nesting Period	Survey Station																										Total # of Individuals
					B1	B1-eve	B1-2	B2	B2-3	B3	B3-4	B4	B4-5	B5	B5-6	B6	B6-7	B7	B7-8	B8	B8-9	B9	B10	B11	B12	B12b	B13	B14	B15	B16	
Song Sparrow	*Melospiza melodia*	Green	Shrubbery	May- Aug							1											2							1		4
Swamp Sparrow	*Melospiza Georgiana*	Green	Wetlands	Late May- mid July																							2				2
White-throated Sparrow	*Zonotrichia albicollis*	Green	Ground at forest edge	Mid May- mid Aug															1				4					1			6
Dark-eyed Junco	*Junco hyemalis*	Green	Forest edge	Early May- late Aug	1			2		1		2				1															7
Red-winged Blackbird	*Agelatus phoenicens*	Green	Marshes with cattails	May-July										1									1								2
Purple Finch	*Carpodacus purpureus*	Green	Conifers	Early June- mid August										3		3						1					2				9
American Goldfinch	*Carduelis tristis*	Green	Open meadows	Late June- mid Sept	3			1		1		3		1		1						1	1				1		1		14
Evening Grosbeak	*Coccothraustes vespertinus*	Green	Southern boreal forest, high in spruce tree	Late June- August				1																				1			2
					11	4	8	14	2	10	6	10	2	11	0	12	4	9	4	8	11	9	9	7	5	6	7	13	10	1	52

Table 6.6-3: Rare Bird Habitat Modelling Exercise, Using ACCDC And NSM Lists Of Rare Birds Reported From Within 100 Km (ACCDC) Or 10 Km (NSM) Of The Site

Common Name	Binomial	Source of Record	Habitat Preference[1]	Potential Presence on site	NSDNR Status[2]
American Peregrine Falcon	*Falco peregrinus anatum*	ACCDC	Rocky cliffs	Unlikely	Red
Piping Plover	*Charadrius melodus*	ACCDC	Sandy Beaches	Unlikely	Red
Roseate Tern	*Sterna dougallii*	ACCDC	Coast	Unlikely	Red
Purple Martin	*Progne subis*	ACCDC	Breeds in colonies in nest boxes in Nova Scotia	Unlikely	Red
Barrow's Goldeneye (Eastern population)	*Bucephala islandica*	ACCDC	Small clear lakes and ponds	Unlikely	Yellow
Northern Goshawk	*Accipiter gentilis*	ACCDC	Mature forest	Possible	Yellow
Purple Sandpiper	*Calidris maritime*	ACCDC	Not known to breed in Nova Scotia, subarctic	Unlikely	Yellow
Common Tern	*Sterna hirundo*	ACCDC	Coast	Unlikely	Yellow
Arctic Tern	*Sterna paradisaea*	ACCDC	Coast	Unlikely	Yellow
Razorbill	*Alca torda*	ACCDC	Coastal islands	Unlikely	Yellow
Atlantic Puffin	*Fratercula arctica*	ACCDC	Coastal islands	Unlikely	Yellow
Short-eared Owl	*Asio flammeus*	ACCDC	Breed in dyked wet meadows near coast in Nova Scotia	Unlikely	Yellow
Boreal Chickadee	*Poecile hudsonica*	ACCDC	Coniferous forest, nest in rotting trees and stumps	Unlikely	Yellow
Eastern Bluebird	*Sialia sialis*	ACCDC	Areas with scattered trees and short ground cover.	Unlikely	Yellow
Vesper Sparrow	*Pooecetes gramineus*	ACCDC	Open field and pastures, often near trees.	Unlikely	Yellow
Bobolink	*Dolichonyx oryzivorus*	ACCDC, NSM	Grasslands, lush meadows	Unlikely	Yellow
Rusty Blackbird	*Euphagus carolinus*	ACCDC	Spruce bogs, swamps and damp alder swales	Possible	Yellow

[1] Erskine (1992) and Sibley (2000).
[2] Nova Scotia Department of Natural Resources (NSDNR) General Status Ranks of Wild Species in Nova Scotia (http://www.gov.ns.ca/natr/wildlife/genstatus/ranks.asp).

Only two of the yellow-listed species listed in the ACCDC database might possibly make use of any habitat types on the Study site. Northern Goshawks (*Accipiter gentilis)* prefer to breed in large, dense mature mixed-wood forests. They will also breed in mature hardwoods, or if that is not available, mature softwoods. Northern Goshawks were not reported from the Atlas square encompassing the Avon Peninsula. This species was not detected during the breeding bird survey or any other survey on the Project site in 2005, 2006, or 2007. Rusty Blackbirds (*Euphagus carolinus)* inhabit spruce bogs, swamps and damp alder swales. As such, they might possibly utilize the treed swamps present on the Project site. Rusty Blackbirds were not reported in the ACCDC list or the NSM environmental screening. This species was not detected during the breeding bird survey or any other survey on the Project site in 2005, 2006, or 2007.

Arctic Terns (*Sterna paradisaea)*, Common Terns (*Sterna hirundo)*, Atlantic Puffins (*Fratercula arctica)*, and Razorbills (*Alca torda*) are coastal species, and will not be present on the site. Vesper Sparrows (*Pooecetes gramineus*) breed in open field and pastures often near trees. These habitats are present in the vicinity of the Project area but not within the Project area. Bobolinks (*Dolichonyx oryzivorus)* are grassland/meadow species and would not be expected to be breed on the Project site, as minimal suitable habitat is present; however, one Bobolink was heard in the non-breeding season (August 2007) on the Project site, when Bobolinks and other blackbirds are gathering in preparation for fall migration.

Although reported within 100 km of the Project site, neither the Purple Sandpiper (*Calidris maritime)* nor Barrow's Goldeneye (*Bucephala islandica*) is known to breed in Nova Scotia. These species tend to live near large bodies of water and thus would not be expected to use the habitat found on the Project site.

One species, the Eastern Bluebird (*Sialia sialis)*, nests in clear-cut areas with old woodpecker cavities and might possibly use some of the habitat on site. However, the low number of Eastern Bluebirds nesting in Nova Scotia in any given year and their lack of nest site fidelity makes it reasonable safe to assume that Eastern Bluebirds would not be expected to use the site in any given year (F. Lavender, pers comm. 2006). Short-eared Owls (*Asio flammeus)* breed in dyked wet meadows near the coast in Nova Scotia. There is no such habitat present on the study site for this species. Boreal Chickadees (*Poecile atricapilla*) prefer boreal coniferous forests, and nest in rotting trees and stumps. They would not be expected to make use of the habitat present on the site.

As stated above, the Barn Swallow and Olive-sided Flycatcher were detected during the breeding bird survey in 2005. An additional male Olive-sided Flycatcher was heard singing in an area separate from the breeding bird survey locations during wetland surveys in June 2007. Barn Swallows nest almost exclusively on human structures in the Maritime provinces (5 of 1,093 nests were in natural settings, usually in caves or underneath cliffs close to water; Erskine 1992). As no human structures are present in the Project area, the Barn swallow was likely nesting outside the Project area on a nearby human structure (*e.g.* barn, bridges). The Olive-sided Flycatchers are associated with forest openings, forest edges near natural openings (*e.g.*, meadows, canyons, rivers), human-made openings (*e.g.*, harvest units), or open to semiopen forest stands (Altman and Sallabanks 2000). In Nova Scotia, Olive-sided Flycatchers are reported to nest in tall trees near farmland and on edges of towns, including apple (*Malus* spp.) orchards (Godfrey 1986). The Olive-sided Flycatchers were likely making use of the agricultural edges and early successional forest clearings within and in the vicinty of the Project area.

An additional yellow-listed species not reported in the ACCDC database or NSM environmental screening searches, the Canada Warbler (*Dendroica canadenis*), was observed during the wetland surveys in June 2007. This species inhabits a variety of forest types during the breeding season but is most abundant in cool, moist forests of mixed-wood, a dense understory and the presence of sphagnum (Conway 1999). An additional Olive-sided Flycatcher was detected

Mammals

The Nova Scotia *Wildlife Act* (1989) provides legislation for the protection, management and conservation of mammals and their habitat in Nova Scotia.

Field surveys for mammals were conducted concurrently with vegetation, bird and wetland surveys conducted on the Project site in 2005 and 2006 and 2007. Field surveys such as these are generally sufficient in detecting the presence of large mammals; however, small mammals, which tend to be very secretive, are poorly surveyed by this method. Fortunately, most rare small mammals have very specific habitat requirements which can be used to predict the likelihood of their presence.

Evidence of large mammals typical of the area, such as red fox (*Vulpes vulpes*), coyote (*Canis latrans)*, varying hare (*Lepus americanus*), raccoon (*Procyon lotor*) and white-tailed deer (*Odocoileus virginianus)*, were observed during field studies on the Project site in 2005, 2006, and 2007. Evidence of American beaver (*Castor canadensis*) was also noted. Striped skunk (*Mephitis mephitis)* and bobcat (*Lynx rufus*) may also be present but were not observed.

Small mammals likely to be present in the area include American red squirrel (*Tamiasciursus hudsonicus,)* meadow vole (*Microtus pennsylvanicus*), red-backed vole (*Clethrionomys gapperi*), eastern chipmunk (*Tamias striatus*), and short-tailed shrew (*Blarina brevicaudata*).

It is likely that bat species such as little brown bat (*Myotis lucifugus*) and northern long-eared bat (*Myotis septentrionalis*) are present in the general area and may make use of habitat on the site. These species are local to the province, and although they may occur during summer foraging, they are primarily of concern due to communal winter hibernating behaviour which concentrates the bats in a few areas that are sensitive to disturbance.

No critical areas for mammals such as deer wintering areas are known to exist on the proposed Project site. White-tailed deer are very common on the Project site, and several deer wintering areas are known to occur around the existing Bailey Quarry, east of Ferry Road. The current mining activities do not appear to have disturbed them, and in fact have provided a sanctuary effect, in that they are free from hunting pressure on the mine site.

Mammals of Special Concern

The ACCDC database and NSDNR's Significant Species Habitats database were reviewed to gain information regarding the presence of rare mammals and sensitive mammal habitat within the study area. The NSDNR Regional Biologist for the area, Doug Archibald, was also consulted. The Environmental Screening conducted by the NSM found four records of rare or uncommon mammals on the Project site (Appendix E.2), two of which were not listed on the ACCDC list. In total, two red-listed and six yellow-listed mammal species were encountered in the 100 km radius ACCDC database search (Appendix E.2) and/or the NSM Environmental Screening. All eight listed species are provided in Table 6.6-4.

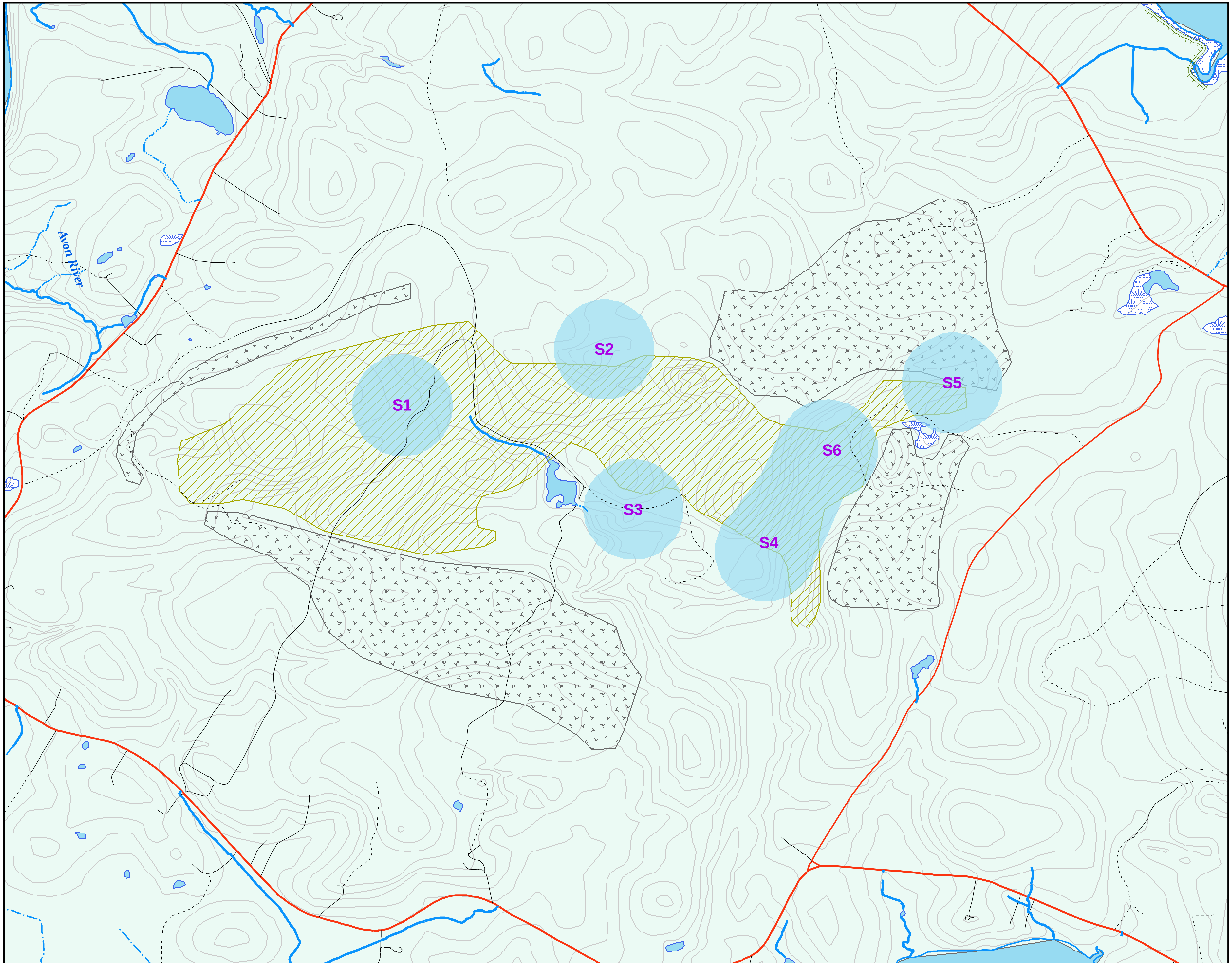
Table 6.6-4: Rare and Uncommon Mammal Species Reported Within 100 Km (ACCDC) or 10 Km (NSM) Of The Site

Common Name	Binomial	COSEWIC Listing	NSDNR Status	*NSESA* Rank	Sub-national Rank	Global Rank	Source of Record
Long-Tailed or Rock Shrew	*Sorex dispar*	Not listed	Yellow	Not listed	S1	G4	ACCDC
Eastern Pipistrelle	*Pipistrellus subflavus*	Not listed	Yellow	Not listed	S1	G5	ACCDC, NSM
Southern Flying Squirrel	*Glaucomys volans*	Not at Risk	Yellow	Not listed	S2S3	G5	ACCDC
Fisher	*Martes pennanti*	Not listed	Yellow	Not listed	S2	G5	ACCDC
Moose (mainland)	*Alces alces americana*	Not listed	Red	Endangered	S1	G5	ACCDC
Canada Lynx	*Lynx lynx*	Not listed	Red	Endangered	S1	G5	ACCDC, NSM
Little Brown Bat	*Mytotis lucifugus*	Not listed	Yellow	Not listed	S4	G5	NSM
Northern long-eared bat	*Myotis septentrionalis*	Not listed	Yellow	Not listed	S2	G4	NSM

Each of these mammals, their status, and their habitat preferences are discussed below.

Long-tailed or rock shrew (*Sorex dispar*) was listed in the ACCDC 100 km search. This species has very specific habitat requirements, living only on talus slopes. This species is listed globally as G4, apparently secure, and subnationally as S1, extremely rare and may be at risk of extinction. Long-tailed Shrew has never been reported from the Avon Peninsula, and the nearest record is over 50 km away (ACCDC database). There is little suitable habitat for long-tailed shrews on the study site, and their presence on the site is unlikely.

One bat species of concern was listed in the ACCDC database within 100 km of the study site, the eastern pipistrelle (*Pipistrellus subflavus)*. Two others species of concern, little brown bat (*Mytotis lucifugus*) and northern long-eared bat (*Myotis septentrionalis*) were listed in the general area by the NSM environmental screening. These species are primarily of concern during winter when individuals preparing to hibernate congregate in suitable caves, known as hibernaculae. Little brown bats are the most common species found in hibernaculae in NS, while low numbers of northern long-eared bats and eastern pipistrelles are usually found in the same caves. Factors such as temperature, humidity, morphology, and air circulation all contribute to whether caves are suitable as hibernaculae (Raesley and Gates 1987).



Legend

- Proposed Mine Pit
- Proposed Stockpiles
- Bat Survey Areas

N

0 0.1 0.2 0.3 0.4 0.5
Kilometres
1:15,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
Fundy Gypsum
Dillon Consulting (Bird & Bat Surveys)

820677B (REP06) GIS-DA661 Feb. 15, 2008

Figure 6.6-1

BAT SURVEY AREAS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

Given the prevalence of karst topography within the area, there is some potential for bats to use the site for hibernation. Bats are sensitive to disturbances within their communal winter hibernating areas. The nearest known bat caves are located over 5 km from the study site along the St. Croix River (Frenchman's Caves I and II). These caves extend over 100 m horizontally into the rock. These caves are known as summer roosting areas for northern long-eared bat, little brown bat and eastern pipistrelle (Garroway 2004) and may be used by some during the hibernating period (Andrew Hebda, NSM, pers. comm., 2006). No bat swarming activity at dusk or daybreak which could indicate roosting sites has been reported from the study site. Bleakney (1965) and Taylor (1997) found low numbers of eastern pipistrelles hibernating in Frenchman's Cave. Additional known caves are located over two kilometres south of Ferry Road along the west side of the St. Croix River and over five kilometres south at Weir Brook; however, winter use of these caves by bats has not been observed (Andrew. Hebda, NSM, pers. comm., 2006).

In 2006, surveys were conducted on the Project site to provide additional information on potential bat habitat. For hibernation, bats require caves or holes of sufficient depth (typically greater than 15 m) to ensure stable and suitable winter temperature and humidity levels (pers comm. Doug Archibald, NSDNR 2006). Information on the distribution of sinkholes, crevasses and other potential bat caves present on the site was obtained from FG's geologist. Sinkholes and crevasses known to be filled or partially filled with water were ruled out as potential bat caves, as bats avoid water-filled caves and caves with water levels which may fluctuate during the hibernation period. Small caves of insufficient depth (< 15 m) were also disregarded. This left six areas of sinkholes with potential as bat habitat. These six areas were visited on two cold March mornings in 2006 to determine if warm air venting could be visually identified which might indicate deeper holes in the area that might permit bat hibernation. These are depicted on Figure 6.6-1. No deep or long caves which might provide constant suitable winter temperatures for hibernating bats were observed, nor was 'warm' (relative to external temperatures) air venting observed. No accumulations of bat droppings were observed in or near the entrances to the crevasses/holes.

Evening surveys for bats were also conducted in May 2006. It was expected that evenings at this time of year had warmed sufficiently to promote insect activity and associated feeding by bats prior to migration to summer roosting areas. Bats were located visually and acoustically using an Anabat II bat detector. These surveys focused on the crevasse/hole areas and a historic rail tunnel, now collapsed (Bat Survey point S4). Bats were observed and heard feeding along the road and in the cutover area between S1 and S3 (10 to 20 bats). An additional two to three bats were detected in the open areas between S2 and S4. Movement observed was foraging behaviour not typical of movement from hibernating areas. Thus it is quite unlikely that any significant bat hibernaculae are present on the site.

Fisher (*Martes pennant*) have been occasionally trapped in west Hants County. Their preferred habitat is mature forest. Based on discussions with NSDNR, it is considered unlikely that fisher would be a concern at this site, given the current population numbers and distribution.

Moose (*Alces alces*) was also listed within 100 km in the ACCDC database. The mainland moose population has been designated as provincially protected and as Endangered under the Nova Scotia *ESA*. The mainland eastern moose population differs from the Cape Breton population, in that the mainland moose population is descended from the original Nova Scotian population of eastern moose (*Alces alces americana)*, while the Cape Breton population is derived from a herd of north-western moose (*Alces alces andersonii)*) introduced to Cape Breton in the 1940s (Parker 2003). The nearest known moose herd on mainland Nova Scotia is over 40 km away from the Project site. No evidence of moose was observed during any field studies in 2005, 2006, or 2007, and it is very unlikely that moose would be present on the Avon Peninsula undetected by local residents.

The southern flying squirrel, *Glaucomys volans*, is a yellow-listed (vulnerable) species which is present in Nova Scotia as a disjunct population at the northern edge of its range. The Nova Scotia population was previously lumped together with the Ontario population and designated a Species of Special Concern by COSEWIC in April 1988. The two populations have since been considered separately and the Nova Scotian population is now listed as Not at Risk (April 2006). Globally, this species is listed as G5, or Secure (NatureServe, www.natureserve.org). This species is associated with nut-bearing deciduous trees and old growth forests and thus may be sensitive to forest fragmentation, current forestry practices, and climate change. In Nova Scotia, the species appears to be patchily distributed, but data are somewhat lacking. Recent research has indicated that this species is more common and widespread than was previously thought (Petersen *et al*. 2003). The previous lack of knowledge regarding this species stems from the fact that it is a nocturnal tree-dweller which is difficult to distinguish from its close relative, the northern flying squirrel (*Glaucomys sabrinus*), which is more common in the Province. A recent public survey of southern flying squirrel sightings did not yield any reports from the Avon Peninsula (Petersen *et al*. 2003). It is unlikely that southern flying squirrels are utilizing any habitat on the Avon Peninsula.

The Canada lynx is a northern species which is red-listed in the province and designated an endangered species in Nova Scotia under the Nova Scotia *ESA*. A single record for lynx in the ACCDC database, almost 30 years old, was over 86 km from the site. The two known remaining populations of Canada lynx in Nova Scotia are found in the highlands of Cape Breton Island. The NSM screening also reported a lynx sighting in the general area. However, most of the area does not represent typical lynx habitat of mature softwoods and softwoods with some 20-year regeneration. Discussions with NSDNR also indicate that lynx are very unlikely to occur in this area. The very similar-looking bobcat (*Lynx rufus*) is common in Nova Scotia and has been reported in the area by several local residents (Peter Oram, CRA, pers. comm., 2006) and the local NSM record may be due to a misidentification of these very similar species.

No rare mammals have been reported from the site.

Herpetiles

The study area for herpetiles and their habitat encompasses much of the peninsula, in particular inside the area bounded by Belmont, Ferry and Avondale Roads. Field surveys for herpetiles were conducted in June 2006 by herpetologist John Gilhen, of John Gilhen Biological Services. The survey focused on six areas within the Avon Peninsula, including ponds, brooks, wetlands, and roadside pools along connecting roads. Abundant wood frog, green frog and spring peeper tadpoles were observed. Adults of these species, as well as northern leopard frog and American toad, were also detected. Red-backed salamanders were also noted, and yellow-spotted salamander larvae were observed in a roadside pool near Wetland 15. Wetland 15 was judged to be suitable breeding habitat for both yellow- and blue-spotted salamanders although no larvae were observed. Wetland 15 was also considered to be suitable habitat for painted turtles, though none were seen. The stockpile locations have been adjusted to avoid this wetland. This survey also involved one day of searching for evidence of turtle nests, however none were detected. One species of snake, the Maritime garter snake (*Thamnophis sirtalis pallidula)*, was observed during the herpetile survey. In summary, no rare or endangered herpetiles or habitats for such species were observed on the Project site.

Information regarding amphibians and reptiles and their habitat within the Project area was also obtained during the 2007 wetland surveys conducted on the Project site. During this survey, yellow-spotted salamander egg masses were observed to be quite common in roadside and vernal pools. Wood frogs were observed to be very abundant around vernal pools on the Project site, and their tadpoles were observed in many roadside and vernal pools during the June 2007 wetland surveys. Green frog adults and tadpoles were also observed in larger roadside pools. A single mature painted turtle was observed in Wetland 15 in June 2007. No rare or endangered herpetiles or suitable habitats for such species were observed on the Project site.

Local residents have expressed concerns about the effects of the mine on wood frog populations on the Project site. Wood frogs live in damp deciduous or mixed woods and are one of the first amphibians to emerge in spring. They are common throughout Nova Scotia and are green-listed by NSDNR, meaning their population is secure. Wood frogs spawn in shallow ponds and the larvae develop quickly, transforming in July and August. This rapid larval development allows wood frogs to utilize shallow, often temporary pools for breeding. Thus they are common in anthropogenic roadside pools and ruts.

On May 10, 2007, a wood frog survey was conducted by CRA staff according a protocol developed for the Alaska Wood Frog Monitoring Program, at five sites in the centre of the proposed Project footprint on the evening of May 13, 2007. This protocol involved visiting each site after dark, remaining silent for three minutes, and then recording the number of frogs heard vocalizing in the subsequent three minutes. No wood frogs were heard vocalizing on this survey, possibly because the survey may have been conducted too late in the season. Spring peepers were abundant, and green and leopard frogs were also heard vocalizing at the survey sites.

Herpetiles of Special Concern

A review of the ACCDC database of rare species records revealed four currently at-risk herpetile species in the region. The environmental screening conducted by the NSM did not report any rare herpetiles from the general area. Blanding's turtle (*Emys blandingii*), wood turtle (*Glyptemys insculpta*), leatherback sea turtle (*Dermochelys coriacea*) and eastern ribbon snake (*Thamnophis sauritus septentrionalis*) were all reported from within 100 km of the site. These species and their status are discussed in the following paragraphs.

Blanding's turtles (*Emyoidea blandingii*) are listed as an Endangered Species under the Nova Scotia *ESA.* Three small disjunct populations are known from central southwestern Nova Scotia, consisting of about 200 adult specimens in total. These turtles are known from areas over 80 km from the site and can safely be considered not to be present on the site.

The Avon Peninsula lies between the estuaries of Kennetcook and St. Croix Rivers. Both of these river systems are known to contain wood turtles (listed as threatened by COSEWIC). A breeding population is known from the Kennetcook River watershed to the northeast while there are verifiable reports of wood turtles in the Herbert River watershed to the east. Both of these river systems eventually empty into the Avon River. Wood turtles prefer extensive, slow-moving meandering rivers in fertile valleys, above the tidal reaches of estuaries, with gravel banks on bends for nesting, and deep soft substrate sections for hibernating. Foraging areas consist of meadows and oxbow ponds. There are no large rivers on the site that would provide habitat for wood turtles, nor is there significant foraging habitat. No evidence of wood turtles or suitable breeding or hibernating habitat was observed during the 2006 herpetile surveys or in any other 2005, 2006 or 2007 field surveys. It is unlikely that wood turtles utilize any habitat present on the study site.

Leatherback sea turtles (*Dermochelys coriacea*) were noted in the ACCDC list within 100 km of the site. This species is obviously not expected to utilize any habitat on the study site.

In Nova Scotia, a disjunct population of Eastern ribbon snakes (*Thamnophis sauritus septentrionalis*) is known only from Queens and Lunenburg Counties. This species is yellow-listed in Nova Scotia, meaning it is considered sensitive to human activities or natural events. The nearest report of an eastern ribbon snake was over 85 km from the Project site. It is very unlikely that Eastern ribbon snakes utilize any habitats present on the Project site.

The ACCDC database contained several records of four-toed salamanders (*Hemidactylium scutatum*) within 100 km of Fundy Gypsum. Four-toed salamanders are a very cryptic species and are generally only easily detected during the breeding seasons, when females deposit their eggs in sphagnum mounds near small pools in swampy areas. This species was previously yellow-listed by NSDNR; however, their status has been recently changed to green, indicating they are not considered to be sensitive or at-risk in Nova Scotia. No suitable spawning habitat for four-toed salamanders was detected during the 2006 herpetile survey.

No rare herpetiles have been reported from the site.

Odonates

The ACCDC request noted eight red-listed and four yellow-listed species of rare or sensitive dragonflies and damselflies in the general area. Their habitat preferences and potential presence on site are summarized in Table 6.6-5. The NSM Environmental Screening did not report any rare odonates from the Project area. The complete ACCDC list of species reported is provided in Appendix E.2. There are no large streams, rivers, or lakes on the site which would provide habitat for species requiring these habitats, so the potential species present are limited to those requiring small pools or slow moving streams, ponds, or bogs.

Table 6.6-5: Rare and Uncommon Odonate Species Reported Within 100 Km (ACCDC) or 10 Km (NSM) Of The Project Site

Common Name	Binomial	NSDNR Status	Habitat	Potential Presence on Site
Dusky Clubtail	*Gomphus spicatus*	Yellow	Boggy or marshy ponds, lakes and slow streams, often sandy.	Possible
Brook Snaketail	*Ophiogomphus asperses*	Red	Clear streams in the open, with brushy banks and sandy, gravely, or rocky riffles.	Not Likely
Maine Snaketail	*Ophiogomphus mainensis*	Red	Clear, moderately rapid rocky streams and rivers in forests, often where they drain lakes or swamps.	Not Likely
Lake Darner	*Aeshna eremita*	Red	Marshy lakes, ponds, deep fens, bogs and slow streams, especially sparsely vegetated or woodland lakes.	Possible
Springtime Darner	*Basiaeschna janata*	Red	Rivers and streams with a gentle current. Also forested lakes, preferable those with little shore vegetation, and oxygenated ponds	Possible
Harlequin Darner	*Gomphaeschna furcillata*	Yellow	Bogs and swamp of bald Cyprus, alder or cedar	Not Likely
Prince Baskettail	*Epitheca princes*	Yellow	Permanent ponds, lakes and slow streams and rivers, with clear to muddy water	Possible
Clamp-Tipped Emerald	*Somatochlora tenebrosa*	Yellow	Shady forest streams from trickles to about 2 yards wide often partially dry and occasionally boggy or swampy.	Possible
Ebony Boghaunter	*Williamsonia fletcheri*	Red	Bog pools and fens in forest.	Not Likely
Emerald Spreadwing	*Lestes dryas*	Red	Prefer small ponds and places that may dry up in summer	Possible
Variable Dancer	*Argia fumipennis violacea*	Red	Common along streams, marshes and at marshy edges of ponds and lakes.	Possible
Taiga Bluet	*Coenagrion resolutum*	Red	Small ponds, roadside ditches, marshes, streams, anywhere with grassy or marshy borders. Prefer shaded habitats.	Possible

The results of the habitat modelling exercise indicate that five red listed species have the potential to be present on the Project site, while three yellow-listed species have potential. None of these species were observed on the site during wetland surveys in 2007.

6.6.2 POTENTIAL IMPACTS, PROPOSED MITIGATION AND FOLLOW-UP

Potential Project-related effects on fauna and habitat include:

- Loss of fauna habitat by creation of the mine and placement of stockpiles;
- Disruption of fauna migration, movement and distribution;
- Increased habitat fragmentation;
- Loss of rare species of fauna and critical habitat for these species, if present;
- Disruption of hibernation and/or breeding activities;
- Changes in surface hydrology leading to changes to habitat;
- Direct mortality of fauna though interactions with mine vehicles;
- Impacts on fauna species and habits due to accidental spills of chemical compounds at the site.

The VEC spatial boundaries for fauna and their habitat are described in the existing environment section for each faunal group (mammals, birds, herpetiles, and odonates). The physical boundaries of potential effects of the mine and stockpiles will be limited to the areas over which these features are positioned and their associated roads. On a temporal and spatial scale, the mine will be in operation continuously for 35 to 50 years. As the mine development slowly progresses from east to west over several decades, multiple habitat types will be gained and lost (*i.e.*, wetland, fish habitat, early successional forest) as reclamation and development progress concurrently. Hence, Project site development will not affect all fauna and habitats simultaneously and will allow time for species to adapt to changing habitat types. Acoustically, the effects of the mine may extend another several hundred meters from the active portion of the mine, although this effect may diminish as fauna species grow accustomed to mining noise.

Development and Operation

Some loss of fauna habitat will occur through site development and clearing activities until the reclaimed forest has matured sufficiently to support these species. This habitat loss will not occur all at once, but will extend westward from Ferry Road as the mine extends over the next 35 to 50 years. Only habitat slated to be mined in the subsequent months will be cleared. Mammals, birds, herpetiles, and odonates will lose habitat in the short term. The Project may also initially disrupt distribution and movement of fauna on the Avon Peninsula. Some fauna species, particularly birds and mammals, may initially relocate to other areas of the peninsula for a short time. Aquatic amphibian species will lose some habitat due to the removal or alteration of twelve small wetlands, and by the removal of forty vernal pools. Species such as wood frogs will also lose terrestrial habitat; however extensive wood frog habitat will still exist in the surrounding area. Some of this habitat loss will be mitigated by the creation of the Conservation Area near the middle of the site and by the creation of compensatory wetlands. Progressive reclamation of the Project site will mitigate the remainder of the habitat loss. Once progressive reclamation occurs and the reclaimed and reforested areas mature, much structural complexity in the area will be regained and recolonized by fauna species. The reclamation phase is discussed further under the Reclamation subsection below. Compensation of wetland habitat loss is discussed in Section 6.4.

There are no rare (COSEWIC or NSDNR red-listed) species of mammals, herpetiles, or odonates known or suspected to be present or to utilize any habitat on the Project site. Two yellow-listed (NSDNR) species of bird, the Olive-sided Flycatcher and the Canada Warbler, may be breeding on the Project site. The loss of potential nesting habitat for three possible pairs of Olive-sided Flycatchers and a single pair of Canada Warblers is not expected to have a significant effect on the provincial population of this species. Two other yellow-listed birds, the North Goshawk and Bobolink, may use habitat in the vicinity of the Project site but are not known to be breeding on the Project site. Loss of some possible breeding and non-breeding habitat for these species due to site development and operation activities will not have a significant adverse effect on provincial populations.

Migratory birds are protected under the *MBCA*. It is illegal to kill migratory bird species not listed as game birds or destroy their nests, eggs or young. Other bird species not protected under the federal act such as raptors are protected under the provincial *Wildlife Act*. In order to avoid contravening these regulations, clearing of forests designated to be mined will only occur outside the breeding season (September 1 to April 30) so that the eggs and young of birds are not inadvertently destroyed. Due to the transitory nature and changing population status of many species of birds, surveys will be conducted in the breeding season immediately prior to forest clearing. The survey locations will include areas designated to be cleared, as well as those in the immediate surrounding area (100 m buffer). In the newly cleared areas, all woody debris will be removed to prevent early migrants from nesting. Grubbing will occur in May in the newly cleared areas to control hydrological processes during snow melt. As several bird species nest on open ground, breeding bird surveys (*i.e.*, nest searching, behavioural observations) will be conducted in May by an experienced ornithologist prior to any grubbing activity to determine if any birds are nesting in the newly cleared areas. In the event that birds are nesting in the newly cleared areas, buffer zones based on territory sizes will be maintained around the nest site and activities will be minimized in the immediate area until nesting is complete and fledglings have naturally migrated from the area. Some species may nest in burrows in stockpiles of soil or the banks of pits (*e.g.* Bank Swallows, *Riparia riparia*). If this occurs, colonial nesting sites will not be hydroseeded and alternate measures will be taken to reduce soil erosion. The nesting sites will be protected until fledglings are no longer roosting at the site and have naturally migrated from the area.

Disruption of migrating birds is expected to be minimal due to the low profile structures, limited lighting and localized activity at the site. While the mudflats of the Minas Basin are an important stopover point for several migrating shorebird species, the proposed mine extension is less than 500 m from the existing mining operation, which is not known to have had any negative effects on migratory birds in the area. Nonetheless, to mitigate potential impacts of artificial light on birds, unnecessary exterior lights such as spotlights and floodlights will be restricted, particularly during the migratory season when the risk to birds is greatest, unless required for health and safety purposes. Lighting for the safety of employees will be shielded to shine down and only to where it is needed, without compromising safety. Road lights will also be shielded so that little light escapes into the sky and it falls where it is required. It is unlikely that mine development or operation activities will have significant negative impacts on migrating shorebirds.

Noise associated with site activities, such as blasting may disrupt individual animals within several hundred meters of the active area; however, similar habitat is available throughout the adjacent area and impacts at the population level or to species at risk are not expected. The existing Bailey Quarry is only a few hundred meters from the proposed Project site and thus any fauna present may already be acclimated to noise from mining activities. Noise is not expected to have a significant adverse effect on hibernation or reproduction of fauna species in the area.

Habitat fragmentation and loss of mature and interior forest habitat has been identified as a major cause of declines in fauna populations across North America. Habitat fragmentation caused by the Project will add to existing habitat fragmentation in the local area; however, the forested area in the proposed Project site is essentially a large fragment surrounded by forestry activities, mining, extensive agriculture and rural developments. Development activities within the centre of the peninsula will decrease the amount of interior forest present and increase the amount of forest edge. Effects of forest edges can extend up to 100 m into the forest, further decreasing the amount of true interior forest. Table 6.6-6 provides a breakdown of changes in forest habitats during the course of development within the forest fragment encompassing the Project site. While there is a significant amount of forested area on the Project site, little of the area is considered mature forest or pristine interior forest habitat due to the network of logging roads and ATV trails intersecting the site. The small mature forest stands being removed by development are dominated by tamarack (*Larix laricina*) and trembling aspen (*Populus tremuloides*).

The increase in forest edge may be beneficial for species that prefer these habitats, but may cause negative impacts on forest interior species such as increased predation, and increased interspecific and conspecific competition. Extensive forest habitat will remain around the boundaries of the site and progressive development and reclamation of the mine site will mitigate much of the habitat loss and reduce habitat fragmentation. The amount of habitat remaining will be adequate to ensure the integrity of the forest ecosystem and associated fauna communities on the Avon Peninsula.

Table 6.6-6: Changes in Forested Habitats Within the Forest Fragment Encompassing the Project Site During the Course of Development

Forest Age/Habitat Type[1]	Present (Ha)	10 Year Plan[5] (Ha)	20 Year Plan[5] (Ha)	Final Development[5] (Ha)
Regeneration/Clear-cut	165.7	145.3	134.2	107.2
Young	148.3	121.2	95.4	76.1
Immature	16.2	14.3	14.1	13.0
Pole	335.7	290.6	256.3	228.5
Mature	17.7	16.7	16.7	16.0
Uneven Aged	255.0	213.2	178.3	166.3
Unclassified	5.6	3.9	3.9	3.9
Total Forested Habitat	**944.2**	**805.2**	**698.9**	**611.0**
Interior[2]	694.9	520.9	367.0	280.3
Edge (Non-Interior)[2]	249.3	284.3	331.9	329.7
Developed Area[3]	0.0	140.4	246.9	334.8
Reclaimed Area[4]	–	0.0	25.6	156.3

[1] Based on 2003 forestry data for Hants County provided by NSDNR (http://www.gov.ns.ca/natr/Forestry_Division_Downloadable_GIS_Data%20.asp).
[2] Based on a 100 m buffer surrounding hard edges (*e.g.*, roads, agriculture).
[3] Includes non-forested (*i.e.*, agriculture) and forested development areas (*i.e.*, mine pit, stockpiles).
[4] The values provided here only represent stockpile areas designated to be reclaimed as early successional forest habitat. Reclamation for the mine pit (not shown here) has yet to be determined but will include a mosaic of wetlands, ponds, streams and early successional forest habitat.
[5] Assumes no forest growth and excludes reclaimed areas.

Amphibians which breed in shallow pools or wetlands will temporarily loose some breeding habitat. Impacts on breeding amphibians, particularly species such as salamanders, wood frogs and spring peepers which have rapid larval development periods, can be minimized by ensuring that excavation of breeding pools is done outside of the breeding period (roughly April to August). This period overlaps quite well with the breeding season for birds and as forested areas should not be cleared during the bird breeding season, salamander, wood frog and spring peeper larvae will also be protected. Impacts to amphibian breeding areas will be mitigated by the creation of compensatory wetlands to replace lost wetland habitat. In addition, shallow depressions which act as vernal pools may also be created as part of the forest reclamation program, mimicking the original sinkhole depressions and creating breeding habitat for salamanders and some frog species. In addition, as wood frogs and spring peepers complete their development in shallow ephemeral pools, pools created by the new mine access roads will likely create new breeding habitat. The creation of the Conservation Area will also mitigate some of the habitat loss resulting in minimal long-term disruption of fauna on the study site.

Concerns have been expressed by local residents regarding the possible effects of habitat fragmentation on deer and subsequent changes in the distribution of hunting activities on the Avon Peninsula. Habitat fragmentation is not expected to be significant for deer on the Project site. While only one area of the Project site will be cleared at any one time during the operation, this area will be smaller than the existing Bailey Quarry, and will be surrounded by heavily forested areas. Deer will move away from the immediate vicinity of the mine; however the scale of this movement is likely less than several hundred meters. Deer will likely move closer to the mine once commencement activities are completed and deer acclimate to the mine extension, as they have done for the existing Bailey Quarry. Deer are very adaptable animals which can inhabit a variety of habitats, and have benefited from the increased abundance of agricultural clearings and establishment of young forests since European colonization. Movement of deer on the Avon Peninsula due to commencement of mining activities is not expected to be significant and is unlikely to result in increased trespassing on adjacent private properties by deer hunters.

There is no evidence of significant hibernating areas on the Project site. No mammal hibernating areas such as bat hibernaculae will be significantly adversely affected by the Project. The Project is not expected to cause long-term adverse effects on herpetile hibernating areas. No rare or endangered herpetiles are likely to hibernate on the site. Wood frogs, a green-listed species, hibernate in forested areas and will lose some non-critical hibernating areas. Reclamation of mined areas will recreate hibernating habitat for this species.

The upgrading of existing access roads to the site and the increased traffic could potentially result in direct mortality of fauna due to interactions with mine vehicles. Responsible operation of vehicles along access roads and adherence to a moderate rate of speed will minimize these effects. Significant adverse effects to fauna due to interactions with mine vehicles are unlikely.

Gypsum mining does not require the use of significant amounts of chemicals, aside from fuel for mine vehicles and compounds for blasting. Relatively small amounts of these compounds will be stored on site and if an accidental spill were to occur, the effects would be very small and localized. No chemical compounds will accumulate in the area due to mining activities. Use of fuels and blasting compounds on mine sites is strictly controlled and regulated and emergency contingency plans will be in place. No significant adverse effects on fauna and their habitat due to accidental spills of chemical compounds at the site are likely to occur.

No chemical compounds will accumulate in the area due to mining activities. There is no chemical effluent associated with this gypsum mine, so toxicity of water in the settling ponds will not occur. The Project site itself is not considered to be an important stopover point for migrating birds and thus is not expected to attract large numbers of migratory waterfowl. In addition, these ponds will be located close to active mine workings and thus are unlikely to attract birds. Thus, the settling ponds are not expected to have a significant adverse impact on migratory or breeding birds.

Reclamation

The reclamation phase of the Project will follow shortly after the operational period for a given portion of the mine, and will focus on restoring the site to a more natural state and recreating both terrestrial and wetland wildlife habitat.

The portion of the proposed mine active at any one time will be smaller than Fundy Gypsum's currently operating Bailey Quarry, located east of Ferry Road. As the mine extends westward, the mined areas will be progressively reclaimed, seeded with grasses and wildflowers, and seedling deciduous and coniferous trees will be planted to re-establish forest habitat on the site. Small depressions which will function as vernal pools may also be created, providing breeding habitat for wood frogs, spring peepers, and salamanders. These pools will also help to increase biodiversity and habitat heterogeneity. The creation of compensatory wetlands (discussed in Section 6.4) will also increase species and habitat diversity. This progressive reclamation will mitigate much of the initial habitat loss and reduce disruption of fauna distribution and movements. Once the re-vegetated areas become established, terrestrial habitat will have been recreated, and will continue to increase as the forest matures, and provide habitat for additional species. Local fauna will recolonize the reforested sections of the Project site once the new forest has established sufficiently. As the reclaimed and reforested areas mature, much of the original structural complexity will be regained and additional wildlife habitat will be created.

Historical and ongoing agriculture has already had significant adverse effects on the fauna of the study site, in that extensive areas of mature forest habitat have been permanently removed and replaced with monocultures of non-native agricultural crops and/or pasture, which has decreased the diversity of fauna species and habitats in these areas. Historical and ongoing forestry activities have also had significant effects on the fauna of the study site, in that extensive areas of mature forest habitat have been removed and are now in varying stages of regrowth. Road construction and historic mining activities have also had significant impacts, leading to the complete loss of forest habitats in some areas. Creation of roads has also led to increased penetration of interior forests by humans, and has decreased the amount of undisturbed interior forest available for fauna. With progressive reclamation, the proposed Project will not add significantly to cumulative habitat loss for fauna species in the local area.

6.6.3 SUMMARY

The proposed mine footprint and stockpiles will have an impact on fauna species and habitat over the life of the Project. These impacts are not considered to be significant. No listed rare species of fauna, with the exception of two confirmed yellow-listed bird species, are known to occur on site. There are no potentially significant impacts to rare or endangered species of fauna anticipated with this Project. There is no critical habitat for any fauna species, such as colonial hibernating or breeding areas or migration routes on the site. The loss of some non-critical fauna habitat will occur gradually, over several decades, and will be mitigated by the creation of new forested and wetland areas, which over time will mature and create habitat for additional species. The loss of some fauna habitat will not result in negative effects at the population level for any species within the Province. As a result, there are no cumulative or adverse long-term effects anticipated to fauna and fauna habitat in Nova Scotia as a result of the Project.

6.7 FISH AND FISH HABITAT

Fish and fish habitat is identified as a VEC because of potential interactions between Project activities and the physical aquatic environment and because of the relationship with hydrology. Surface water/hydrology is also a VEC due to public concerns of fish and fish habitat and landowners drawing water for their cattle/dairy operations. Fish and fish habitat is defined by the federal *Fisheries Act* as spawning, rearing, nursery, food supply, overwintering, migration corridors and any other area on which fish depend directly or indirectly in order to carry out their life processes.

6.7.1 EXISTING ENVIRONMENT

Aquatic habitat was surveyed in August and October 2005; September and October 2006; and June and July 2007. The study area for fish and fish habitat encompasses much of the peninsula, in particular inside the area bounded by Belmont, Ferry and Avondale Roads because of the existing obstruction and habitat damage effects on the lower reaches from roads (*e.g.* culverts) and agriculture. The mine and stockpile footprints occur within a portion of 10 of the 15 catchments on the Avon Peninsula (Figure 6.2-2). The mine site and four stockpiles, including the possible sound barrier on the western end of the site will be placed over intermittent headwater tributaries of several watercourses that flow to the St. Croix, Avon and Kennetcook Rivers.

The watercourses on the peninsula are very narrow (<1 m), shallow (10 cm) and mostly are intermittent in flow. Significant portions of the recorded hydrology monitoring data were zero flows (Photo 6.7-1).

Photo 6.7-1: Typical peninsula watercourse (November 2006)

Only three watercourses are named in the vicinity of the site: Miller Creek, Shaw Brook and Fish Brook. Shaw Brook is the largest of these with the most extensive catchment basin on the peninsula. The upper reaches of Shaw Brook have been logged and considerable silt has entered the brook as a result of runoff from the logging road and logged sites. A large beaver dam presents a barrier at "Dump Pond", a relic mine stockpile area. Dumping of garbage into the watercourse below the dam appears to be common practice. A logging road on the southern tributary of Shaw Brook has also created a barrier where the culvert has been installed in a steep grade and beavers have blocked the culvert. Flows are minimal below these obstructions. The lower reach of Shaw Brook flows through a dairy farm and it is used for watering the livestock. The aquatic habitat for fish is basically destroyed in this section and the water quality degraded from manure and runoff (Photos 6.7-2 & 6.7-3). Therefore, there is no fish habitat for passage in Shaw Brook.

Photos 6.7-2: Shaw Brook – Upstream of Avondale Road

Photo 6.7-3: Shaw Brook – Downstream of Avondale Road

A desktop survey to establish the dominant types of land use that surround the various watercourses on the peninsula was conducted using 2003 aerial photographs. The boundaries for the survey were contained within the extents of Avondale, Belmont, and Ferry Roads. Table 6.7-1 provides a list of 19 watercourses by numerical order for reference that corresponds to the discussion on Hydrology in Section 6.2. These watercourses were enumerated based on the presence of a culvert in the roadbed to permit water passage. In total, of the 27 watercourses identified and investigated, 14 of these will be affected by mining activities. Presently, 63% of the watercourses were directly adjacent to agricultural land uses (Photo 6.7-4) (at some point along the watercourse path), while the remaining 37% of the watercourses had a continuous buffer (the width of the buffer varied).

TABLE 6.7-1: WATERCOURSES

Watercourse No.	Drainage	General Description
1 - Shaw Brook	St. Croix River	The watercourse's first 90 metres from Avondale Road are buffered by a cleared agricultural/grazing field. Cattle were noted in the aerial photograph. The remaining portion of the watercourse varies from a forested buffer to agricultural activity on both sides. The approximate length of the watercourse buffered by agricultural activities is 200 metres.
2 – unnamed tributary	St. Croix River	This watercourse meanders in several different directions as it progresses away from Avondale Road. The watercourse is primarily buffered by a 10 to 40-metre brush or forest cover with agricultural fields flanking the buffers.
3 - unnamed tributary	St. Croix River	A 10-metre forested buffer (approximate) is adjacent to this watercourse.
4 - unnamed tributary	St. Croix River	The watercourse's first 50 metres from Avondale Road has a 40-metre forested buffer. An agricultural field surrounds the watercourse for the next 300 metres, followed by a 100-metre forested buffer.
5 - unnamed tributary	St. Croix River	The watercourse's first 100 metres from Avondale Road has a 30-metre forested buffer to the eastern side and is directly adjacent to a cleared agricultural field on the western side. The watercourse splits to the in eastern and western directions. The east side split crosses a residential driveway and is buffered by a cleared field. The west side split is buffered by forest ranging from 80 metres to 150 metres in width.
6 - unnamed tributary	Avon River	The entire watercourse has a forested buffer ranging from 50 metres to 400 metres in width. The buffer is narrow closest to Belmont Road and is flanked by agricultural land uses on both sides. The watercourse meanders into a sparsely forested area as it progresses further from the road.
7 - unnamed tributary	Avon River	The watercourse is buffered by forest cover and a forestry logging road.
8 - unnamed tributary	Avon River	The watercourse is completely buffered by forest cover.
9 - unnamed tributary	Avon River	The watercourse's first 230 metres from Belmont Road is buffered by agricultural uses on both sides. The watercourse splits in northern and southern directions.

TABLE 6.7-1: WATERCOURSES

Watercourse No.	Drainage	General Description
		The watercourse is buffered by an un-identified agricultural plantation to the north and an agricultural field to the south.
10 - unnamed tributary	Avon River	The watercourse's first 390 metres from Belmont Road has a 40-metre buffer followed by a dense forest cover. The forest buffer is flanked by agricultural uses.
11 - unnamed tributary	Avon River	The watercourse has a forest buffer ranging from five to 110-metres in width. Agricultural activities boarder both sides of the forest buffer.
17 - unnamed tributary	Kennetcook River	The watercourse's first 160 metres is buffered by an old field consisting of low-lying brush that does not appear to be in agricultural usage at the time the aerial photograph was taken. The remaining portion of the watercourse is buffered by a thin forest cover, which is remnant of forest harvesting activities. The watercourse is completely surrounded by agricultural uses.
18 - unnamed tributary	Kennetcook River	The watercourse's first 80 metres as it moves away from Belmont Road is buffered by a cleared field with some low-lying brush cover (likely an old agricultural field). The remaining portion of the watercourse is buffered by a dense forest.
19 - unnamed tributary	Tributary to Shaw Brook	The first 130 metres of the watercourse as it moves away from Ferry Road is buffered by an old field, which appears to have been used for agriculture at one time. The remaining portion of the watercourse moves through a forested area.

Photo 6.7-4: Typical loss of riparian vegetation in agricultural fields on the peninsula

All watercourses on the Avon Peninsula discharge to an estuary, be it the mouths of the Avon, Kennetcook or St. Croix Rivers. The watercourses and these rivers have the distinctive red beds that fringe the Minas Basin and Cobequid Bay. Typical of the large Bay of Fundy Rivers in Nova Scotia, the banks of the rivers are steep and of mud around the peninsula, making upstream migrations difficult and tidal dependent. A 12 m tide occurs in this area (Photo 6.7-5).

Photo 6.7-5: A watercourse channel flowing through mud flats

The mud forms from the deposition of sediment in sheltered tidal water, particularly in estuaries where there is a large sediment supply. The area is depositional as it is sheltered with low fetch and wave exposure. There can be large populations of molluscs, amphipods and polychaete worms.

The animal and plant species are affected by the substrate and tidal conditions. Fish species occurring in the Avon, Kennetcook and St. Croix Rivers include alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), Atlantic salmon (*Salmo salar*), striped bass (*Morone saxatilis*), white perch (*Morone americana*), tomcod (*Microgadus tomcod*) and American eel (*Anguilla rostrata*). In the winter months, the rivers are not biologically active for most aquatic species or with fish migrations other than tomcod. Tomcod spawn between November and February in estuaries or stream mouths, in salt, brackish or freshwater.

The inner Bay of Fundy (iBoF) Atlantic salmon population was designated by COSWEIC as endangered in May 2001 and in April 2006. Adult numbers are estimated to have declined by more than 95% in 30 years, and most rivers no longer have either adults or juveniles. In 2003, fewer than 100 adults are estimated to have returned to the 32 rivers known to have historically contained the species. Threats to the species in the freshwater environment are thought to be historical and contemporary in nature. Historical threats include loss and degradation of habitat (attributable to the construction of barriers to migration and logging); contemporary threats may include interbreeding with escaped farmed fish and environmental change (warmer temperatures, contaminants). Nine iBoF salmon watercourses on the Avon Peninsula were assumed to be present based on DFO's internal SPAtlas database. DFO Habitat Assessment biologists surveyed these streams and due to anthropogenic damage or small size, considered them not to be viable fish habitat, especially for salmonids. Habitat requirements for spawning and rearing salmon include rapid flow and pools and loose gravel/cobble with good air spaces for eggs, to gravel to boulder sized substrate for juveniles. Upstream reaches of the Kennetcook and St. Croix Rivers provide this type of habitat and are both listed as iBoF salmon rivers. The portions of these rivers adjacent to the study area are generally tidal and salmon are restricted by tidal mudflats, physical damage to stream channels and lack of watercourse flow for passage to spawning areas.

The striped bass was categorized by COSEWIC in 2004 as threatened. Repeated spawning failures led to the disappearance of the Annapolis and Saint John River populations. These disappearances are thought to be due to changes in flow regime and poor water quality. In the Shubenacadie River population, the presence of the introduced chain pickerel in overwintering sites may constitute a threat. Another threat to the population is by-catch from various commercial fisheries. The Bay of Fundy is also used by striped bass breeding in rivers in the United States. Striped bass require long river systems for spawning and rearing, the Avon, Kennetcook and St. Croix Rivers would be used only for feeding as they are too short for spawning and nursery habitat. None of the peninsula watercourses is suitable habitat for this species.

Chemically, the water quality of the Avon, Kennetcook and St. Croix Rivers is contaminated with sufficient fecal coliform bacteria to classify it occasionally as "not suitable for shellfish harvesting". Agriculture and three urban centres contribute treated sewage and 12 rural hamlets are on septic systems that also contribute to bacterial contamination in the local watercourses and rivers. Stormwater from urban centres are an additional source of contamination of metals, nutrients, suspended solids, petroleum hydrocarbons and bacteria.

6.7.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP MONITORING

Potential Project-related effects on fish and fish habitat include:

- loss of fish habitat from a reduction in groundwater baseflow;
- reduced water quality from sedimentation, deposition of fines and acid drainage;
- introduction of contaminants (*e.g.* nitrate) from blasting operations; and
- petroleum hydrocarbon releases from within the mine area.

The VEC spatial boundaries are described above. As the mine and stockpiles are positioned over the headwaters of many watercourses, the entire length of the watercourse to the estuary is considered. On a temporal scale, the mine will be in operation continuously for 35 to 50 years. However, as the mine progresses from east to west and as reclamation occurs, not all watercourses will be affected at once and over that time period.

A significant adverse effect is one that affects freshwater fish and fish habitat physically, chemically, or biologically, in quality or extent, to such a degree that there is a decline in the species diversity of the habitat. Such an effect would be reflected by a decline in abundance and or change in distribution of one or more populations of species dependent upon that habitat. Natural recruitment would not return the population(s), or any populations or species dependent upon the habitat, to their former level within several generations.

Development and Operation

DFO developed the Policy for the Management of Fish Habitat (1986) which applies to all projects and activities, large or small, in or near water that could alter, disrupt or destroy fish habitats 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. The policy is regulated by Sections 20 to 42 of the federal *Fisheries Act*.

Shaw Brook and Fish Brook have the two largest catchment areas on the peninsula. Besides being small brooks, aquatic habitat in the lower reaches in both have been severely impacted by agricultural activities such as loss of riparian habitat, livestock watering and uncontrolled fording, not to mention degraded water quality from manure spreading on adjacent fields and direct from the livestock. DFO has deemed that no productive fish habitat is present. Logging activities add a cumulative effect.

Photo 6.7-6: Lower reach of Fish Brook, upstream of Belmont Road – riparian habitat lost due to land clearing.

There is no habitat, critical or otherwise, for any regional fish species at risk. The number of fish species, the abundance of fish or the genetic integrity of fish populations will not change. However, it is important to maintain present levels of water quality and quantity downstream of the Project to maintain ecosystem functioning of other aquatic species such as invertebrates, amphibians as well as for wildlife and vegetation in riparian zones. Farmer's use of watercourses for watering livestock is addressed under Hydrology in Section 6.2.

To mitigate loss of the drainage from upper reaches of the watercourses under the proposed stockpiles, the stockpiles will have a perimeter ditch to collect rain and runoff which will be directed to a settling pond before discharge into the watercourses. In the mine area, two settling ponds will be established at the southern boundary of the pit where the two main branches of Shaw Brook are located. Water from this area of the pit will be directed to the settling ponds and then into Shaw Brook. Water quality will be monitored for regulated NSEL parameters before discharge. There will be no liquid emissions from the proposed Project, therefore, water quality is only subject to change by gypsum dust. A site visit in July 2007 revealed that dust is not an issue for water quality. The existing two settling ponds in the Bailey and Miller's Creek Quarries are extremely clear, with a vertical visual depth from surface to about six metres or more. Miller's Creek pond has a dense growth of submergent aquatic vegetation around its perimeter (Photo 6.7-7). This pond has a population of small mouth bass likely introduced by local residents. Large fish specimens were observed milling about the pumphouse. One of the reclaimed ponds was also stocked and mine staff noted the presence of Bald Eagles (*Haliaeetus leucocephalus*) perched around the pond.

Photo 6.7-7: Settling Pond in Miller's Creek Quarry

Photo 6.7-8: Settling pond in Bailey's Quarry

FG has been approached by locals to participate in adopting a-stream program, a common practice in Nova Scotia particularly in partnership with the Nova Scotia Salmon Association being the largest organization. However, the barriers to this concept on the peninsula are the following:

- There are no crown lands on the peninsula, all lands are privately owned, FG cannot dictate what the individual landowner does on those lands;
- all watersheds are currently impacted by agriculture, roads and/or forestry; and
- productive habitat for commercially and recreationally important species is limited naturally by the physiography or does not exist.

Standard mitigative measures consistent with NSEL guidelines (NSDOE 1988) will be undertaken to minimize the potential for erosion and sedimentation of watercourses from site runoff while soils are exposed and unstabilized, and from mine roads. These measures will be specified in erosion and sediment control procedures to be included in the IA. A Stormwater Management Plan will be developed for the IA to prevent sediment-laden runoff from the facility from entering streams. This plan will be designed to meet all provincial requirements for surface runoff quality.

POL will be kept in a contained area for refueling of equipment. As per standard practice, this area will be 30 metres or more from a watercourse to prevent accidental discharge in surface waters. Equipment will be mechanically sound with no leaking fuel tank or hydraulic lines. There will be no washing of vehicles within 30 metres of a watercourse or in an area where wash water will flow into a watercourse.

Reclamation

The reclamation plan is to follow the mining activity with a lag period. Ultimately, there will be three or more separate ponds/lakes within the final mine pit. Many potential uses are available that will be decided by FG and the CLC. Stocking of the lakes with native species by a qualified and experienced organization such as Ducks Unlimited would greatly enhance the present fish habitat, fish population and diversity on the peninsula. Photo 6.7-9 and 6.7-10 below show reclaimed ponds and wetlands on the existing property. Both have aquatic vegetation, shoreline and a variety of depths to provide habitat diversity.

Photo 6.7-9: Reclaimed pond and wetland upslope from Miller's Creek

Photo 6.7-10: Half of the second reclaimed pond on the existing mine site. It was reported that this pond was stocked with fish (small mouth bass) by local residents.

During community public information sessions, one resident's comment was that Nova Scotia does not need any more lakes. However, within a 7.5 km radius of the proposed mine, Lily Lake (north of Site) is the only lake present and is smaller than any of the proposed lakes. Thus on a regional context, there are at present no lakes on the peninsula and, similar sized lakes are a considerable distance away and thus not convenient for recreational purposes.

Monitoring of water quality and quantity of offsite water discharges will be undertaken by FG and as required by NSEL. Monitoring data can be provided to the CLC.

6.7.3 SUMMARY

The proposed mine and stockpiles will alter the physical habitat of the upper reaches of 14 watercourses over the 35 to 50 year life span of the Project. Fish habitat, critical or otherwise, is not present in these watercourses. Nutrient cycling is expected to change very little as it is only headwaters of the 14 watercourses that are affected and gypsum is relatively inert. Thus there is no expected cumulative impacts from the mine operation or stockpiles with nutrient overloading resulting from the downstream contributors. The water quality and quantity will be maintained in the middle and lower reaches by controlled release of storm water and runoff from the mine site and stockpiles. Thus, there is no cumulative effect from changes in water flow resulting from downstream users. Therefore, there is no anticipated significant adverse effect to fish populations on the peninsula.

The mine site will be reclaimed as the mining progresses westward. Lakes will be incorporated that can be stocked to create fish productivity of recreationally important species where none now exist on the proposed mine site.

6.8 ATMOSPHERIC CONDITIONS/AIR QUALITY

6.8.1 EXISTING ENVIRONMENT

NSEL monitors ambient air quality at ten locations across Nova Scotia. Generally, ambient air quality meets or exceeds national standards in most communities. The common air pollutants monitored regularly are respirable particulate (PM 2.5), sulphur dioxide (SO_2), carbon monoxide(CO), ground level ozone (O_3), nitrogen dioxide (N_2O), and hydrogen sulphide (H_2S). Exceedances for these pollutants are, typically, small and infrequent in Nova Scotia.

Meteorology

The Project is located within the Northwestern Nova Scotia climatic region, on the border of the Annapolis Valley. The sheltered lowlands are characterized by warmer temperatures and lower precipitation totals than other parts of Nova Scotia. The nearest climate station with historical data that is representative of that region is the Kentville (EC) climate station (ID# 8202810) operated by the Meteorological Service of Canada (MSC). The station is located approximately 40 km northwest of Windsor.

The following is a summary of average climate conditions at the Kentville Station, based on climate normals published by Environment Canada for the period from 1971 to 2000. Historical wind data is taken from the Halifax Airport climate station (MSC ID# 202250), which is located approximately 45 km west of the mine site. This is the closest station to the site for which historical wind data exists. Current wind conditions will be taken from the Kentville monitoring station that coincides with monitoring dates and times. (See Appendix F for tabulated meteorological data for both Kentville (F.1) and Halifax International Airport (F.2)).

Observations from the historical Kentville weather data indicate an average total annual precipitation of 1,211 mm, which includes 266 cm of average snowfall per year and 948 mm of average rainfall per year. Rainfall patterns remain fairly constant through out the months of May to November. Measurable precipitation occurs on an average of 284 days per year, with 220 days of measurable rainfall and 77 days of measurable snowfall.

The extreme one day rainfall for the station is 145 mm on September 22, 1942 and extreme one day snowfall is 53cm on January 5, 1952.

Average annual temperature is 6.9°C, with an average monthly range from -2.5°C to 19.4°C. Temperature extremes can range from -31.1°C to 37.8°C. There is an average of 306 days per year with an average temperature above 0°C.

Average wind direction taken from Halifax International Airport (1971 to 2000) is generally westerly from November through to March and southerly April to October. Wind speeds average approximately 18.4 km/hr, with an average range of 13.5 km/hr in September to 18.6 km/hr in February. Maximum hourly speeds can range from 56 km/h in September to 89 km/hr in March, with maximum gusts of up to 132 km/hr recorded.

Wind conditions from the Kentville station for the month of June were northeasterly and westerly. For the month of July winds were predominantly westerly.

Generally the meteorological data from MSC is sufficient for mine design and operation. FG looks forward to working with Environment Canada's Atmospheric and Meteorological Services staff relative to the use and analysis of data collected from the site's meteorological station. FG intends to use the site specific data collected to periodically review the original design and the need for refinements based on the site meteorological data.

Total Suspended Particulate and Fine Particulate Matter

The Miller's Creek extension area is bordered by Belmont, Avondale and Ferry Roads. Both Belmont and Avondale Roads are paved, while Ferry Road is not. Existing environmental conditions were observed during site visits. Particulate dust generated along the paved roads was minimal, while on Ferry Road, there was more dust created from vehicles and farm machinery in use. It was commented by a local resident that Ferry Road is usually sprayed in late May to minimize dust levels. In general, local vegetation and trees do not show signs of stress from particulate levels. Visual examinations and observations made during the air and noise monitoring program support these findings. There were no signs of poor health or visible dust layers present on the vegetation.

The National Air Pollution Surveillance (NAPS) network is a cooperative program that measures air quality across Canada. The closest NAPS monitoring location to the Fundy Gypsum Miller's Creek extension site is at Kentville, approximately 40 km away. At present, NSEL monitors PM 2.5 levels at that location, not PM 10. Monthly PM 2.5 measurements for 2005 ranged from 3 $\mu g/m^3$ -7 $\mu g/m^3$. Currently, USEPA regulates PM 2.5 under the National Ambient Air Quality Standard (NAAQS) at 35 $\mu g/m^3$ for a 24-hour sample and an annual average of 15 $\mu g/m^3$. PM 2.5 will be further regulated at 30 $\mu g/m^3$ for a 24- hour sample in 2010 through the Canada Wide Standards (CWS). Prior to December 2006, the NAAQS criterion for PM10 was 35 ug/m^3. Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the agency revoked the annual PM10 standard. The only regulated value for PM10 is 150 $\mu g/m^3$ sampled over a 24 hr period.

To further study baseline levels of total suspended particulate (TSP) and particulate matter less than 10 microns in size (PM 10) in the existing environment, a monitoring program was developed in accordance with United States Environmental Protection Agency Code of Federal Regulations (USEPA CFR) 40 part 50 – *National Ambient Air*

Quality Standards for Particulate Matter (http://epa.gov/ttn/amtic/files/ambient/pm25/pt5006.pdf).

Six sampling locations were determined based on meteorological forecasts for the sampling period and the proximity to the proposed extension area (Figure 6.8-1). Meteorological conditions for each sampling event was obtained from Environment Canada's Kentville Station for average temperatures, wind speed and direction, and are presented in Appendix F.1. A wind rose diagram depicting wind direction and frequency through the monitoring program is represented as Figure 6.8-2 for the month of June and Figure 6.8-3 for the month of July.

Sampling equipment utilized by CRA consisted of three high volume air samplers equipped with 8 inch X 10 inch glass fiber filters for sample collection. Approximately $1m^3$/min of ambient air is drawn through the filter during a 24-hour sampling period. The particulate is trapped on a pre-weighed glass fiber filter. The samplers were calibrated according to the referenced method as well as manufacturers' specifications. Sampler flow calibration sheets and calculated flow rates are provided in Appendix F.3.

After each sampling event, filters were stored in a clean dry area. Upon completion of the program, samples were shipped to Maxxam Analytics for analysis in accordance with the appropriate method. The laboratory results and certificate of analysis are provided in Appendix F.4.

TSP values range from 6.5 $\mu g/m^3$ -11.1 $\mu g/m^3$. The calculated TSP values reported as ug/m^3 are presented in Table 6.8-1. PM 10 values ranged from 1.2 $\mu g/m^3$ – 3.5 $\mu g/m^3$. Flow rate calculations and final sampling volumes are presented in Table 6.8-2 and 6.8-4. All calculated values for TSP are below the maximum permissible ground level concentration of 120 $\mu g/m^3$ outlined in Schedule A of the *Nova Scotia Air Quality Regulations*. Calculated values for PM 10 (Table 6.8-3), although no longer regulated at 35 $\mu g/m^3$ by the EPA (December 2006), are still below that value. All PM 10 values were < 5 $\mu g/m^3$. Given that most of the fugitive dust generated at the site will be from trucking operations, most of suspended particulates generated will be in the coarser fraction (>2.5 microns). Hence it is most likely given that PM 10 values were all <5 $\mu g/m^3$, the baseline values of PM 2.5, although not measured, will be below the PM 2.5 NAAQS criteria value of 35 $\mu g/m^3$ as well. Baseline monitoring for both particulates and noise was conducted while operational activities continued at the Bailey mine location.

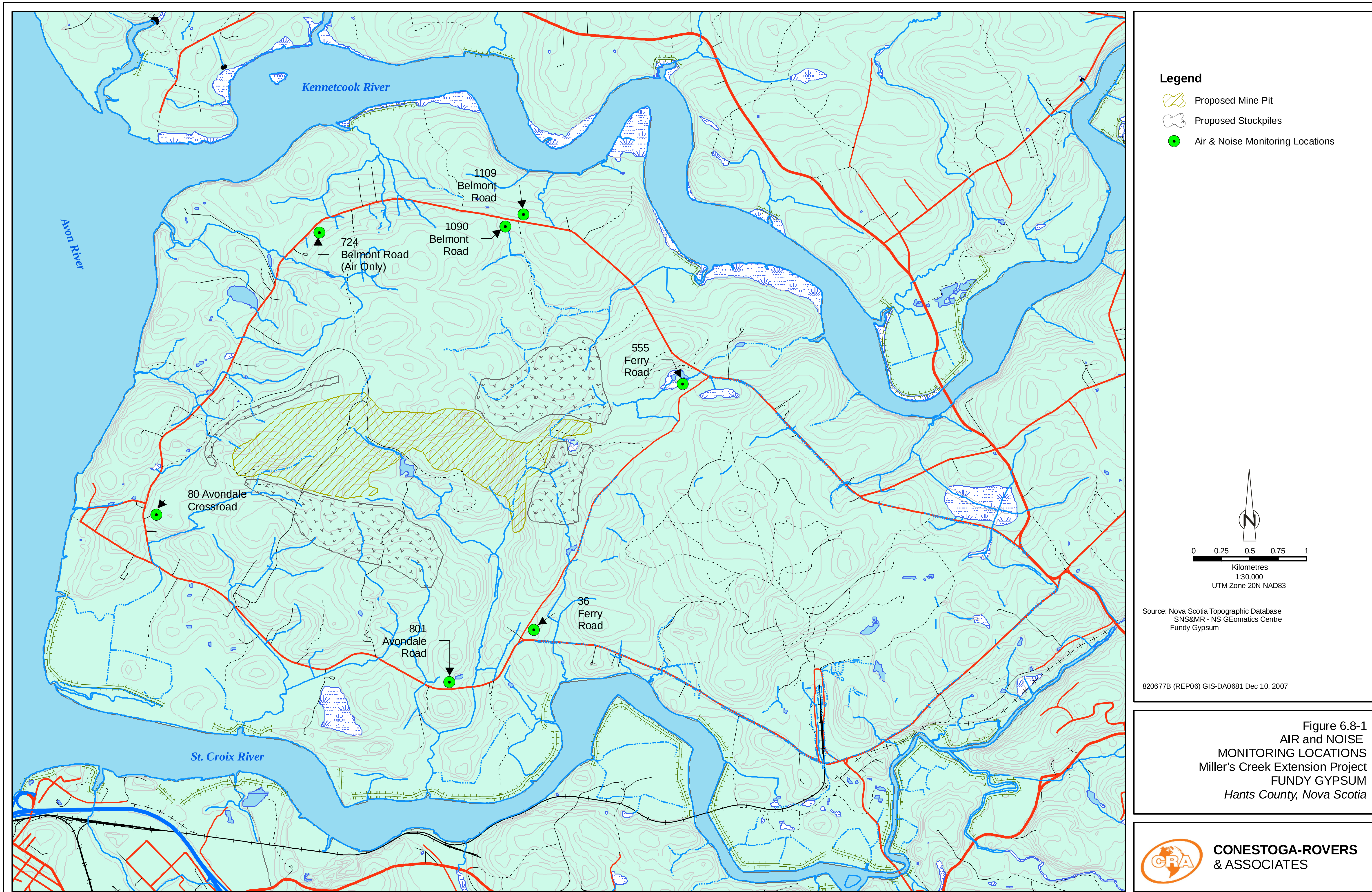
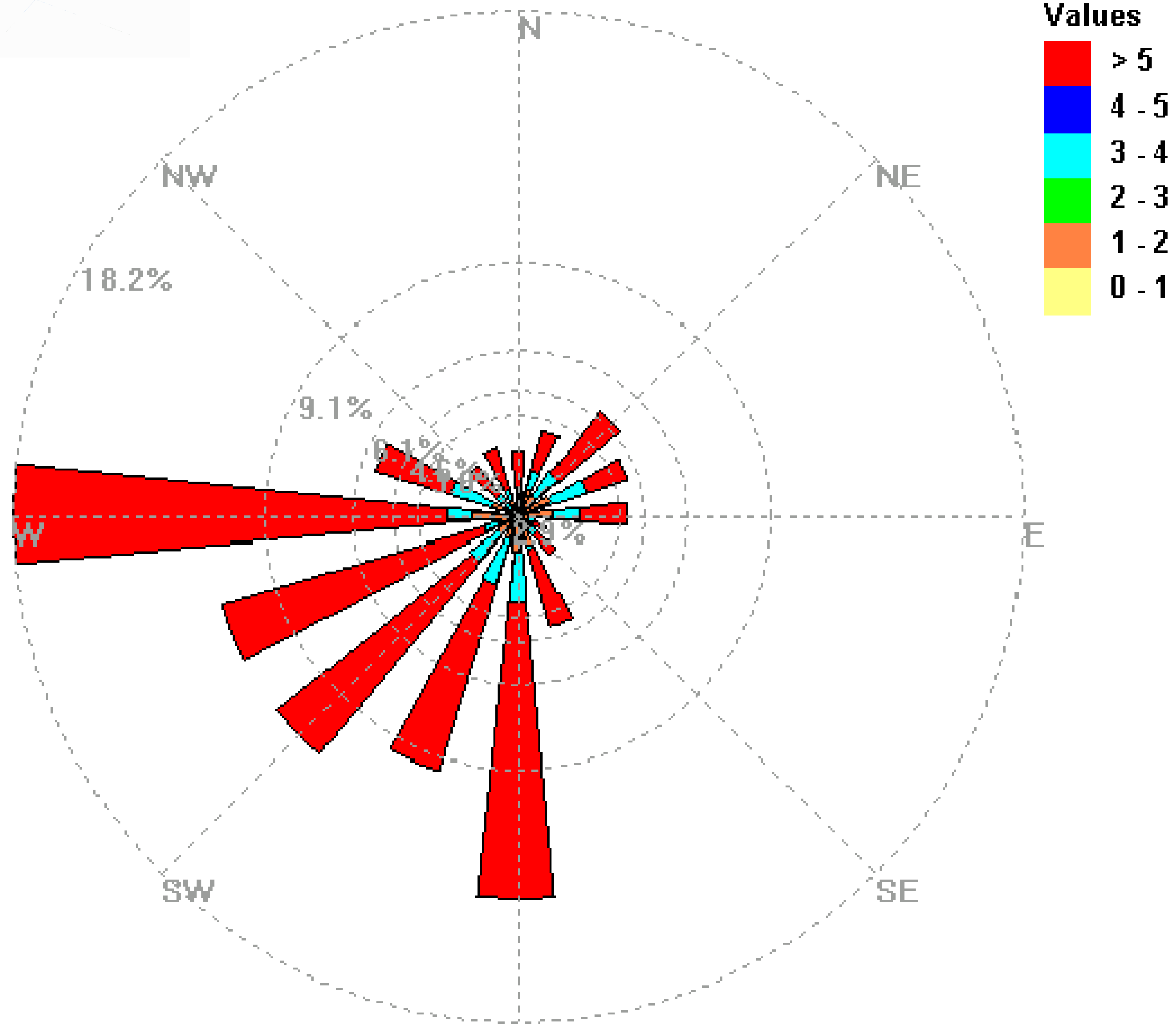


Figure 6.8-1
AIR and NOISE MONITORING LOCATIONS
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

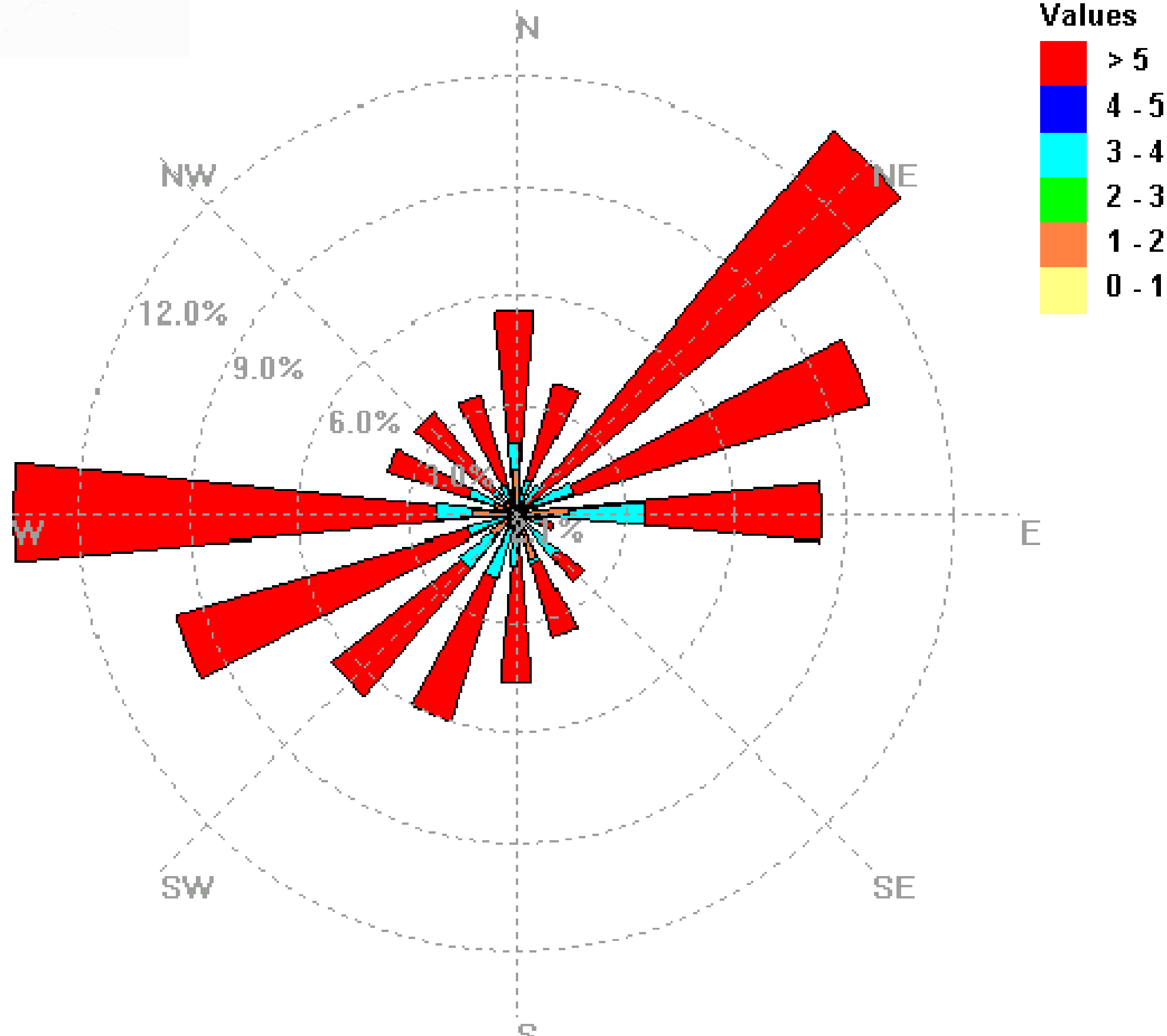


Kentville Station CDA CS 8202810 July 2007 Wind Data

figure 6.8-2

WINDROSE DIAGRAM - KENTVILLE STATION (JUNE 2007)
MILLER'S CREEK EXPANSION PROJECT
FUNDY GYPSUM
Hants County, Nova Scotia

820677-B GN-DA06.8-2 OCTOBER 17/2007



Kentville Station CDA CS 8202810 June 2007 Wind Data

figure 6.8-3

WINDROSE DIAGRAM - KENTVILLE STATION (JULY 2007)
MILLER'S CREEK EXPANSION PROJECT
FUNDY GYPSUM
Hants County, Nova Scotia

820677-B GN-DA06.8-3 OCTOBER 17/2007

The results indicate that current values are low compared with allowable limits in proximity to an existing operation that is similar in nature to that proposed.

TABLE 6.8-1: TSP VALUES CALCULATED as µg/m³

Sample ID	Volume Sampled (m^3)	Results in µg	Results in µg/m³
Location #1-36 Ferry Road	1714.59	19000	11.1
Location #2- 555 Ferry Road	1681.39	11000	6.5
Location #3- 801 Avondale Road	1669.92	13000	7.8
Location #4-80 Avondale Cross Roads	1526.25	12000	7.1
Location #5-1109 Belmont Road	1525.84	13000	8.5
Location #6-724 Belmont Road	1519.65	15000	9.9

TABLE 6.8-2: TSP FLOW CALCULATIONS

EPA accepted criteria 30-60CFM

Sample ID	Sampler Used	Sample Time(min)	Flow (m^3/min)	Flow (CFM)	Total Volume (m^3)
Location #1-36 Ferry Road	W00-01	1495	1.15	40.96	1714.59
Location #2- 555 Ferry Road	W00-02	1460	1.15	41.13	1681.39
Location #3- 801 Avondale Road	W00-03	1420	1.18	42.00	1669.92
Location #4-80 Avondale Cross Roads	W00-01	1360	1.12	40.08	1526.25
Location #5-1109 Belmont Road	W00-02	1323	1.15	41.19	1525.84
Location #6-724 Belmont Road	W00-03	1310	1.16	41.43	1519.65

TABLE 6.8-3: PM 10 VALUES CALCULATED as µg/m³

Sample ID	Volume Sampled (m^3)	Results in µg	Results in µg/m³
Location #1-36 Ferry Road	1731.60	3600	2.1
Location #2- 555 Ferry Road	1707.46	2000	1.2
Location #3- 801 Avondale Road	1588.39	5600	3.5
Location #4-80 Avondale Cross Roads	1541.10	3300	2.1
Location #5-1109 Belmont Road	not available-instrument failure		
Location #6-724 Belmont Road	1479.67	4100	2.8

TABLE 6.8-4: PM 10 FLOW CALCULATIONS

EPA accepted criteria 30-60CFM

Sample ID	Sampler Used	Sample Time(min)	Flow (m3/min)	Flow (CFM)	Total Volume (m^3)
Location #1-36 Ferry Road	W02-01	1470	1.18	42.07	1731.60
Location #2- 555 Ferry Road	W02-02	1468	1.16	41.51	1707.46
Location #3- 801 Avondale Road	W02-03	1430	1.11	39.67	1588.39
Location #4-80 Avondale Cross Roads	W02-01	1360	1.13	40.47	1541.10
Location #5-1109 Belmont Road	W02-02	not available- instrument failure			
Location #6-724 Belmont Road	W02-03	1310	1.13	40.34	1479.67

Nitrogen Oxides (NO_X)

Nitrogen oxides are produced by combustion processes; typically from high temperature and pressure processes created by diesel engines, and consist mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). Together they are often referred to as NO_X. Nitric oxide is a colorless gas, with no direct effects on health or vegetation at ambient levels. NO_2 is an orange red gas that is corrosive, classified as an irritant and is harmful to animals and vegetation. Most NO_2 in the atmosphere is created by the oxidation of NO. The ratio of NO and NO_2, in the presence of hydrocarbons and sunlight are the most important factors in the formation of ground–level ozone. Further oxidation in the presence of water can also contribute to “acid rain”.

For this project, onsite trucking and hauling vehicles can contribute to increases in NO_X emissions.

Sulphur Dioxide (SO_2)

Sulphur dioxide is a colourless gas with a distinctive sulphur odour. It is produced by combustion processes by the oxidation of sulphur in the fuel. SO_2 at elevated concentrations can cause damage to vegetation and health effects to animals. Further oxidation of SO_2 in the presence of water can also contribute to “acid rain”.

Sulphur dioxide emissions from this project will be minimal, given that sulphur content in diesel fuel is regulated.

Carbon Monoxide (CO)

Carbon monoxide is a colourless odourless gas. It is classified as an asphyxiant and is toxic to humans. It is the product of incomplete combustion of carbon compounds notably in internal combustion engines. Typically, levels of CO rarely exceed ground level acceptable concentrations in Nova Scotia.

Throughout this Project there will be CO emissions created by mobile equipment and utility vehicles.

Ozone

Ozone is a colourless gas that acts as an oxidant. It is as a secondary pollutant created through the photosynthesis reaction of the primary contaminates of NO_X, and hydrocarbons present in the atmosphere. Most of the ozone in this region is the result of long range transport of primary contaminants from the US and central Canada.

For this project there will be emissions of NO_X and hydrocarbon products from on site vehicles, resulting in a potential for ozone formation.

Hydrogen Sulphide (H_2S)

Hydrogen sulphide is one of the ambient air contaminants regulated by the province, but there are no emissions of H_2S expected from the various processes utilized in this Project.

Other Greenhouse Gases

Carbon dioxide (CO_2) is a colourless, odourless non-flammable gas and is the most prominent Greenhouse gas in Earth's atmosphere. The largest contributors to CO_2 emissions are the combustion of fossil fuels and deforestation.

Methane is a colourless, odourless, flammable gas. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Through the emissions of onsite mobile equipment and utility vehicles there is a potential for greenhouse gases to be formed.

6.8.2 POTENTIAL EFFECTS, PROPOSED MITIGATION, AND FOLLOW-UP MONITORING

Temporal boundaries for the assessment of air quality have been developed for the time periods during which Project air emissions will have the potential to degrade the local air quality in and around the extension site. The extension Project is expected to proceed in stages over the next 35 to 50 years. Local ambient air quality will be affected throughout that time period. However, the extension process will be conducted in stages, thus the air quality will be affected in stages following the course of the extension process. Process emissions will be generated throughout the life of the project. The extension process and operations are not seasonal; therefore there are no significant seasonal boundaries.

The spatial boundary is the zone of influence, of emissions from the extension and existing processing operations that will affect the local ambient air quality. The zone of influence will encompass an area within 1 to 1.5 km south and east along Avondale and Ferry Roads, expanding to within 6 kilometres north on Belmont Road.

Discussed below are some potential interactions and concerns that could impact ambient air quality.

Development and Mining Operations

Air-borne particulate matter will be generated during development and operation phases of the Project. Airborne particulate matter is a complex mixture of organic and inorganic materials. Size and particle distribution can be categorized as either coarse particles, >2.5 microns (µm) in size, or fine particles, <2.5 microns (µm) in size. Total suspended particulate includes dust, dirt, soot, smoke and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires and natural windblown dust. Particles formed in the atmosphere by condensation or the transformation of emitted gases such as SO_2 and volatile organic carbons (VOCs) are also considered particulate matter.

During clearing and grubbing activities, topsoil will be stockpiled for use in progressive and final reclamation activities. This material is rich in organics and will retain moisture from precipitation. Should dust be a problem during dry periods, FG will wet the stockpiles as needed.

Given that most of the fugitive dust generated during the extension process will be from blasting and trucking operations, most of suspended particulate generated will be in the coarser fraction (>2.5 microns TSP values measured in and around the proposed extension site were below the Nova Scotia Ambient Air Quality Regulations. PM 10 values although no longer regulated at 35 $\mu g/m^3$, were all below 5 $\mu g/m^3$.

Blasting and wind erosion from waste rock piles could all contribute to increased particulate levels. Blasting could also contribute to overall dust emissions. Observations from a recent blasting event show the dust plume settling back down with in four to six minutes of the initial blast time. The noise of the blast and the dust and particles were well contained with in the open pit area. Photo 6.8-1 is a picture of the area prior to blasting. Photo 6.8-2 is the initial blast, showing particulate and dust well contained inside the pit. Photo 6.8-3 is the second blast, 2 to 3 minutes after the first. The dust from the first blast has already settled significantly. Photo 6.8-4 is approximately four minutes after the second blast and as shown by the photo, most of the dust has dissipated and stayed contained within the pit area. The photographs were used as a visual aid to document the blasting event. More quantitative data will be collected from blasting events as the extension process continues.

Several mitigative measures will be utilized to reduce particulate emissions:

- Wet suppression controls on unpaved surfaces;
- Speed reduction to keep dust levels at minimum; and,
- Stabilized slopes of either mulch or vegetation for waste rock stockpiles.

The primary air quality impact requiring consideration is the control of fugitive dust from the extension site and related trucking operations. Dust control requires careful and consistently applied mitigative measures throughout the Project, if non-compliant or nuisance levels are to be avoided. Wet suppression techniques will be applied on an as needed basis. Water is pumped from the mine settling ponds into water trucks and sprayed on the roads as required.

The proposed mitigation measures for specific process components are outlined below. These are similar to measures routinely used at most other Nova Scotia surface mine operations. Fundy Gypsum personnel are very familiar with regulatory requirements relating to air quality.

A significant adverse environmental effect with respect to TSP is one that would reduce air quality, such that the level of TSP exceeds 120 $\mu g/m^3$ over a 24 hour averaging period or 70 $\mu g/m^3$ over an annual averaging period. Using the Nova Scotia Air Quality

Regulation as a reference, an adverse affect would be significant if particulate results exceeded air quality guidelines.

Photo 6.8-1: Pre-blast.

Photo 6.8-2: Initial blast.

Photo 6.8-3: Second blast site.

Photo 6.8-4: 4 minutes after second blast.

Given that the proposed mine extension will not involve additional crushing facilities, the net fugitive dusts from crushing will not increase. The majority of dust emissions from the mine extension will be from mobile equipment and transport vehicles. Any increases in total suspended particulate will not have a significant adverse affect over the life of the project.

Additional TSP monitoring would be required to measure the full effects of suspended particulate matter once the mine extension begins. An audit program of the same sampling sites originally chosen for the baseline monitoring can be implemented.

On-site Vehicle Operations

On site vehicles operations, as well as trucking operations can contribute to overall dust, as well as increased emissions of nitrogen oxides (NOx), sulphur dioxides (SO_2), carbon monoxide (CO), ozone, hydrogen sulphide, and greenhouse gases including methane and carbon dioxide (CO_2).

To minimize dust and other emissions produced by on-site vehicle operations, the following may be used as required:

- Wet suppression controls on unpaved surfaces(as discussed above);
- Hardened surfaces where practical;
- Speed reduction;
- Equipment maintained in good working order;
- Use of large haul vehicles so as to minimize trip frequency;
- Low sulphur diesel fuel;
- Reduced idling

Nitrogen Oxides (NOx)

Nitrogen dioxide emissions produced through combustion processes primarily from project onsite trucking and hauling vehicles will be controlled through the mitigative measures discussed in the "On-site Vehicle Operations" section above. An estimated emissions factor was calculated at 16 g/s or 58 tonnes annually. As long as the extension project proceeds as outlined, there will not be significant increases in nitrous oxide emissions relative to the exiting environment.

Sulphur Dioxide (SO_2)

Sulphur dioxide is produced by combustion processes by the oxidation of sulphur in the fuel. An estimated emissions factor for this project was calculated as 3.5 g/s or 33 tonnes annually. Emissions from this project will be minimal, given that sulphur content in diesel fuel is regulated.

Carbon Monoxide (CO)

Carbon dioxide is the product of incomplete combustion of carbon compounds notably in internal combustion engines. Throughout this Project, there will be CO emissions created by trucks, loaders, dozers and excavators. Based on current manufacturers information an estimated emission factor was calculated as 5.9 g/s or 58 tonnes annually. Carbon monoxide emissions will be controlled through the mitigative measures discussed in the "On-site Vehicle Operations" section above. As long as the extension project proceeds as outlined, there will not be significant increases in carbon monoxide emissions relative to the existing environment.

Ozone

Ozone is as a secondary pollutant created through the photosynthesis reaction of the primary contaminates of NOx, and hydrocarbons present in the atmosphere. Most of the ozone in this region is the result of long range transport of primary contaminates from the US and central Canada.

For this project there will be emissions of NOx and hydrocarbon products from on site vehicles, resulting in a potential for ozone formation. Estimated emission factors for hydrocarbons and nitrogen oxides were calculated at 0.8 g/s or 7.3 tonnes and 16 g/s or 158 tonnes respectively. Ensuring mitigative procedures as outlined in the "On-site Vehicle Operations" section above are followed, and as long as the extension project proceeds as outlined there will not be significant increases in NOx and hydrocarbon emissions that can contribute to an overall increase in ozone emissions.

Emission factors for the above mentioned parameters were calculated using current EPA protocols and available utilization data provided (hours of operation and horse power usage) from Fundy Gypsum. Modeling will be required to estimate site specific ground level concentration**.** However total annual emissions can be estimated based on current operating hours provided. See Appendix F for operating hours and calculated emissions in tonnes per year.

Potential Carbon Dioxide, Methane and Nitrous Oxide Emissions

Other project related emissions could include carbon dioxide, methane and nitrous oxide. Increased levels of carbon dioxide can result from the burning of fossil fuels and loss of forest cover. For this Project, increases in carbon dioxide emissions will be minimized as on site reclamation processes precede. Methane is considered a chemical process green house gas and is generated through the decomposition of organic matter and the carbonization of coal. Methane emissions generated on site will not be significant. Nitrous oxide is generated predominantly through industrial and agricultural processes with a smaller contribution from vehicle exhaust. Well maintained mobile equipment and replacements as equipment ages will minimize nitrous oxide emissions. Reclamation processes will ensure that the overall effect to the forest cover

over time will not be significant. Additional mitigative measures will be employed to help reduce green house gases emitted on site. They will include:

- specifying idling limits for vehicles and operating equipment to reduce green house gases
- incorperating native shrubs and trees in the reclamation plan to further reduce carbon dioxide levels and other green house gases

In conjunction with these mitigative measures, several energy saving techniques may be incorporated where applicable to further reduce green house gas emissions. Outlined below are a number of maintenance/processing initiatives that could be implemented:

- conduct regular pump maintenance and checks
- repair leaks as necessary
- conduct regular servicing and cleaning of equipment and vehicles
- reduce vehicle use where possible
- minimize idling
- increase driver education and awareness
- maintain accurate fuel records
- use correct size and efficient engine, motors, and pumps for task

These energy saving measures incorporated into the extension project where applicable, in addition to the mitigative measures discussed above, will aid in reducing project related emissions. Green house gas emissions will be generated, but the impact to the existing environment will not be significant.

Waste Rock Piles

Wind erosion from elevated waste rock piles containing finely divided material can be a major source of dust at mine sites. Slopes will be stabilized with mulching and or vegetation, where appropriate. Waste rock piles will be sprayed as necessary to minimize emissions.

National Pollutant Release Inventory (NPRI) Reporting

The NPRI is a federally administrated program that collects data on annual on site emissions, of substances released to the air, water and land, as well as offsite transfers of substances for disposal or recycling. NPRI reporting is a requirement of sub section 46(1) of the Canadian Environmental Protection Act (CEPA). Fundy Gypsum has been reporting PM, PM 10 and PM 2.5 annual emissions since 2003. PM emissions ranged from 88-91 tonnes from 2004 to 2006. PM 10 emissions ranged from 42-43 tonnes from 2004 to 2006 and PM 2.5 emissions remained constant at 13 tonnes for the years 2004 to 2006. It is unlikely that total PM emissions will increase drastically due to the nature of the proposed extension project. The NPRI reporting process will continue, ensuring environmental management of the project.

Reclamation

Progressive reclamation will be integrated in the overall mine plan. Dust and exhaust types emissions will be produced from equipment and machinery used for reconstruction and re-contouring of stock piles and waste rock piles, back filling and overburden relocation. Similar mitigative measures as outlined for waste rock piles, including wet suppression of unpaved surfaces and roads, will help reduce dust impacts from these activities. Regular machinery maintenance, the use of low sulphur fuel, the overall distance of the reclaimed areas from sensitive receptors and the natural buffers of the reclamation areas will help reduce emissions and dust impacts associated with the equipment utilized in the reclamation process.

In addition to the Project extension operations, current agricultural practices and farming operations will contribute to the cumulative effects on air quality. Fugitive emissions from farming vehicles and trucks, as well as emissions from spray fertilizers and other agricultural operations are at present contributing to the overall air quality of the study area. Additional emissions from the Miller's Creek extension process will affect the over all air quality, but the contribution is not significant. The extension project has a life span of 35 to 50 years. Progressive reclamation processes as well as mitigative measures discussed above will control overall emissions.

FG may vary the mitigation depending on specifics of the situation as long as the dust levels are in accordance with the regulatory approval. Fundy Gypsum is aware that the proposed Project will be regulated by the Nova Scotia Air Quality Regulations and will ensure that operations meet these requirements.

6.8.3 SUMMARY

In summary, assuming appropriate mitigation to minimize dust generation during loading and hauling operations, project-related effects on air quality are not significant. Additional TSP and emissions monitoring would be required to measure the full effects on suspended particulate matter and exhaust emissions once the extension process begins and as it continues on. Particulate monitoring throughout different phases of the extension process can be conducted utilizing a Beta Array Monitor (BAM). In addition, detailed modelling can be conducted to better estimate emissions contributions and ground level concentrations.

6.9 NOISE LEVELS

6.9.1 EXISTING ENVIRONMENT

The proposed extension of the existing surface mining operation is bounded by Avondale, Belmont, and Ferry Roads. There are several contributing factors to existing noise in this area:

- Existing background noise from farm machinery;
- Existing background noise from road traffic including local traffic, and farm equipment;
- Existing background noise from current mining operations;
- Existing noise from scheduled blasting events; and,
- Noise from current blasting procedures and siren warnings.

To further study the existing environment, CRA conducted sound level monitoring for FG in order to determine the baseline ambient background sound levels. Six sampling locations were determined based on meteorological forecasts for the sampling period and the proximity to the proposed extension area. Figure 6.8-1 shows the monitoring locations. These sampling locations were specifically chosen to establish baseline background ambient values surrounding the perimeter of the proposed extension project. There is no active mining or development related processes occurring in that area at this time.

Noise measurements taken around the FG proposed extension site were obtained for the period of June 28, 2007 to August 3, 2007. As specified in the Noise Measurement and Assessment Guidelines, L_{eq} values should be ≤ 65 dBA between the hours of 0700 and 1900 hours, ≤ 60 dBA between the hours 1900 and 2300 hours and ≤ 55 dBA between the hours of 2300 and 0700 hours. The guidelines specify a minimum of two consecutive hours in each interval to be monitored.

The long-term sound level monitoring was conducted using a microphone and data logging system. The sound level measurements were taken using a Quest Sound Pro-DL Class 1 Precision Integrating Sound Level Monitor (Serial Number BIF030021). The system was calibrated at 114 decibels (dBA) before and after the measurement period using a Quest Acoustic Calibrator. The meteorological conditions during the monitoring periods consisted of light winds (<20 km/hr) and seasonable temperatures. Weather conditions were mostly cloudy with some fog and drizzle on July 10th and 11th, and some rain showers on July 6th and 9th. A foam weather protector was utilized during the monitoring periods to protect the microphone from the elements and to minimize any contributions that the wind and rain would add to the sound level measurement. Meteorological conditions were obtained from Environment Canada's Kentville station and used to assess adverse weather conditions that could have affected the noise measurements. The weather conditions were considered in order to validate the minimum background sound levels. Continuous 1-hour sound level measurements were taken with the detector in slow response using the A-weighting (dBA).

Continuous, one–hour Leq values were observed throughout the above specified time intervals. The average one-hour Leq values observed for each monitoring location are summarized in Table 6.9-1.

TABLE 6.9-1: AVERAGE Leq VALUE FOR EACH MONITORING LOCATION

Location	Date	Average Leq Values		
		23:00-07:00 ≤55 dBA	07:00-19:00 ≤65 dBA	19:00-23:00 ≤60 dBA
36 Ferry Road - Location #1	July 19.2007			41.5
	July 20,2007	35.1	43.5	45.0
	July 23,2007	34.7	41.7	37.8
	July 24,2007	33.6	41.4	40.7
	July 25,2007	33.8	38.3	
555 Ferry Road – Location #2	July 6,2007		39.8	39.2
	July 9,2007	36.2	41.6	38.7
	July 10,2007	37.3	40.6	38.6
	July 11,2007	38.4	46.1	
801 Avondale Road - Location #3	July 17,2007		44.7	40.3
	July 18.2007	32.4	46.1	43.1
	July 19,2007	41.2	43.0	
1109 Belmont Road- Location #5	June 29,2007		38.7	33.9
	July 2,2007	32.4	40.7	34.7
	July 3,2007	32.0	39.1	
80 Avondale Cross Roads- Location #4	July 25,2007		39.9	35.8
	July 26,2007	32.4	44.7	38.8
	July 27,2007	32.2	42.6	
1090 Belmont Road-Location 6	July 30,2007		37.1	32.1
	July 31,2007	29.3	34.3	33.4
	August 1,2007	30.6	35.9	

Average L_{eq} reading for those locations monitored have all been below the Nova Scotia Guidelines for Environmental Noise Measurement and Assessment for each specified time interval. Noise trends at each location, show low L_{eq} values in the early morning hours increasing as the day progresses, and decreasing into the evening hours. There were only six hourly average values measured above 50 dBA. The complete long-term sound level monitoring data set outlining the lowest measured L_{eq} values is provided in Appendix G.

6.9.2 POTENTIAL EFFECTS, PROPOSED MITIGATION, AND FOLLOW-UP MONITORING

The mine extension Project will create blasting, loading and hauling noise. Noise is defined as any unwanted sound which may be hazardous to health, interfere with speech and verbal communications or is otherwise disturbing, irritating or annoying. Noise is measured as sound pressure levels (SPL) in decibels (dB). This scale is "A" weighted to approximate the way the human ear hears. Noise measurements are, therefore, represented as dBA units. In general, an increase in noise levels from 1 to 3 dBA will not be noticeable, 3 to 5 dBA will be noticeable by most people, 5 to 7 dBA will be easily heard and an increase of 7 to 10 dBA will be considered by most to be twice as loud (USEPA 1974). Because the decibel scale is logarithmic, doubling of the number of noise sources will increase noise levels by 6 dBA. A tenfold increase in the number of noise sources will add 10 dBA to the noise level.

Temporal boundaries for the acoustic environment have been developed for the time periods during which related Project noise will have the potential to degrade the local air quality in and around the extension site. The extension Project is expected to proceed in stages over the next 35 to 50 years. The acoustics environment will be affected throughout that time period. Most of the noise impacts will result from heavy vehicle operations. Impacts will occur during the development and blasting operations as the project proceeds, and as a result of decommissioning and reclamation. The extension and reclamation processes will be conducted in stages, thus noise related impacts will vary depending on the stage of development or reclamation and the types of equipment utilized. The extension is not seasonal; therefore, there are no significant seasonal boundaries.

The spatial boundary is the zone of influence of noise emissions from the extension area that will affect the local ambient air quality. The nearest resident to the proposed mine extension boundary is approximately 400 m. The zone of influence will encompass an area within 1 to 1.5 km south and east along Avondale and Ferry Roads, expanding to within 6 kilometres north on Belmont Road.

A significant adverse effect occurs where the project increases background noise levels at a residential area above the NSEL guidelines or by more than 10 dBA. An adverse effect that does not meet these criteria would be considered as not significant. A positive effect would be project-related activities that decrease the ambient noise levels.

Sources of Project-related noise may include blasting, onsite heavy truck traffic and operation of other heavy machinery. Table 6.9-2 outlines some typical noise ranges for heavy construction equipment. Noise levels for stationary construction equipment will decrease by approximately 6 dBA at a doubling of the distance from the source

TABLE 6.9-2: Typical Noise Levels 15 m from Heavy Construction Equipment

Type of Equipment	**Noise Level Range (dBA)**
Front Loaders	70-85
Backhoes	70-95
Trucks	85-95
Excavator	85-95
Jack Hammers/Rock Drills	80-100
Reference: "Traffic Noise Analysis and Mitigation Manual" Environmental Section ,Oregon State Highway Division,1990	

The level of noise will vary according to the type of development activity. Noise from the equipment and lack of effective mufflers is a source of noise. Regular maintenance of the equipment will reduce noise levels. This measure will adequately mitigate potential noise impacts. Noise monitoring will be conducted and the results submitted to regulators as requested. The mitigation procedures may vary as long as noise levels are in accordance with the regulatory approval.

Blasting Noise

Blasting at the existing Miller's Creek mine site typically occurs daily sometime between 2 and 4 pm. There is an audible horn and siren warning 10 minutes before the actual blast occurs, followed by all clear horn blasts. The following observations were documented during several site visits to monitoring locations during blasting events:

- siren sound was prominent;
- horn blasts were sometimes audible;
- blast was audible; and,
- noise spikes did not increase above allowable day time value of 65 dBA at anytime during blasting.

FG has had a blasting monitoring program in place for over 20 years. Sound pressure values and peak particle velocities are recorded for each blast and reported monthly. Sound pressure values are compared to those specified in the IA for the Site. In the past four years there were only two values above the 128 dB sound pressure criteria, January 2006 and February 2005. Outlined in Table 6.9-3 are the blast times and decibel readings coinciding with the noise monitoring program. This data was used to examine current blasting effects from the existing Miller's Creek Site on the proposed extension project. Also presented in the table are minimum and maximum noise level values ± 15 minutes of blast times.

Table 6.9-3 Blast Data and Noise Monitoring Comparisons

Blast Date	Blast Time	dB Reading Measured By Fundy Gypsum	Corresponding Measurement By CRA	dBA Range Readings From 2 pm to 4 pm Measured By CRA	dBA Range Readings ±15 Minutes From Blast Time Measured By CRA	
					- 15 minute min./ max. values	+15 minute min/max. values
3-Jul	3:46pm	106	45.7(1109 Belmont Rd.)	36.1 - 51.3	33.5(15:33) 51.3 (15:36)	31.3 (15:51) 46.2(15:52)
3-Jul	3:47pm	95.9	37.3 (1109 Belmont Rd.)			
9-Jul	3:19pm	103.5	53.0 (555 Ferry Road)	34.0 - 53.2	35.5 (15:12) 53.0 (15:19)	35.3 (15:26) 45.7 (15:21)
9-Jul	3:20pm	94	45.0 (555 Ferry Road)			
10-Jul	3:24pm	98.8	41.5 (555 Ferry Road)	34.5 - 51.3	37.5 (15:06) 51.3 (15:24)	37.7 (15:41) 53.3 (15:33)
10-Jul	3:25pm	110.2	39.8 (555 Ferry Road)			
11-Jul	3:38pm	107	54.5 (555 Ferry Road)	39.3 - 61.4	50.5 (15:30) 60.1 (15:39)	40.4 (15:51) 53.3 (15:40)
11-Jul	3:39pm	101	60.1(555 Ferry Road)			
17-Jul	3:51pm	109.5	45.0 (801 Avondale Rd.)	37.2 - 58.7	39.6 (15:38) 58.9 (15:41)	37.2 (15.54) 55.6 (16:00)
17-Jul	3:53pm	108	54.4 (801 Avondale Rd.)			
18-Jul	4:04pm	112	59.0 (801 Avondale Rd.)	41.8 - 62.7 (15:00-17:00)	43.5 (16:00) 56.2(15:50)	46.9 (16:16) 59.7 (16:10)
18-Jul	4:05pm	110.9	51.3 (801 Avondale Rd.)			
19-Jul	3:57pm	101.9	54.0 (801 Avondale Rd.)	38.8 - 55.9 (15:00-17:00)	38.8(15:42) 54.4(15:57)	38.1(16:08) 55.4(15:59)
19-Jul	3:58pm	111.5	54.4 (801 Avondale Rd.)			

Noise level readings obtained on July 3 from 1109 Belmont Road and readings from July 9 from 555 Ferry Road, do not show a significant increase in readings when compared to the previous hour before blast time of 3:46 pm and 3:19 respectively. Average Leq reading from July 3 14:00 to 14:59 were 40.1 dBA and hourly average reading from 15:00 to 15:59 was 39.9 dBA. Average Leq reading from July 9 14:00 to 14:59 was 40.3 dBA and Leq hourly average reading from 15:00 to 15:59 was 40.4. All values are below NSEL criteria for day time hours of 65 dBA.

Blast time on July 10 was at 3:24 pm. Hourly average noise levels readings obtained from 15:00 to 15:59 show an increase in sound level values of 2 to 3dBAwhen compared to the previous hour (40.5 dBA vs. 38.7 dBA) but are still below the NSEL criteria. Continued monitoring on July 11 at 555 Ferry Road show increased noise level readings in the afternoon hours when compared to the previous days data. Blast time was at 3:38 pm. Hourly average reading from 14:00 to 14:59 were 47.9 dBA, and from 15:00 to 15:59 were 50.7 dBA. These readings are consistently higher through out the hour and do not appear to be blast related. There were no spikes above the NSEL criteria and average hourly readings are still below 65dBA.

For July 17 monitoring at 801 Avondale Road, average hourly dBA measurements are relatively the same from 14:00 hrs to 17:00 hrs, measuring 47.12, 46.4, and 46.8 dBA respectively. Throughout this monitoring time there are several readings above 50 dBA . This particular location utilizes field farm equipment. Elevated noise readings are most likely a result of noise from farming equipment and not blast related. Average readings are still below NSEL criteria. Similar comparisons can be made for monitoring data collected on July 18. Average hourly readings are elevated between the hours of 15:00 to 17:00 are most likely the result of noise related to farming equipment. Elevated readings (around 50dBA) occur on July 19 coinciding with blast times. But average hourly readings are slightly above 40 dBA. Readings are consistent 15 minutes before and after the blast at between 40 to 45 dBA. Spikes could be a result of blast noise, but readings are below NSEL requirements.

As the proposed mining extension moves westerly noise spikes could result during blasting events and mining activities. Noise from blasting events is considered a short term event. Wind direction and other meteorological conditions greatly affect wind propagation. If the wind is blowing towards the sources (upwind propagation) sound waves are refracted upward and audibility can be reduced. A temperature decrease with altitude, during sunny weather or when strong winds are blowing, causes upward refraction reducing audibility. Heavy snow cover can have the same effect. The snow cover on the ground is very soft and ground attenuation is enhanced (NSWMC 2006).

Wind directions observed during the months of June and July were westerly and north easterly. More westerly winds blowing in the direction of the source will aid in reducing noise levels. Local topography, surface ground cover, and forested areas can block and absorb noise, resulting in additional noise reductions.

The existing environment is already exposed to noise from blasting and general mining operations, as well as heavily influenced by farming equipment. Average Leq values obtained from monitoring locations along Belmont, Avondale and Ferry Roads , ranging from 500 m to 2 km from the current blasting locations were all below NSEL criteria. As the proposed extension moves from east to west, residences located east of Ferry Road should see less of an influence in background noise from proposed mining and blasting activities. Residences along Belmont and Avondale may experience spikes from blasting activities and perceived increases in noise levels from mining operations, but considering noise reduction factors discussed above, there will not be a significant affect on the existing environment. Average noise level reading should remain below the NSEL criteria.

Reclamation

Progressive reclamation will be integrated in the overall mine plan. Noise impacts from reclamation processes will result from equipment and machinery used for reconstruction and recontouring of stock piles and waste rock piles, back filling and over burden relocation. Typical noise ranges for types of equipment used in this process are outlined above in Table 6.9-2. Regular machinery maintenance, the overall distance of the reclaimed areas from sensitive receptors and the natural buffers of the reclamation areas will help reduce impacts of noise associated with the equipment utilized in the reclamation process.

Should the Project be completed as described, the blasting and most heavy equipment noise will be confined to the open pit area, and transportation routes. The likelihood of any dwellings in this rural area being occasionally impacted by sound from the site, as well as by vehicular traffic to and from the site is very low. Noise data reviewed specifically around blasting times show very little contribution from warning signals and the actual blast. Influences at several locations are a result of background noise from operating farming equipment. The majority of mining operations will occur in the pit well below ground surface, thereby provide excellent noise shielding.

FG will control operations and equipment to ensure noise levels are kept within recommended limits for surface mining operations. Mine site noise will be periodically measured at the property boundaries to ensure regulation levels are not exceeded. Should it be required, a sampling program to collect representative noise level data will be undertaken when surface clearing and operations begin.

6.9.3 SUMMARY

The nearest residence to the proposed extension site is approximately 400 m away. Given that the existing environment (already exposed to mining and operational noise), is well below the daytime permissible level of 65 dBA and night time readings below nighttime levels of 55 dBA, additional project impacts will not be significant. Appropriate mitigation to minimise noise levels to reasonable levels will be made.

All noise emissions will meet the specifications outlined in the IA, as well as the Guidelines for Environmental Noise Measurement and Assessment, 1990.

Additional noise level monitoring would be required to measure the effects once the extension process begins. Monitoring stations can be set up at any time through the process should noise complaints arise. An audit program can be implemented at the property line as directed by NSEL, to monitor project related noise levels.

6.10 ECONOMY

6.10.1 EXISTING ENVIRONMENT

The proposed undertaking is to be located in the Avon Peninsula area of Hants West (Provincial Electoral District), however the socio-economic effects of the proposed undertaking will, for the majority, be felt throughout the broader region of Hants West.

Considerations for selecting Hants West as the project socio-economic effects area are as follows:

a. Existing Company Operations: FG operates three facilities in Hants West, which includes a ship loading facility in the Town of Hantsport, the Wentworth Mine located near the Town of Windsor, and the Miller's Creek Mine, also located near the Town of Windsor. The proposed undertaking is an extension to the existing Miller's Creek Mine, on the Avon Peninsula. The proposed project socio-economic effects relate to the continuation of operations at the Miller's Creek Mine site.

b. Drawing Area of Labour Force: FG has examined the labour force records for the facilities. It has been determined that the overwhelming majority of employees reside in the area best described as Hants West. The term 'Hants West' refers to an electoral area which is defined on the 2002 Province of Nova Scotia Electoral Map as District number 33. We note that this area contains the Municipality of the District of West Hants, the Town of Windsor (a separate Municipality), and the Town of Hantsport (a separate Municipality).

The 2001 Statistics Canada aggregated census data for Hants West is reported below. We note that the 2006 census data will not be completely available until 2008. For the purpose of this profile, we have defined the project area as the Provincial Electoral District of Hants West which includes the towns of Windsor and Hantsport, and the Municipality of the District of West Hants.

	2001 Census Data	2006 Census Data
Total Population	18,755	18,790
Total Labour Force Age	11,090	11,115
Percentage in the Labour Force	54.5	Not Available
Unemployment Rate	8.3%	Not Available
Average Income (all Households)	$44,484	Not Available

Source: Nova Scotia Community Counts web page - data modeled from Statistics Canada, Census of Population, 2001, 2006.

Economic Profile

Hants West has long been associated with traditional industries such as farming, mining, lumbering and, at one time, had a large number of ship-building industries along the north shore areas. The area remains primarily rural. Windsor and Hantsport are the main towns in the District.

Other Major Industries in the Area:

Avon Valley Greenhouses Ltd., based in Falmouth, was founded in 1935. Avon Valley is a leading provider of cut flowers, potted plants, foliage and florist supplies. It has supplied floral retailers in Atlantic Canada and New England for more than 70 years. The company has more than 900 metres square of fresh cut flower cooler space, 5 hectares of greenhouse production and 200 (full and part time) employees. Over the years, Avon Valley has occasionally been assisted financially by government, most recently in 2005, when it received a $1.2 million loan from the Nova Scotia Farm Loan Board to expand and update its greenhouse facilities. The company also runs two smaller operations in New Brunswick.

Minas Basin Pulp and Power Company Limited was founded in 1927 in Hantsport, Nova Scotia. In the beginning, the family-owned and operated company produced a single product - groundwood pulp, adding paperboard capacity in 1946. Today, Minas Basin produces 100% recycled paperboard products such as linerboard and coreboard and has a production capacity of 100,000 metric tonnes per year. This company employs 160 individuals.

Mason Apples is one of the largest apple growing operations on Canada's East Coast. The operation consists of 600 acres of land added to the output of more than 20 local farms. One hundred (100) full and part-time employees ensure that the quality, which starts on the tree, is seen throughout all phases of production, storage, packing, and shipping.

Sepracor Inc. is a research-based pharmaceutical company dedicated to treating and preventing human disease through the discovery, development, and commercialization of innovative pharmaceutical products directed towards unmet medical needs. Sepracor has been located in Windsor, Nova Scotia since 1994 and employs a highly educated workforce of approximately 60 people. The focus of the 4,000 square metre facility in Windsor is research and development, and commercial manufacturing of Active Pharmaceutical Ingredients for Sepracor Inc.

6.11 LAND USE AND VALUE

Land use has been identified as a Project Valued Socio-economic Component (VSC) due to the potential for the Project to interact with current land uses surrounding the Project area. Land use and land use planning can have a significant impact on natural resources. Land use planning is closely related to environmental assessment, such that an environmental assessment addresses environmental issues and concerns to reduce conflicts between neighbouring land uses. Land use planning is typically carried out by municipal governments that have been given their authority through the *Municipal Government Act* by the provinces. It must be noted that land use powers are not exclusively municipal as provincial governments maintain certain authorities, such as management of mining activities.

The historical and existing land uses of the Project site and surrounding areas of the Avon Peninsula are important considerations to determine any potential site contamination and to describe the planned and existing land uses the may be impacted by the mine extension project. The analysis of potential effects focuses on public stakeholder concerns of agricultural land uses. Anticipated environmental effects resulting from the Project are characterized as interruptions or disruptions to present land use activities.

6.11.1 EXISTING ENVIRONMENT

Past land use of the proposed Project site has consisted of minor gypsum mining activities dating back to the early 19^{th} and early 20^{th} centuries (as detailed in Section 5 Mine History). The site has not been developed in any significant capacity and the potential for contamination that may have resulted from past land use is thought to be low. Aside from mining activities, the proposed site and surrounding area have historically been used for forest harvesting and agriculture practices, as well as some recreational activities, such as hiking, hunting and fishing.

The current land use around the proposed Project site consists primarily of agriculture and some forestry activities with associated residential dwellings. A large area east of the proposed Project site is used for gypsum mining activities, which are operated by FG.

Land Use Zoning

The proposed mine extension is located between Avondale, Belmont and Ferry Roads on the Avon Peninsula. The Municipality of the District of West Hants is currently in the process of completing a comprehensive review and consolidation of the Municipal Planning Strategy (MPS) and Land Use By-Laws (LUB) for the entire West Hants District. The consolidated MPS and LUB are currently in draft form. The existing mine and the proposed extension fall within the West Hants MPS.

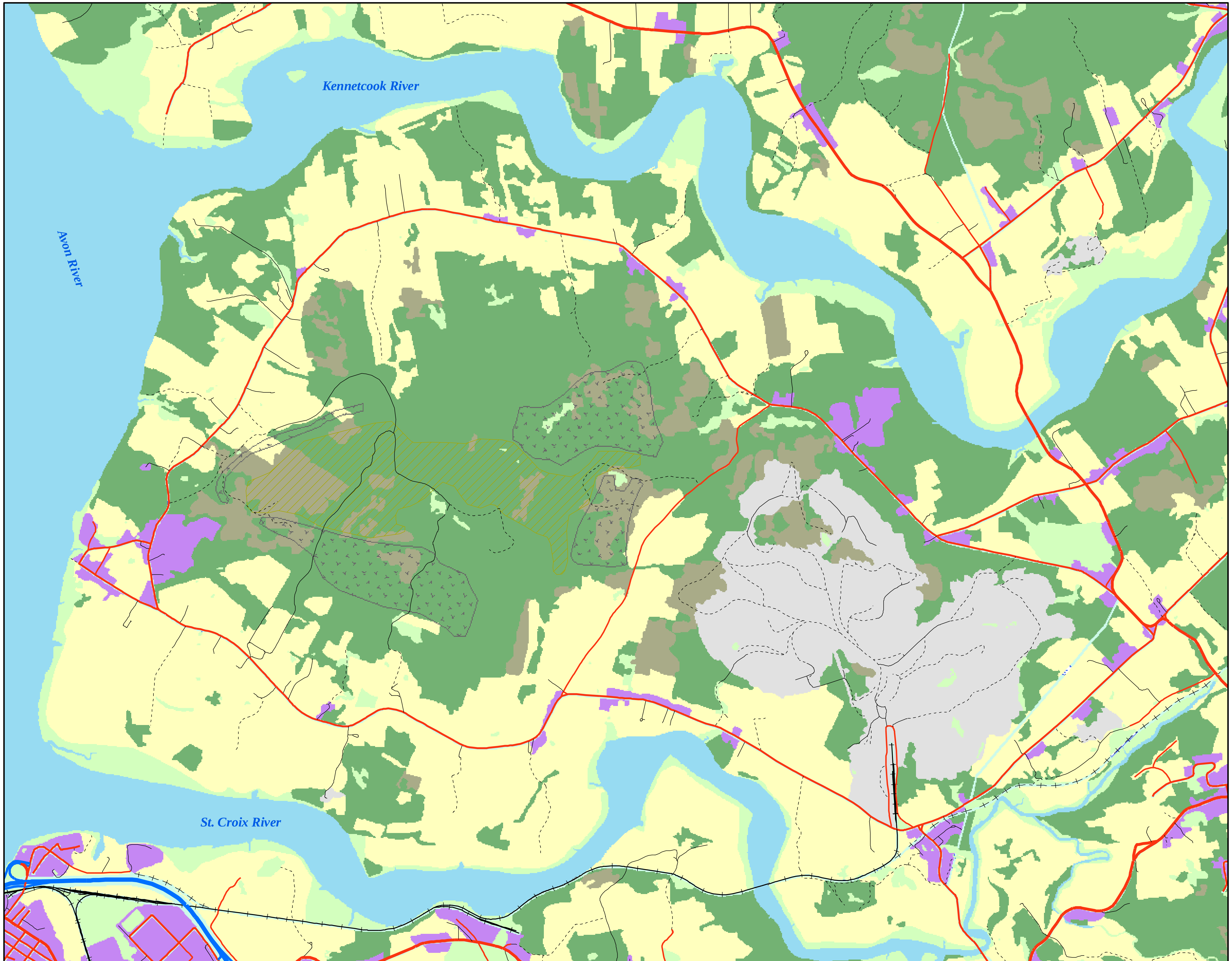
The primary goal of the West Hants Municipal Planning Strategy is to establish a controlled development approach to achieve a settlement pattern that accommodates a wide range of activities in a compatible and efficient manner.

The draft municipal zoning indicate that the lands surrounding the proposed mine extension are zoned Agricultural Priority 2 (AR-2), while the existing Miller's Creek mine is zoned Mineral Resource (MR). The AR-2 designation is intended to encourage the preservation of farmland and discourage the fragmentation of larger farm properties. Permitted uses in an AR-2 zone include, but are not limited to, agricultural and support uses, churches, community centres, fire halls, forestry and forestry related activities, manufactured homes, and one or two unit dwellings. The Mineral Resource zone applies only to those sites actively being mined. The zone regulates only the location of the mine structures since mining activities fall under the authority of the Province of Nova Scotia. Figures 6.11-1 and 6.11-2 show the range of land use and zoning in the area surrounding the Project site. General Land Use (Figure 6.11-1) derived from the NS Natural Resources Forestry database, shows actual land use based on aerial photo interpretation. In addition to the proposed AR-2 zoning at the Project site and the adjacent MR zoning for the existing mine site, the only other proposed zoning designation is R-4 (Rural Residential) southwest of the Project site, in the hamlet of Newport Landing (Figure 6.11-2). This is a low-density subdivision with houses using private wells and septic systems.

Agricultural Land Use

The predominant land use in the Project area, aside from current gypsum mining activities, is agriculture. A variety of crops, vineyards and livestock operations surround the Project site.

The Canada Land Inventory (CLI) Land Capacity of Agriculture system classifies soils for agricultural use into seven different classes with Class 1 being the soil of highest agricultural potential and Class 7 having no agricultural value. Soils in Classes 1 to 3 are of adequate quality for successful cultivation with minimum to moderate improvements. Nova Scotia is predominantly comprised of Class 2 and Class 3 soils, with approximately 36,400 hectares in West Hants rated. The West Hants MPS maintains that Class 2 and Class 3 soils will be reserved for agricultural production with limited non-agricultural development. The Miller's Creek Mine extension area is not located in a region where conflict with current or future agricultural practices is predicted due to the existing under-utilization of agricultural lands and wide distribution of Class 2 and Class 3 soils throughout the region.



Legend

- Proposed Stockpiles
- Proposed Mine Pit
- Forest
- Clearcut Area
- Non Forest
- Agriculture
- Urban
- Gypsum Mine
- River

N

0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source:
Topographic Features: Nova Scotia Topographic Database,
SNS&MR - NS Geomatics Centre
Fundy Gypsum

Landuse: Nova Scotia Forestry Database,
NS Natural Resources

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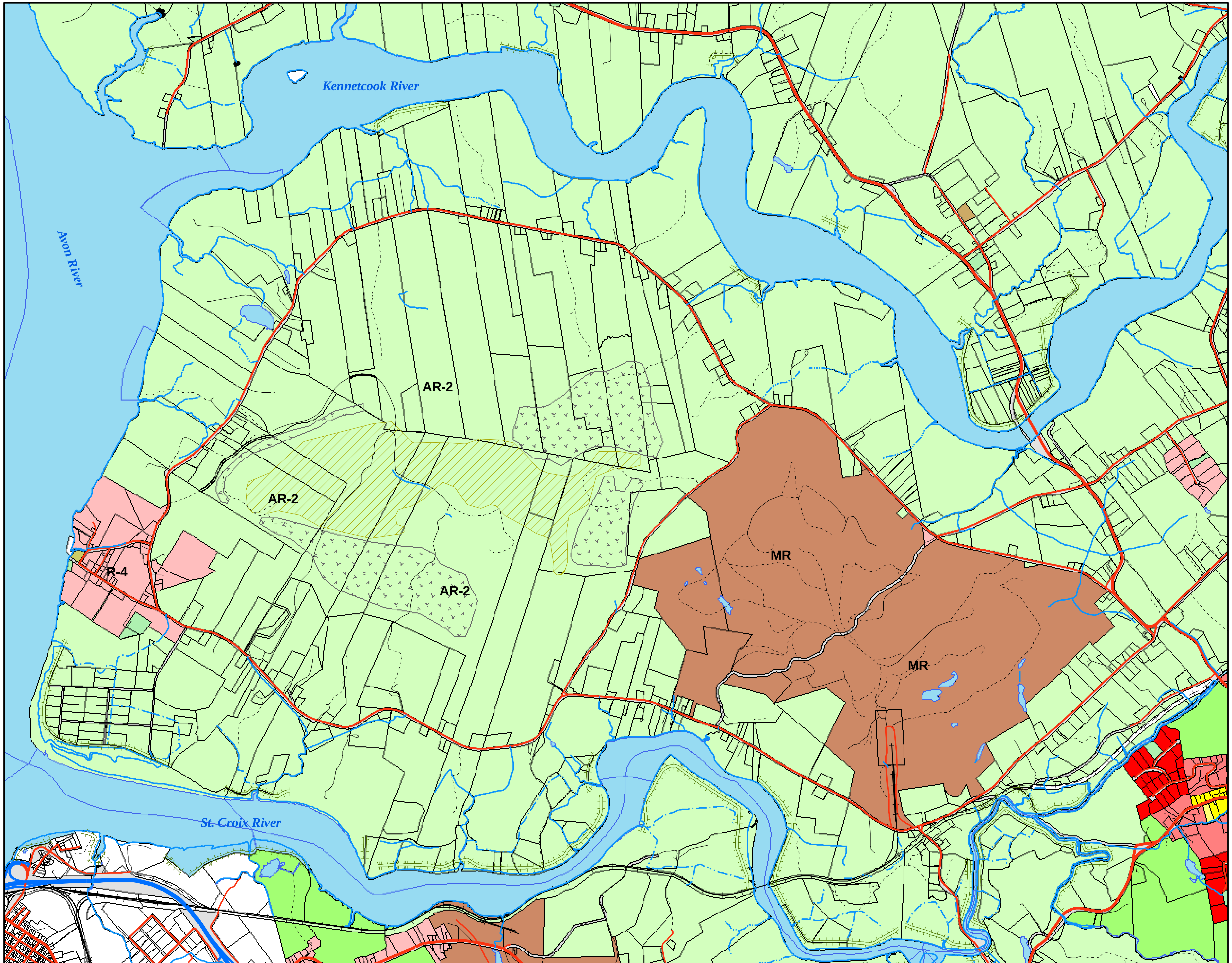
Figure 6.11-1

LAND USE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES



Legend

- R-1 - Single Unit Residential
- R-2 - Two Unit Residential
- R-4 - Rural Residential
- GC - General Commericial
- HC - Highway Commercial
- LC - Local Commericial
- RC - Rural Commericial
- AR-2 - Agricultural Priority 2
- AR-3 - Agricultural Priority 3
- MR - Mineral Resource
- M-1 - Resource Industrial
- M-2 - Hamlet Industrial
- LI - Local Industrial
- LI-2 - Joint Industrial Type 2
- LI-3 - Joint Industrial Type 3
- I - Institutional
- OS - Open Space
- Road
- Water
- Not Classified
- Proposed Mine Pit
- Proposed Stockpiles

0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source:
Municipality of the District of West Hants Land Use By-Law
(in Draft form as of July 2007).
Draft Zoning Maps - Page 24,25,28,29
http://www.windsorwesthantsplanning.ns.ca/whplan.html

Zoning derived from the Nova Scotia Property Records
Database (NSPRD), Copyright Province of Nova Scotia.

820677B (REP06) GIS-DA6112 Dec. 10, 2007

Figure 6.11-2

PROPOSED MUNICIPAL ZONING
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES

6.11.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP

Land Use Zoning

According to the West Hants Municipal Planning Strategy (MPS) and Land Use By-Laws, the proposed Project may appear to be inconsistent with existing and future land use in the area. Municipal governments do not have the authority, under the *Municipal Government Act*, to control the locations of mines and quarries in Nova Scotia. This is under provincial jurisdiction. The MPS recognizes the authority of the provincial government over mining matters. The municipality may have the authority to regulate the location of supporting infrastructure (*e.g.*, storage buildings). FG will consult with the Municipality of West Hants with regards to the proposed Project. All mining activities will be conducted in accordance with Industrial Approval.

Land Use

An analysis of the potential effects of the Project on land use must consider those activities that will have an impact on the use and enjoyment of an individual property owner, as well as from a community perspective. It is important to consider compatibility with existing land uses when examining the Project activities, such as blasting operations.

Since the Project involves an extension to the existing mine operation at Miller's Creek, the Project activities already co-exist with current land uses in the surrounding communities.

Blasting operations associated with the proposed mine extension will be strictly regulated. Blasting will be conducted in accordance with the General Blasting Regulations made pursuant to the *Nova Scotia Occupational Health and Safety Act*. A pre-blast survey will be conducted prior to any blasting activities in accordance with the NSEL Procedure of Conducting a Pre-Blast Survey.

There will be no additional processing equipment on the mine extension site. All crushing and processing activities from the proposed Project site will be conducted at the approved existing Miller's Creek site. This will reduce potential dust emissions. In addition, trucks hauling gypsum from the mine extension will travel through the Ferry Road crossing to the Bailey Quarry, therefore further reducing potential dust emissions. Section 6.8 contains additional information on potential air quality issues and Section 6.9 contains additional information on potential noise issues.

Mining naturally competes with other land uses due to the location of available resources. As the Miller's Creek mine extension progresses through development and operational phases, those areas that are no longer needed for gypsum extraction will be reclaimed, reducing the mine's impact footprint. The full extent of the proposed mine extension will not be in operation at any one time.

Agricultural Land Use

The Project is not predicted to have an adverse impact on agricultural practices in the area. Lands within the extent of the Project are not currently used for agriculture and do not interfere with existing agricultural land uses. Agricultural use of adjacent lands may continue throughout the life of the Project. The agricultural activities on the Avon Peninsula have co-existed with mining activities for decades with no significant impacts.

6.11.3 SUMMARY

In summary, assuming that the proposed progressive reclamation and predicted mitigation measures are applied, there are no significant adverse Project-related effects on land use in the area.

6.12 VISUAL ENVIRONMENT

The visual environment has been identified as a VSC for this environmental assessment. The proposed mine extension will result in changes to the landscape, which is a valuable natural scenic area. The landscape is the visual presentation of an area of land. Scenery refers to the aesthetic qualities of the landscape.

Local residents and stakeholders are concerned with the potential negative visual effects associated with the proposed mine and stockpiles. A visual impact assessment provides the extent of potential impacts on the landscape, and thus with scenery.

To address these concerns, CRA completed a visual impact assessment of the proposed development. This assessment is strictly an estimate, given that visual assessment is an individual and subjective experience because it depends on preferences related to social conditioning, personal experience, temperament, sensibilities, and even formal artistic training (Nova Scotia Museum of Natural History 1996).

Figures 6.12-1 to 6.12-8 depict the graphic presentation of the visual impact assessment.

6.12.1 EXISTING ENVIRONMENT

The perimeter of the Avon Peninsula is primarily comprised of agricultural lands, which are predominantly cleared and in grass or pasture, and residences. There are also small areas of row crops, orchards and vineyards present. A mixed forest dominates the rest of the Project area. Many residents living along Avondale, Belmont and Ferry Roads, regard the current viewscape as a valued natural feature adding significantly to the quality of life in the area.

Many residences along these roads are situated in such a manner to take advantage of the scenic viewscapes across the Avon Peninsula. Currently, from the viewing perspective of these named roads, gently rolling hills serve as the background of the undeveloped (non-agricultural) portion of the Project area. FG currently owns or has mining rights through a Non-Mineral Registration to these elevated lands. These viewscapes, as with most viewscapes in Nova Scotia, are not protected by Provincial legislation.

The existing mine, located east of Ferry Road, creates no lasting net effects on the local visual environment. The largest existing stockpile, located southeast of the Belmont and Ferry Road intersection, may impact the visual environment to varying degrees depending on the viewpoint location. Progressive reclamation of the existing mine has reduced the visual impact of new development over time and the existing mine will be reclaimed once mining activity ceases. Revegetation is rapid and progressive reclamation is built into the proposed project as discussed in Section 5.6.3.

Analysis of the existing mine site and a field survey predicted that about 38 civic addressed buildings on the Avon Peninsula (14.7%) may currently experience some degree of visual effect from current mining activities (mine or exposed stockpiles). A projective mapping exercise (inside looking out) was completed to establish the extent to which the proposed stockpiles could potentially affect local viewscapes. This initial projective mapping exercise was completed in order to understand the potential viewscape conditions, and to provide a statement for choosing reflective mapping viewpoints (outside looking in). Figures 6.12-1 to 6.12-3 illustrate the areas from which the stockpiles may be visible.

6.12.2 POTENTIAL EFFECTS, PROPOSED MITIGATION, MONITORING AND FOLLOW-UP

Visual impacts refer to a change in the character and scenic value of the landscape and the effects of those changes on people. The direct visual impacts of any development will affect the landscape through intrusion or obstruction in some manner, the reactions of viewers, and the overall impact on visual amenity (Zhang *et al.* 2000). In the life of a project, many different sources of impact occur at different stages, such as development, operation, decommissioning and restoration. The erosion of scenic value can occur with changes in land use, including rapid or uncontrolled developments (Millward and Allen 1994). FG understands the effects this Project may have on the visual environment and is working to develop the mine in a sustainable manner, which includes protecting the natural visual amenity of the area. The mine and associated stockpiles will be developed gradually (*e.g.* 35 years), in a controlled manner, to reduce the potential for visual impairment effects. The assessment was completed using the full extent of the proposed mine boundaries and stockpiles, with no progressive reclamation or mitigation undertaking.

The visual impact assessment of a proposed development addresses three types of issues: spatial, quantitative and qualitative. Spatial issues include where the development is visible from or, more specifically, what or whom it is visible to; quantitative issues include how much of the development is visible, how much of the surrounding area is affected, and to what degree; and qualitative issues include the visual character of the development and its compatibility with its surroundings (Zhang *et al.* 2000).

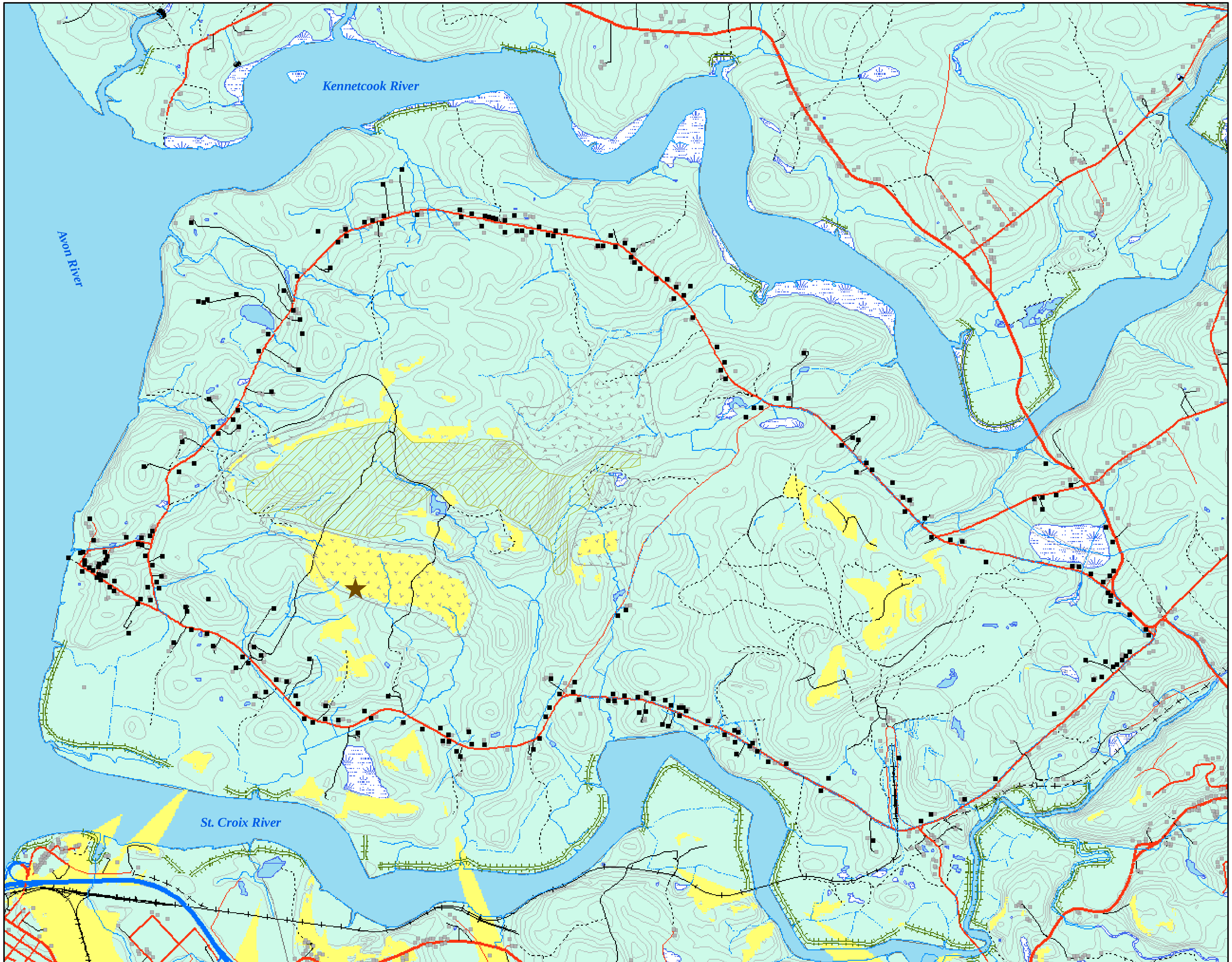
Local residents and stakeholders are concerned over the impact the proposed mine will have on the quality of the scenic views to which they are accustomed. Respondents at the public open house indicated that the stockpiles are a concern with regards to the proposed development.

Presently, there are no guidelines for visual impact assessment in Nova Scotia or in Canada. The Province of British Columbia has created a Visual Impact Assessment Guidebook (Government of British Columbia 2001) as a component of their Forest Practices Code. This guidebook primarily applies to forest harvesting activities and planning and it is not particularly relevant to visual impact assessments of mining or industrial developments.

To address the spatial and quantitative issues with the proposed mine extension, CRA used Geographic Information System (GIS) modeling tool software (ESRI ArcGIS and Spatial Analyst extension) to create reflective mapping of the area. Projective mapping was initiated from viewpoints on the proposed stockpiles (inside looking out) to reveal the potential extent of visibility of the stockpiles to the surroundings, and therefore, inferring from where the stockpiles are potentially visible. Reflective mapping was then conducted from viewpoints in the surrounding landscape (outside looking in) with the objective of determining whether and to what extent the development is visible from its surroundings. The following assumptions were built into the model:

- Removal of all vegetative cover within the proposed mine extension boundaries;
- Forest and vegetative cover remains outside the proposed mine extension boundaries;
- Forest cover and vegetation height is assumed to be as per NSDNR forest data updates 2003 to 2005;
- Complete mine and stockpile development;
- No progressive reclamation of the mine;
- Height of the observer is 1.8 metres (about 6 feet);
- 360 degree observer viewing radius; and
- The top of the proposed stockpiles are flat at 60 masl.

Using these assumptions, the model is intended to be a worst-case scenario, since the mine will be developed in a gradual manner over the Project duration. The mine will develop in a westward direction from Ferry Road and will undergo progressive reclamation throughout its lifetime. The visual impact model assumes the full extent of the Project footprint and represents a larger impacted area than would actually be present at any given time.



Legend

- ★ Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- ■ Civic Addressed (Assessment Area)
- ■ Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

Viewplanes may only see tops of trees and changing heights of tree canopy through growth or logging may alter the predicted effect.

N

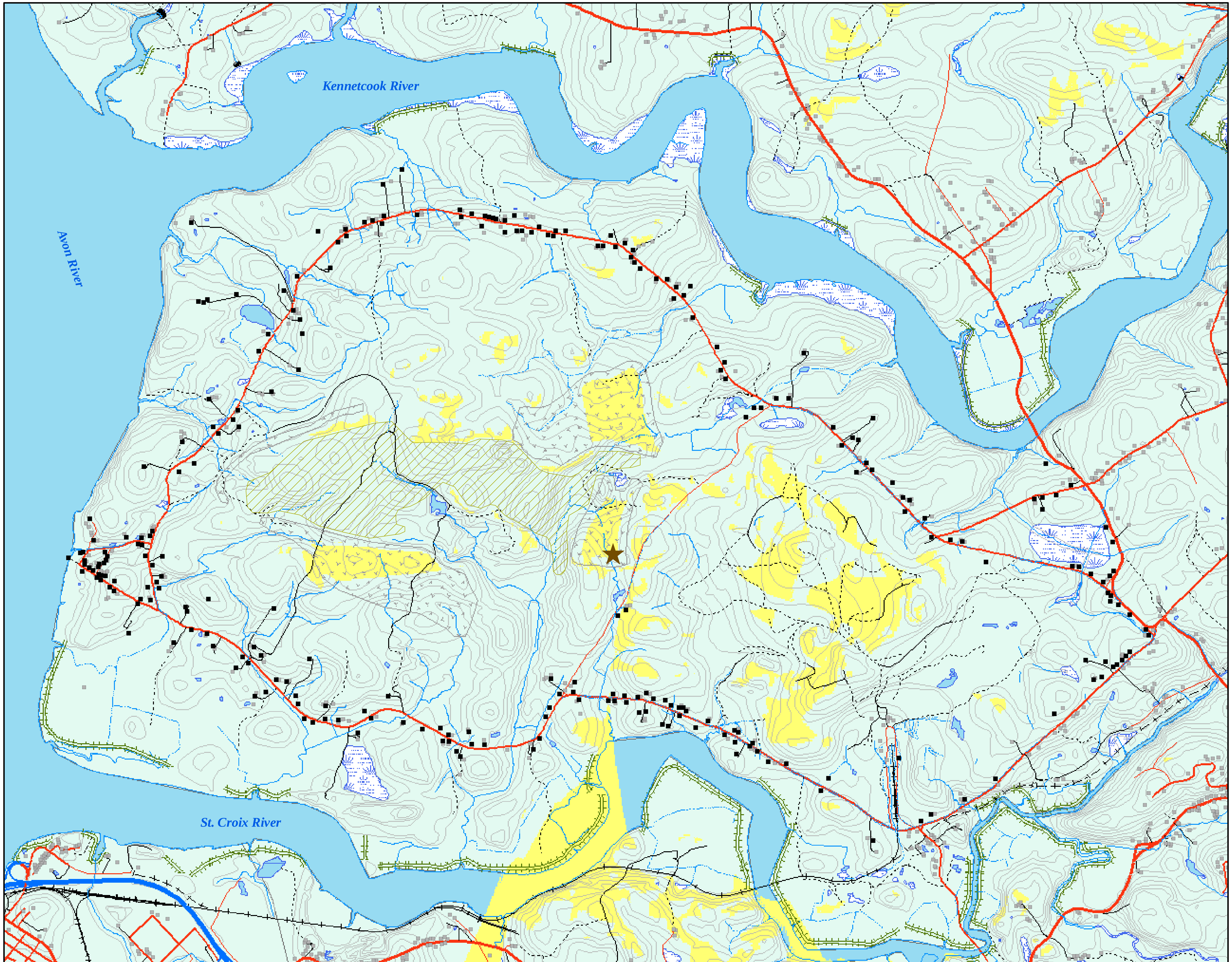
0 0.2 0.4 0.6 0.8 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Topographic Database - SNS&MR
Forestry Database - NS Natural Resources (2003-2005)
Topography (Lidar) - Fundy Gypsum

820677B (REP06) GIS-DA6121 Dec. 10, 2007

Figure 6.12-1
VIEWSHED ANALYSIS
PROPOSED SOUTH STOCKPILE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed (Assessment Area)
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

Viewplanes may only see tops of trees and changing heights of tree canopy through growth or logging may alter the predicted effect.

0 0.2 0.4 0.6 0.8 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6122 Dec. 10, 2007

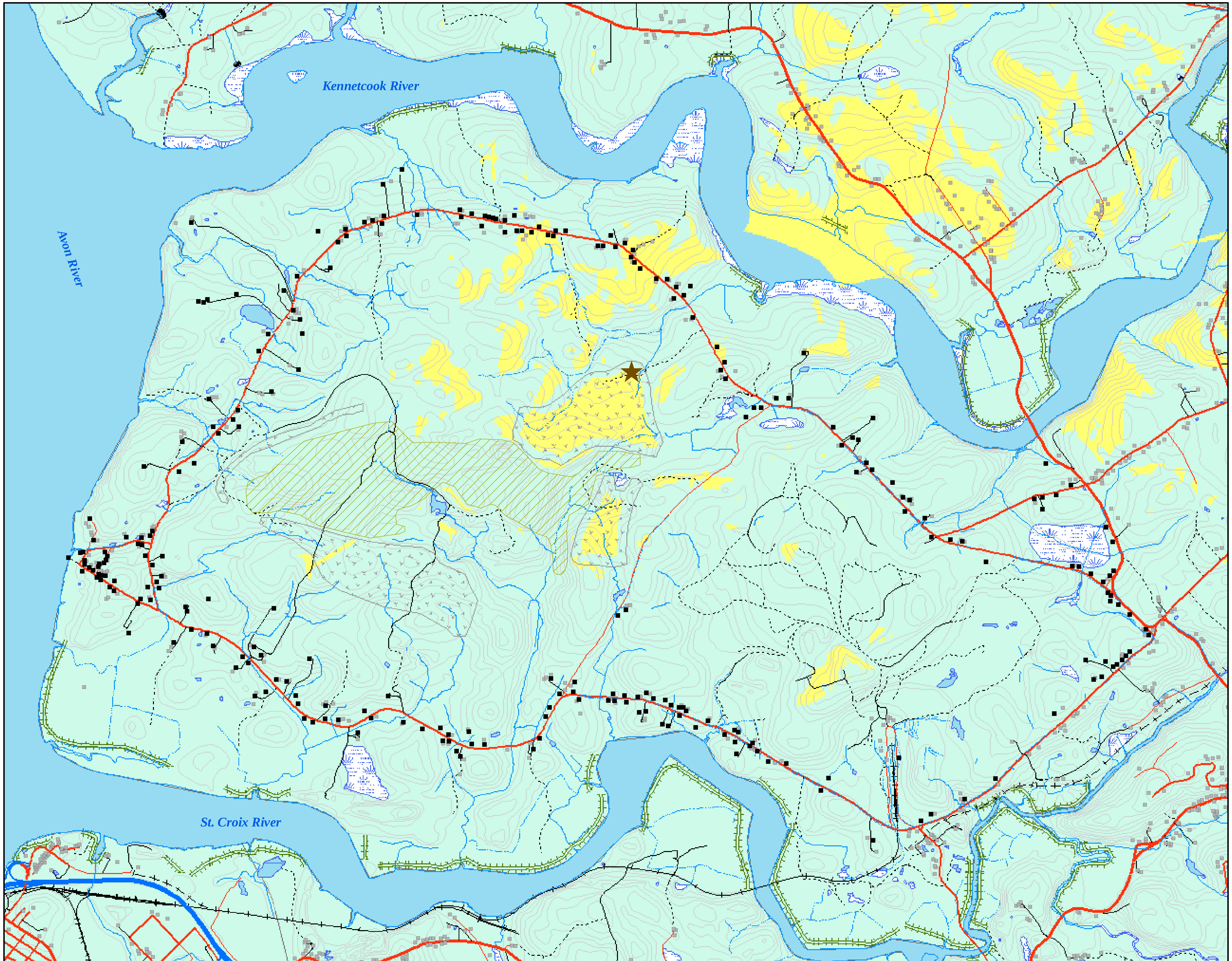
Figure 6.12-2
VIEWSHED ANALYSIS
PROPOSED EAST STOCKPILE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES

The analysis revealed that the residential areas most potentially affected include Centre Burlington, Upper Burlington, Scotch Village, Union Corner, Belmont, Poplar Grove, Avondale, Mantua, Wentworth Creek and Windsor. The yellow shaded areas denote potential areas from which the proposed stockpiles may be visible (Figures 6.12-1 to 6.12-3). While the analysis revealed that these areas are potentially affected, the actual visual effects to those areas will be minimal since most of these areas are located three to six kilometres away from the mine and stockpile locations. It is reasonable to state that with such a distance it does not significantly compromise the visual environment for the observer from those areas.

The communities of Belmont, Avondale and Poplar Grove, on the Avon Peninsula, are within approximately three kilometres of the proposed development and these areas are most likely to experience significant visual effects as a result of the Project. Based on the results of the projective analysis, there are approximately 18 homes in Belmont and six homes in Poplar Grove which could be visible, and likewise, the stockpiles would be visible from these homes. Based on a count of 259 homes/buildings with a civic address on the Avon Peninsula, 9.3% of residences will have at least some view of the stockpiles. As previously noted, the view of the stockpiles is based on worst-case scenario assumptions and may be partially obstructed by existing vegetation, forest cover, and terrain.

This projective mapping exercise (Figures 6.12-1 to 6.12-3) and an on-site survey, aided in determining the appropriate viewpoint locations in the surrounding landscape for a reflective mapping exercise. Reflective mapping was conducted to confirm whether, and to what extent, the stockpiles would be visible from these predetermined locations (Figures 6.12-4 to 6.12-8). Viewpoints were based on residence locations.



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed (Assessment Area)
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

Viewplanes may only see tops of trees and changing heights of tree canopy through growth or logging may alter the predicted effect.

N

0 0.2 0.4 0.6 0.8 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6123 Dec. 10, 2007

Figure 6.12-3
VIEWSHED ANALYSIS
PROPOSED NORTH STOCKPILE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

Figure 6.12-4 predicts the view from a Windsor residence on Colonial Road, north of Highway 101. This viewpoint is about 2.8 kilometers from the nearest proposed stockpile. Small areas of the south stockpile may be visible from this viewpoint. No portion of the mine or the other stockpiles is predicted to be visible from this location.

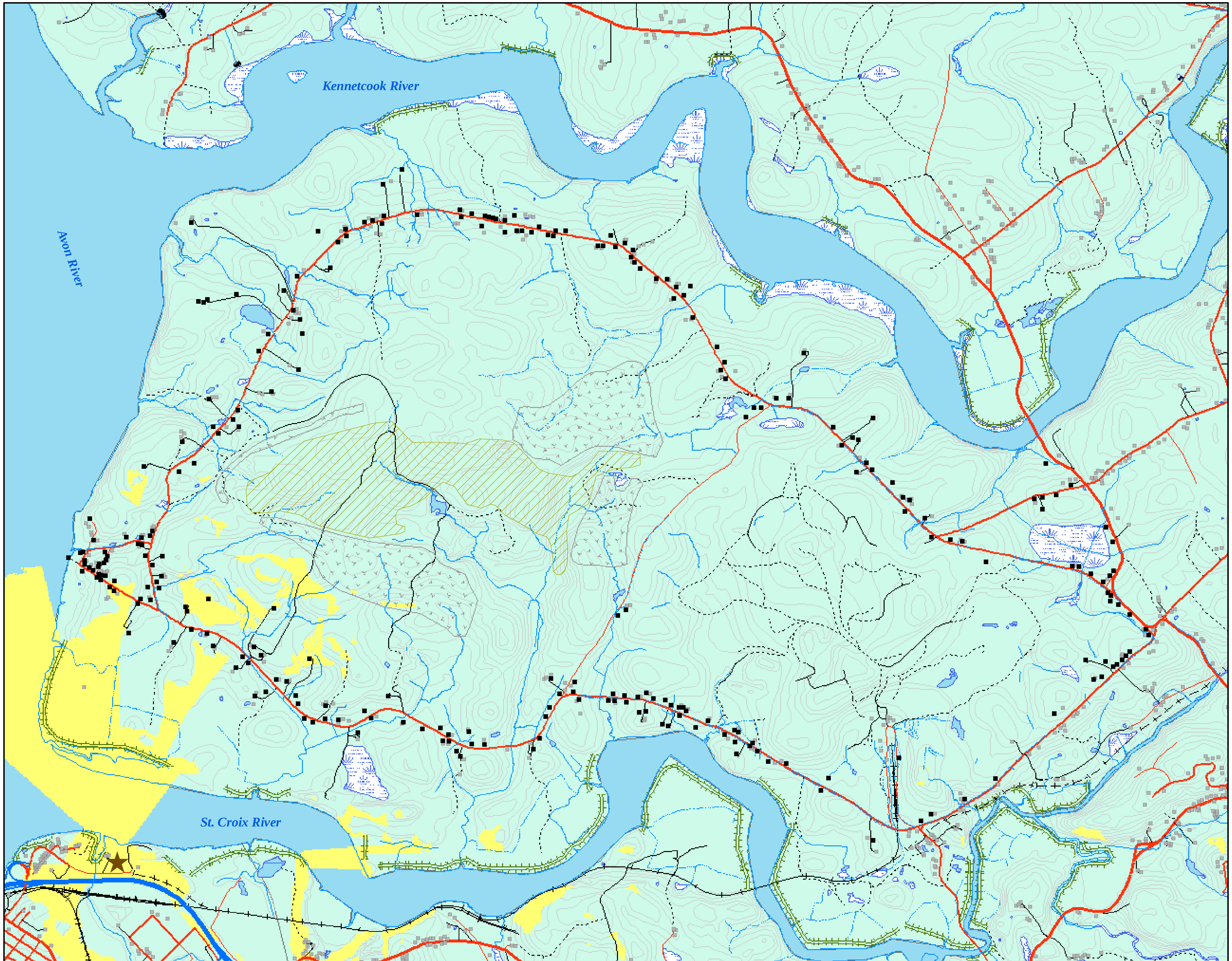
A viewpoint was located at a relatively exposed residence along Wentworth Road, approximately three kilometres southeast of the nearest proposed stockpile location (Figure 6.12-5). This viewpoint was selected due to its higher elevation and was identified during the on-site survey as an area potentially affected through the visual analysis. It is predicted that some portions of each proposed stockpile may be visible. Small portions of the mine may also be visible from this viewpoint. This viewing location is predicted to be the most affected residence with respect to the visual environment given that the sightline across the St. Croix River to the Avon Peninsula yields a rising topography.

Figure 6.12-6 illustrates a viewpoint from Avondale Road south of the proposed site, within 1,000 metres of the proposed project. The model predicts that the face of the south stockpile may be visible.

The viewscape from a residence on a high point on Belmont Road, less than 500 metres west of the site is shown in Figure 6.12-7. This figure predicts that the proposed visual berm is a deterrent to site lines into the mine.

Figure 6.12-8 predicts the view from a residence on Belmont Road, on an elevated location, 750 m from the intersection with Ferry Road and approximately 500 metres from the nearest proposed north stockpile. A small section of the proposed north stockpile may be visible from the selected viewpoint. No portions of the mine or the other stockpiles are predicted to be visible from this location.

Approximately 24 residences on the Avon Peninsula may experience some visibility of one or more of the stockpiles on the proposed project site. The extent of the visibility varies depending on the location of the viewpoint. The largest stockpile located south of the proposed mine is predicted to cause the most impacts regarding the visual environment. The results are based on the worst-case scenario modelling assumptions listed above (*e.g.* no progressive reclamation) and assume no mitigation measures are undertaken. It must be noted that the visual impacts of the proposed mine will occur gradually as the mine is developed over the next 35 to 50 years with the full extent of the mine predicted as shown in the figures (assuming no progressive reclamation and or mitigation measures).



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed Buildings in Assessment Area
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

Viewplanes may only see tops of trees and changing heights of tree canopy through growth or logging may alter the predicted effect.

N

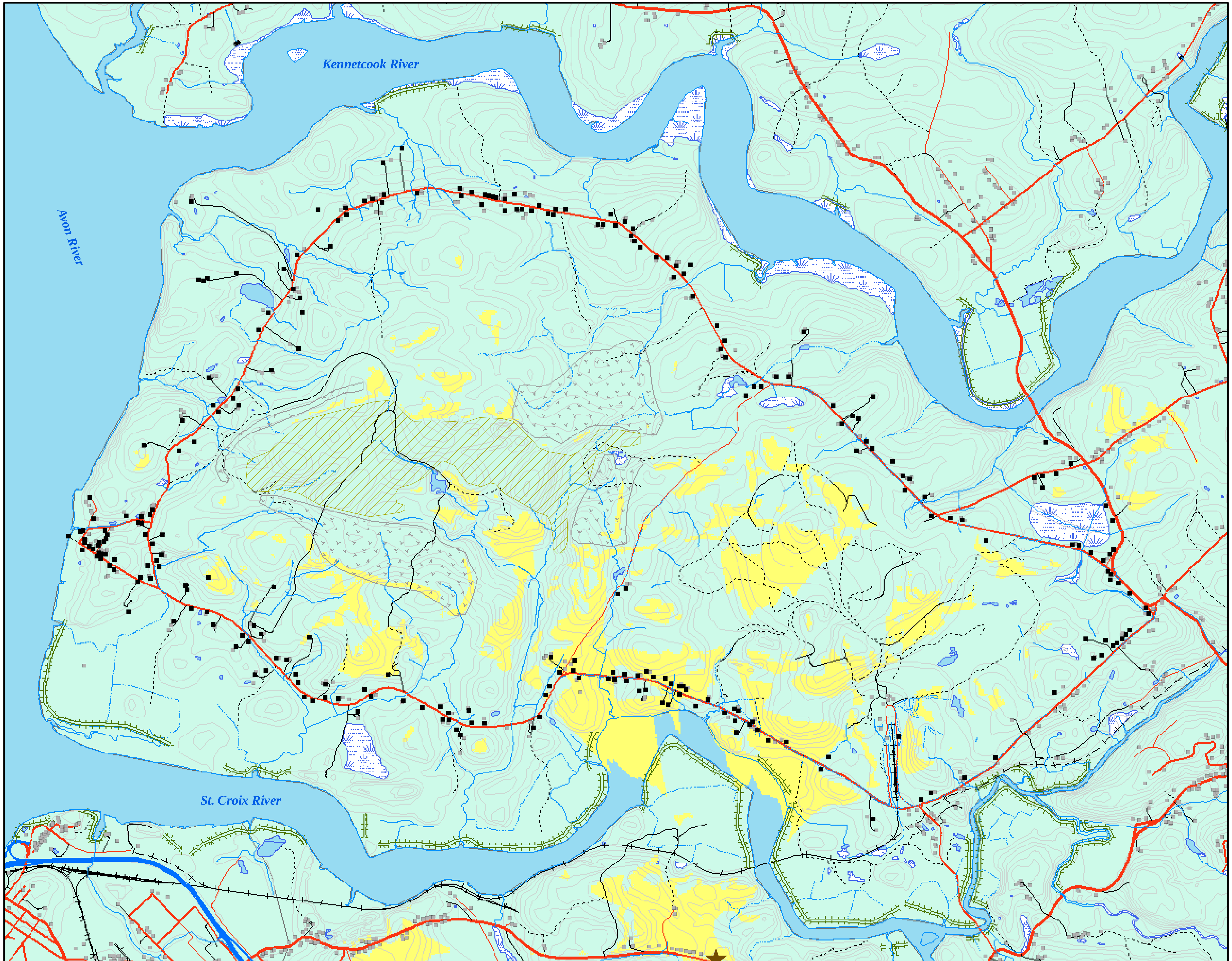
0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6124 Dec. 10, 2007

Figure 6.12-4
VIEWSHED ANALYSIS
159 COLONIAL RD, WINDSOR
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed Buildings in Assessment Area
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

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N

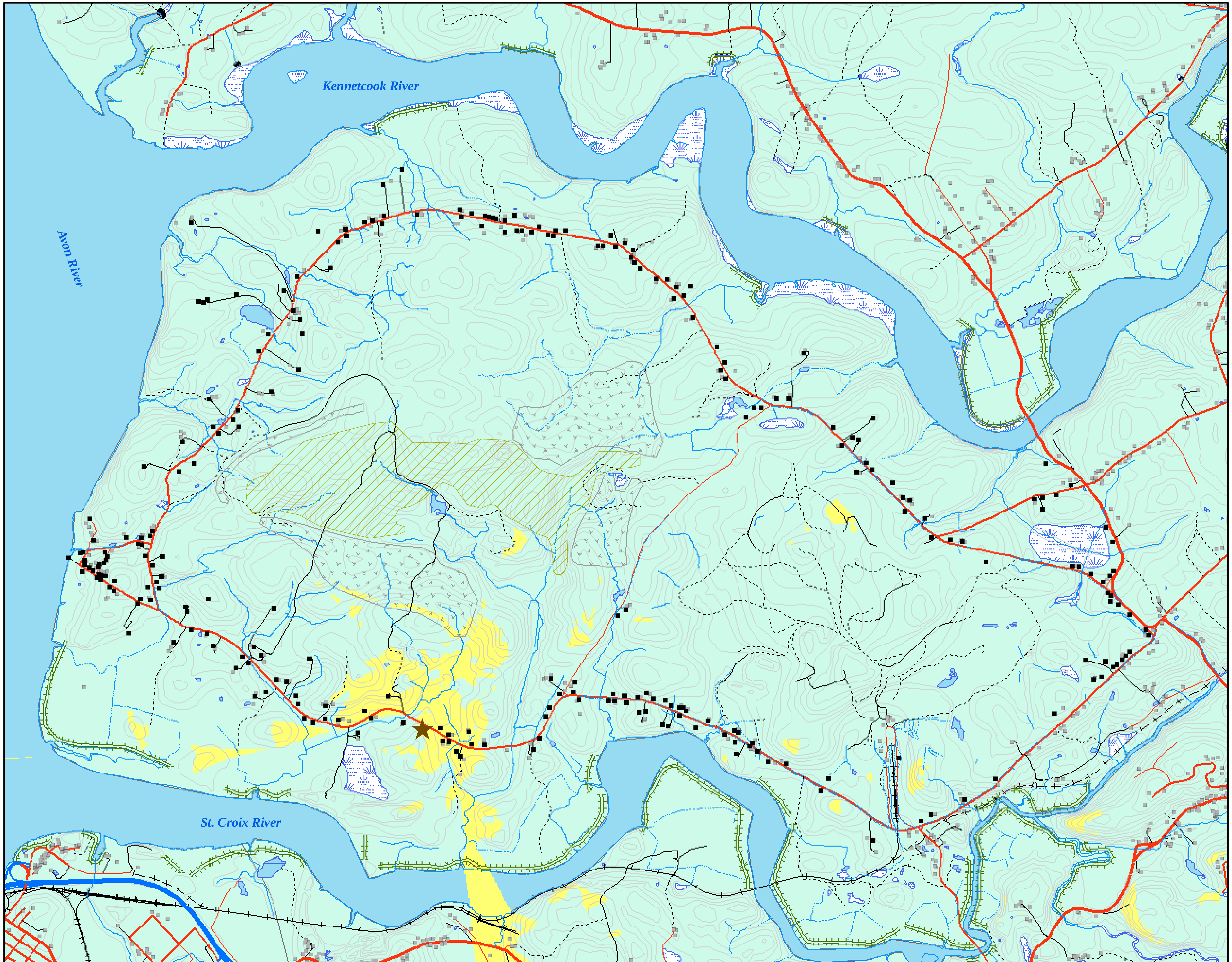
0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6125 Dec. 10, 2007

Figure 6.12-5
VIEWSHED ANALYSIS
1093 WENTWORH RD, SWEETS CORNER
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed Buildings in Assessment Area
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

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N

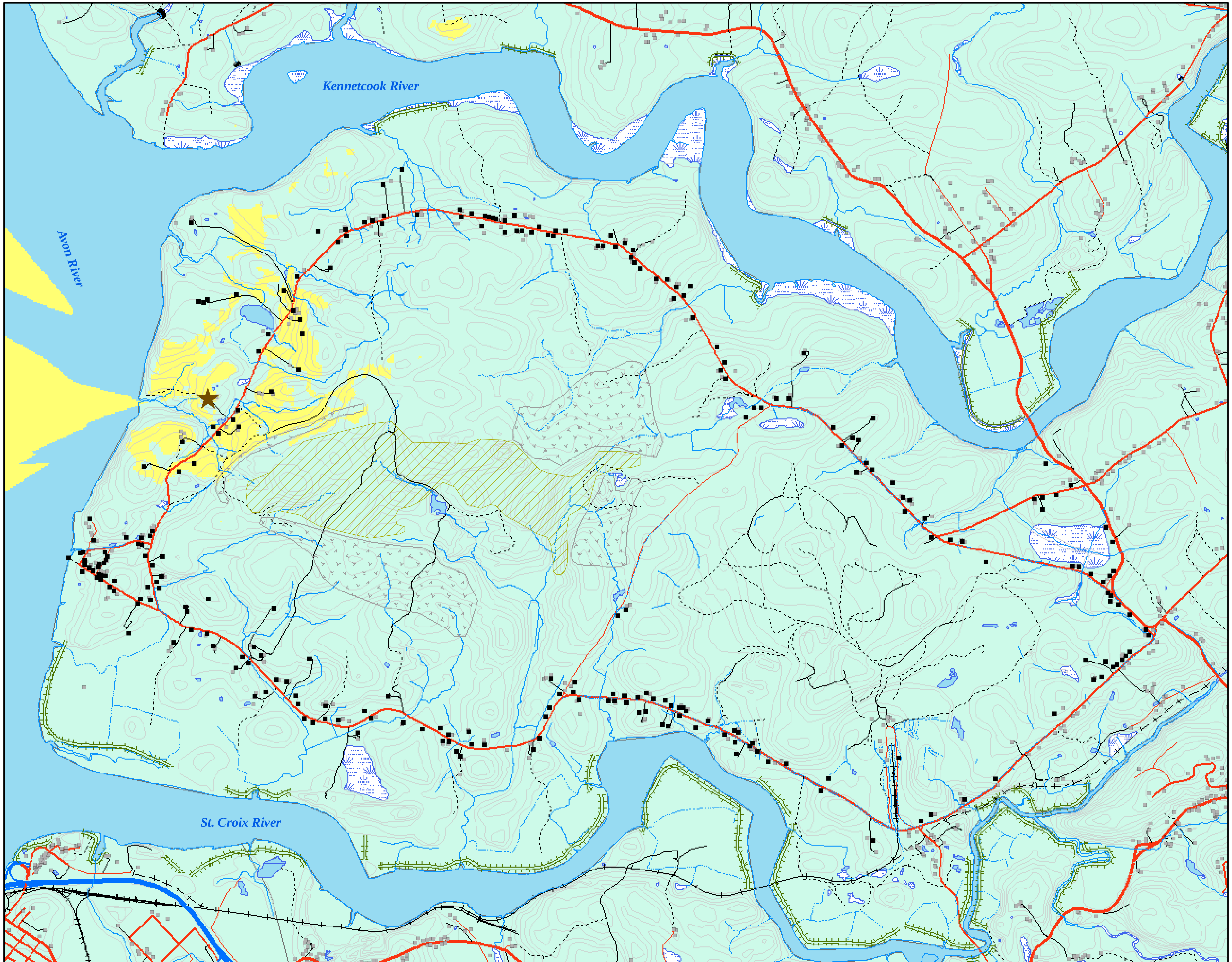
0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6126 Dec. 10, 2007

Figure 6.12-6
VIEWSHED ANALYSIS
696 AVONDALE RD, POPLAR CROVE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed Buildings in Assessment Area
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
- flat 60 m elevation stockpiles.

The visual impact analysis is a snapshot in time based on full mine development with no progressive reclamation and removal of all vegetative cover in the mine area. As the mine and stockpiles are developed and progressively reclaimed views will change.

Viewplanes may only see tops of trees and changing heights of tree canopy through growth or logging may alter the predicted effect.

N

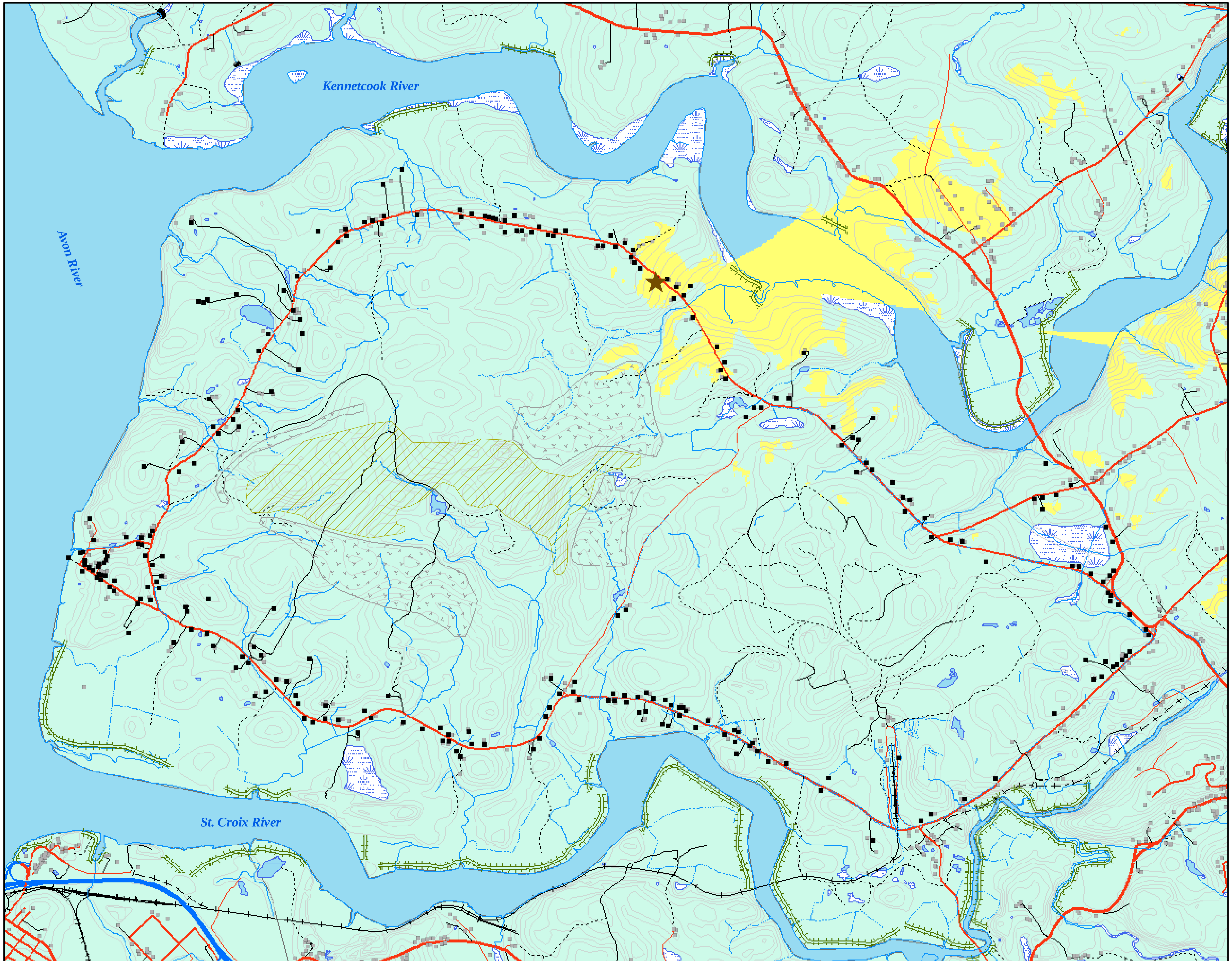
0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6127 Dec. 10, 2007

Figure 6.12-7
VIEWSHED ANALYSIS
381 BELMONT RD, AVONDALE
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES



Legend

- Viewpoint
- Visible Area
- Proposed Stockpile
- Proposed Mine Pit
- Civic Addressed Buildings in Assessment Area
- Other Buildings

The visual impact analysis assumes:
- observer height of 1.8 m (6 ft) and 360° viewing radius.
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N

0 0.25 0.5 0.75 1
Kilometres
1:30,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre
NS Forestry Database - NS Natural Resources
Fundy Gypsum

820677B (REP06) GIS-DA6128 Dec. 10, 2007

Figure 6.12-8
VIEWSHED ANALYSIS
1272 BELMONT RD, BELMONT
Miller's Creek Extension Project
FUNDY GYPSUM
Hants County, Nova Scotia

CONESTOGA-ROVERS
& ASSOCIATES

The primary form of mitigation for effects to the visual environment will be the implementation of a progressive rehabilitation plan, which will include re-contouring of spoil piles and mine faces, and re-vegetation of areas no longer required for mining activities. In addition, FG will maintain the undeveloped forested lands between the stockpiles and the surrounding residences as a visual buffer zone for the duration of the mine extension project.

FG will also investigate the feasibility of planting tall tree species such as, but not limited to, the large-tooth aspen, trembling aspen and/or yellow birch, adjacent to the stockpiles to further screen them from view.

6.12.3 SUMMARY

In summary, the proposed extension to the Miller's Creek mine may result in some non-significant adverse environmental effects on the visual environment. These effects are not considered to be significant or of a great detriment to the scenic quality of the Avon Peninsula, particularly given that the mine will be developed gradually over a long period of time (*e.g.* 35-50 years) and that the mine will undergo progressive reclamation during its life span. A relatively small portion (*e.g.* approximately 9.3%) of civic addressed buildings on the Avon Peninsula may experience some degree of visual effects as a result of the proposed mine extension, assuming no progressive reclamation or mitigation measures. Cumulatively, there are approximately 19.3% of the civic addressed buildings on the Avon Peninsula that may experience some visual effects by the combination of the existing stockpile and the proposed additional stockpiles for the mine extension. This cumulative effect results in a 4.6% increase in potential visual effects on the Avon Peninsula as compared to the existing mine (14.6%). Residents located south of the St. Croix River are likely to experience the greatest extent of visual effects because of their elevated viewpoint as a result of the proposed project. As discussed above, mitigative measures such as progressive reclamation and maintenance of undeveloped buffer lands will reduce visual impacts.

6.13 TRANSPORTATION

The development and operation of the site will have no change on existing traffic patterns, volumes or road configurations. Employee access to the site will be via a transportation corridor from the existing operation, across Ferry Road at a level crossing and into the extension area. Suppliers and site visitors will be required to visit the Main Office at the existing operation before accessing the extension site and therefore will use the same route as the site employees. Some site work such as surveying or environmental monitoring would access the extension site from the closest or most convenient location along existing roads but this represents a very limited traffic volume and one that currently exists.

6.14 RECREATION AND TOURISM

Recreation and tourism has been identified as a VSC because they provide important lifestyle and economic benefits to communities throughout Nova Scotia. Essential to the environmental assessment process is to determine the impact that the proposed Project will have on recreation and tourism on the Avon Peninsula.

6.14.1 EXISTING ENVIRONMENT

Anecdotal information suggests that the proposed mine extension site, although mainly privately owned land, is currently utilized by residents and non-residents. Uses such as nature/recreation walks and hikes in the mixed forest, as well as some ATV usage occur on a year-round basis. No sport facilities or community centres are located in the immediate Project area; however, the Belmont Community Hall is located outside the Project site along the west side of the peninsula.

In addition, recreational hunting and fishing regularly occur in the area. Moose hunting is not permitted by NSDNR in Mainland Nova Scotia, however, deer hunting is allowed. The general open deer hunting season extends from the last Friday in October to and including the first Saturday in December (excluding Sundays). The Miller's Creek Mine extension is situated in the provincial Deer Management Zone 4, which allocates 2,000 antlerless deer stamps for the area (NSDNR 2007). Zone 4 is the largest deer hunting zone and currently allocates the greatest number of stamps to hunters. Recreational hunting and fishing occur locally but the extent to which the area is used is not documented and thought to be limited due to safety concerns with residential dwellings in close proximity.

Tourists may frequent specific destinations in the area surrounding the Project site as both the Fundy Shore Ecotour and the Glooscap Trail describe the Avon River Heritage Society Museum and the Avon Spirit Shipyard as points of interest. The museum and shipyard strive to re-capture the art of shipbuilding that once dominated the coastal region. The museum operates in the summer months only. These tourist features are located outside the Project area.

There are no designated parks within or surrounding the Project area.

6.14.2 POTENTIAL EFFECTS, PROPOSED MITIGATION AND FOLLOW-UP

The Miller's Creek mine extension Project is not likely to have a significant impact on hunting and recreational fishing in the general area. The mine extension is situated in a hunting management zone, but the Project is not located on Crown land, and hunters will therefore require permission from local landowners to engage in hunting activities in the area.

The Project is located outside the tourist features of the area and will therefore not significantly impact the tourist industry in the local area.

6.15 ARCHAEOLOGICAL AND CULTURAL RESOURCES

6.15.1 EXISTING ENVIRONMENT

Archeological Resources

An archaeological impact assessment of the proposed Miller's Creek Mine Extension was conducted by Cultural Resource Management (CRM) Group Limited under Heritage Research Permit A2006NS14 (Appendix H.1), to locate and identify archaeological resources within the proposed impact area, and to offer resource management recommendations. The assessment built upon an earlier archaeological screening prepared by CRM Group which identified areas of archaeological interest within the potential footprint of the mine. The archaeological screening and impact assessment identified a variety of archaeological features, including eight historic quarries or quarry complexes, four historic cabin sites, an Aboriginal isolated find spot and a network of historic trails and railway lines.

Historical Background Research

The land within the Miller's Creek Mine Extension study area was once part of the greater Mi'kmaq territory known as Pisiquid. Historical maps situate the principal Mi'kmaq settlement at the confluence of the Avon and St. Croix rivers - today the location of the town of Windsor, approximately two kilometres from the southern edge of the study area. The closest registered Native archaeological site (BfDa-1) is located to the southeast along the banks of the St. Croix River. Despite the proximity of this known Mi'kmaq archaeological site, the study area, which is set back from the Kennetcook, Avon and St. Croix rivers by a distance of at least one kilometre, is considered to have relatively low potential for Native archaeological resources, either Precontact or Historic. Reconnaissance in the western portion of the study area recovered a quartz biface in the gravel bed of the brook, yet a thorough visual reconnaissance of the surrounding area, failed to locate any further artifacts or any topographic features that were considered to have high archaeological potential.

French settlers began to arrive in the area in the late seventeenth century. Pisiquid quickly became a principal centre of Acadian settlement and agriculture and by the mid-eighteenth century, there was extensive Acadian settlement around the perimeter of the study area. Following the expulsion of the Acadians in 1755, the area was quickly resettled by Planter families, the first of whom arrived from Rhode Island in the spring of 1760.

The gypsum industry in the Avondale area evidently began soon after the arrival of the Planters, who commonly used gypsum as fertilizer. The first quarries would have been small-scale operations, privately owned by local farmers or leased to others as a source of extra income. By the beginning of the nineteenth century, these small quarries began to expand, providing employment for local residents. By the late nineteenth century, the gypsum quarries began to consolidate into the hands of a small group of companies. The Newport Plaster Mining and Manufacturing Company (NPMMC) was established by J.B. King around the turn of the century and by 1906 had begun purchasing gypsum in Avondale. In 1907, King acquired the shipyard in Newport Landing and in 1908 purchased a 5 acre lot in Avondale, the site of the first NPMMC quarry. The NPMMC ceased operations at Avondale in 1920, when the company was hit by a general strike and the business was transferred to the Wentworth facilities on the St. Croix River.

Field reconnaissance identified a significant number of cultural features. The study area has a long history of industrial use and many of the features identified by the field team represent elements of that history.

Shaw Plaster Quarry

The Shaw Plaster Quarry, located in the southeast portion of the study area was owned and operated by the Shaw family, who were among the first wave of New England Planters to settle in the area in 1760. While the age of the Shaw Quarry has not been established, it represents one of the oldest quarries in the study area. Historical documents dating to 1818 refer to “Mr. Shaw’s Quarry”, an existing “Plaster Road”, and “shipping” facilities, clearly indicating that the quarry was already in operation by that time. It is likely that local men were employed in the Shaw operations and there may have been facilities, such as a cook shanty and temporary housing for the workers, constructed near the quarry. Charles Shaw sold the mineral rights to the northern portion of the property, including the quarry, to the J.B. King Company in 1906. It is not known if the J.B. King Company ever actively mined this portion of the study area.

Haliburton/Bennet Quarry

The Haliburton/Bennet Quarry is located just northwest of the Shaw Plaster Quarry. Thomas Chandler Haliburton, perhaps best known for his contribution to Canadian literature, was also actively involved in the early development of the gypsum industry in Nova Scotia. He owned, leased and operated several gypsum quarries in Hants County and acquired the mining rights to the Haliburton/Bennet Quarry in 1818. Historical documents suggest the presence of buildings associated with, and in the vicinity of, the Haliburton Quarry. Haliburton released his rights to the quarry to William Bennet in 1830.

Newport Plaster Mining and Manufacturing Company Cookhouse

By 1912, the NPMMC had expanded both its holdings and operations. The construction of a large wharf and narrow gauge railway system increased the productivity and facilitated the extension of the NPMMC operations. The large quarry, commonly referred to as the "Upper Quarry", represents the main NPMMC operations and was connected to the railway line, which ran southwest from the quarry to the former Kings Wharf in Avondale. Local residents made mention of a cook shanty associated with the NPMMC located between the Upper Quarry and the Dump Pond. The field team identified a feature in this general area which could be the remains of the reported structure. This feature was identified during borehole reconnaissance and as such has not yet been subjected to subsurface testing.

'W.K.'

During the archaeological screening of the study area, the notation 'W.K.' was identified on the 1871 "Topographical Township Map of Hants County, Nova Scotia", published by Ambrose Church. Based on the historic map, the feature was located in the southwestern portion of the study area, situated adjacent to a north-south oriented road into the study area from the Avondale Road. The W.K. initials have been tentatively identified as W. Knowles, who also owned property on the southern side of the Avondale Road. The 'W.K.' feature was not identified during field reconnaissance.

6.15.2 ARCHAEOLOGICAL TESTING

During the initial site reconnaissance, conducted in August of 2005, in conjunction with the archaeological screening, a number of potential features were identified. These features were subjected to archaeological testing in the summer of 2006.

Feature 2

Feature 2 was a rectangular depression surrounded by a mound approximately 10 metres west of the Old Plaster Road. Testing included shovel tests excavated at five metre intervals on all dry ground around Feature 2. Testing also included a 50 centimetre by 3 metre trench excavated through the centre of Feature 2. Artifacts were recovered from 4 of the 50 test pits and from the test unit within the feature. The artifacts reflect a post-1820 domestic context. Feature 2 may be a structure associated with the Haliburton/Bennet Quarry as it is located just northeast of the proposed mine extension, on the western side of the Old Plaster Road. Although no structural remains were encountered in the testing, 22% of the artifact assemblage consisted of architectural remnants, such as nails and shards of window glass, indicating that there was likely a structure in the area.

Haliburton Road Site 1

Field reconnaissance identified an artifact scatter on the ground surface at the junction of the original Haliburton Road and a modern offshoot which leads to the west side of the Dump Pond. A total of 48 artifacts were recovered during the reconnaissance. The surface assemblage reflects an early to mid-nineteenth century context. A baseline was established along an east-west aligned portion of the original Haliburton Road. Subsequently all relatively flat land in the area was subjected to shovel tests at five metre intervals. Of the 61 shovel tests excavated, four yielded artifacts which reflected a c. 1830's occupation. While no structural remains were encountered, a linear concentration of stones visible on the ground surface may represent an archaeological feature.

Mi'kmaq Land and Resource Use

There are no Indian Reserves located within the current site study area, however, there are two reserves located within approximately 12 kms of the project area. The closest reserve is Horton IR 35, controlled by Glooscap First Nation, at a distance of approximately 12 km to the southwest. The St. Croix Indian Reserve # 34 is located at the north end of Panuke Lake, approximately 12 km south of the project area. Annapolis Valley First Nation controls the St. Croix reserve.

A Mi'kmaq Knowledge Study (MKS) has been prepared by The Confederacy of Mainland Mi'kmaq which is provided in Appendix H.2. The MKS includes:

1) A study of historic and current Mi'kmaq land and resource use;

2) An evaluation of the potential impacts of the Project on Mi'kmaq use and occupation and constitutionally based rights;
3) An evaluation of the significance of the potential impacts of the Project on Mi'kmaq use and occupation; and
4) Recommendations to proponents and regulators that may include recommendations for mitigation measures, further study, or consultation with Mi'kmaq.

The study area for current Mi'kmaq land and resource use sites is a five kilometre area surrounding the Fundy Gypsum property boundary. Two plant study areas were chosen within the Fundy Gypsum property boundary. Plants were surveyed in the fall of 2005 and the spring of 2006. The areas were chosen based on access and representative habitat types. Both study areas are located within the Fundy Gypsum property boundary. Plant Study Area 1 has a total area of 68 hectares. Plant Study Area 2 has a total area of 92 hectares. The study area for Mi'kmaq communities is a five kilometre area surrounding the Fundy Gypsum property boundary.

The historic land and resource use study area is in the Mi'kmaq district of Segepenegatig and encompasses the area of Minas Basin and its river system, particularly the Avon and Kennetcook rivers, and the surrounding lands. Mi'kmaq traditional use of the land in Nova Scotia involved semi-permanent and permanent settlements. Summer villages of the Mi'kmaq were usually located on the banks of streams or rivers. The most important factor in the choice of a site was the proximity of the site to a navigable body of water. Sites around the mouths of rivers with heavy spawning runs were highly favourable for use, as well as smaller rivers running back into a system of lakes. It is therefore likely that the Mi'kmaq settled in the study area, which exhibits these types of natural features.

Two known archaeological sites are located within the study area. Site BfDa-1, known as the St. Croix Site, runs along the east bank of the St. Croix River from the St. Croix Bridge for a distance of approximately 560 m. The site is on the flat bank just behind the original riverbank. Much of it is now under lawns, houses and gardens. Both Ceramic and Archaic Period artifacts are represented. Flakes, stone tools, and large amounts of prehistoric pots were found at this site.

Site BfDa-02 is a Contact Period site near Windsor where an iron hatchet was found. Site BfDb-03 is located along the southwest branch of the Avon River, about 10 km northeast of the Avon River proper near Upper Falmouth. This was an isolated find of ground slate from the Archaic Period.

Current Mi'kmaq Land and Resource Use:

- Fishing activity is concentrated north of the project area in the Kennetcook River. Trapping occurred to the east of the project area.

- Burial Sites are not located within the project footprint.

Plants of significance to Mi'kmaq in the study area are divided into three categories:

1) Medicinal,
2) Food/Beverage, and
3) Craft/Art.

Plant Study Area 1 is comprised of farmland, active select cuts, and areas of clear-cut in various stages of regeneration. Plant Study Area 2 is comprised predominantly of mixed forest habitat. Plant Study Area 2 contained the largest concentration of specimens. Specimens were scattered throughout plant Study Area 1. A substantial population of a rare medicinal plant has been identified surrounding the Dump Pond, feeding into Shaw Brook.

6.15.3 POTENTIAL EFFECTS, PROPOSED MITIGATION, AND FOLLOW-UP MONITORING

As the actual footprint of the mine was refined, it was determined that extension of the mine would impact only five of the eight quarries, two of the historic cabin sites and portions of the trail and rail network (Figure 6.15-1). The remainder of the mine footprint is considered to have low archaeological potential.

Based on the results of the archaeological assessment and the refined mine footprint, CRM Group offered the following management recommendations for the study area:

1. It is recommended that the Old Plaster Road site (Feature 2) and the Haliburton Road Site (Feature 1) be subjected to further archaeological testing and, if warranted, archaeological excavation to mitigate the impacts of development related impacts.

2. It is recommended that archaeological testing be conducted at the site of the possible NPMMC Cookhouse to assess the age, function and integrity of the feature.

3. It is recommended that further archaeological reconnaissance and testing be conducted in the area of the potential feature identified as 'W.K' on historic maps.

4. It is recommended that, if possible, the Shaw Plaster Quarry and the Haliburton (Old Bennett's) Quarry be set aside for future interpretation. The quarries are historically significant and were important in the development of the local community.

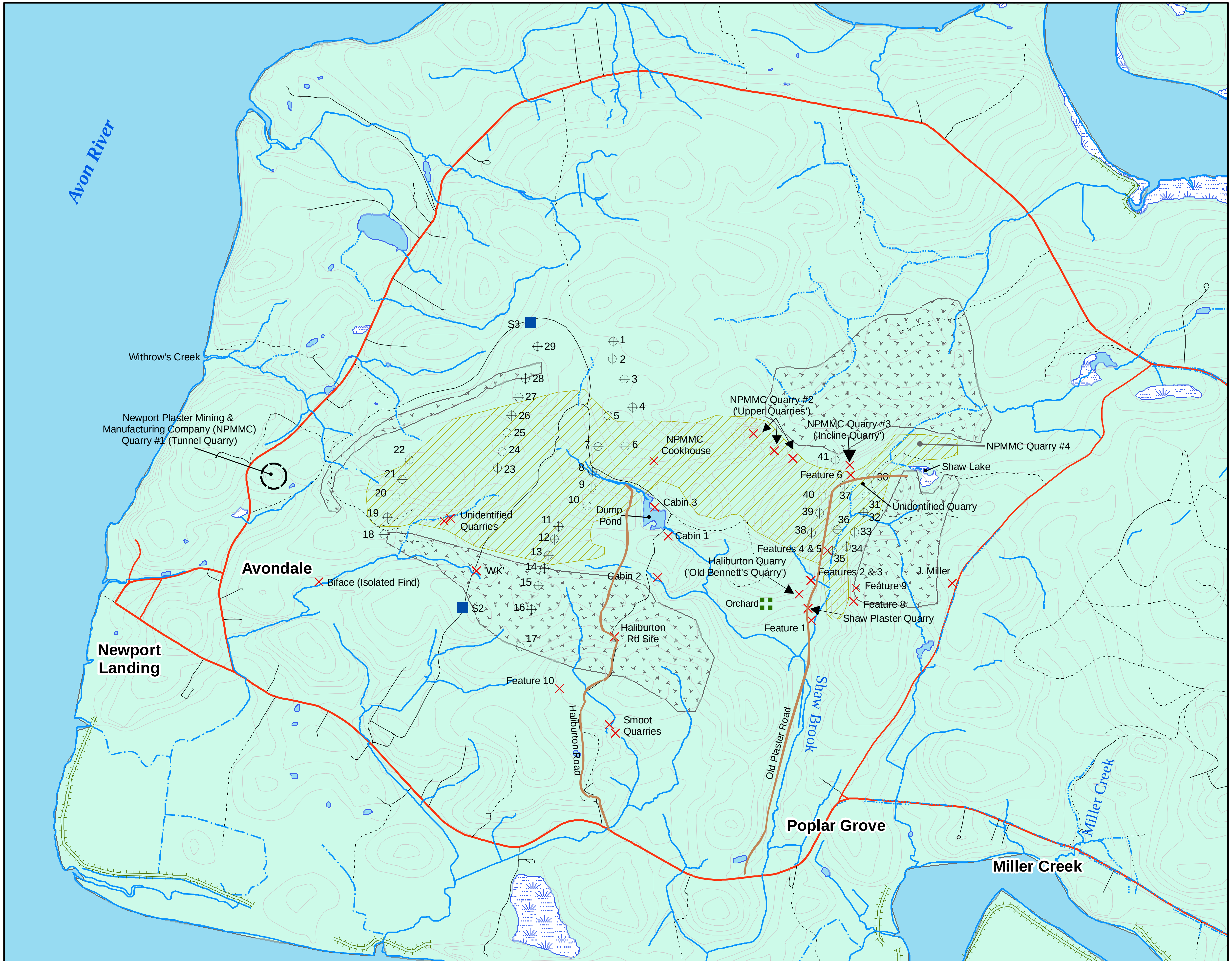
5. It is recommended that detailed documentation be conducted of all features, including quarries, historic trails and the rail line, likely to be impacted by development. Documentation should include video, photography and surveyed plans.

6. It is recommended that caution be taken when using existing historical trails, such as the Old Plaster Road, so as to ensure minimal impact.

The historic review of Mi'kmaq use and occupation documents considerable historic Mi'kmaq use and occupation in the study area, and potentially the project area. A potential impact of the project is the disturbance of archaeological resources. Mi'kmaq archaeological resources are extremely important to Mi'kmaq as a method of determining Mi'kmaq use and occupation of Mi'kma'ki and as an enduring record of the Mi'kmaq nation and culture across the centuries. Archaeological resources are irreplaceable. Any disturbance of Mi'kmaq archaeological resources is significant. In the event that Mi'kmaw archaeological deposits are encountered during development or operation of the Project, all work should be halted and immediate contact should be made with David Christianson at the Nova Scotia Museum and with Donald M. Julien at The Confederacy of Mainland Mi'kmaq.

The permanent loss of a substantial population of the rare medicinal plant surrounding the Dump Pond area is a potential impact of the project. The rare medicinal plant species found within the Dump Pond area, feeding into Shaw Brook, is not commonly accessible throughout Nova Scotia, and is not commonly found in such concentrations; the population is therefore judged to be a significant population of the species. Disturbance of the sensitive area containing the rare medicinal plant species should be avoided during clearing/development.

The rare medicinal plants discussed here and in the MKS are all located within the proposed conservation area.



Legend

Feature

- Features (GPS Located)
- Borehole
- Hydro test Location
- Orchard
- Proposed Mine Pit
- Proposed Stockpiles

N

0 0.1 0.2 0.3 0.4 0.5
Kilometres
1:20,000
UTM Zone 20N NAD83

Source: Nova Scotia Topographic Database
SNS&MR - NS Geomatics Centre

Fundy Gypsum

Features identified during August 2006 Reconnaissance
Cultural Resource
Management Group Ltd.

CRM Group

820677B (REP06) GIS-DA6151 Jan 30, 2008

Figure 6.15-1
ARCHAEOLOGICAL ASSESSMENT
Miller's Creek Extension Project
FUNDY GYPSUM

Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

6.15.4 SUMMARY

FG recognizes the historical aspects of the Avondale area and commits to completion of the recommendations should they be included as Conditions of the Environmental Assessment Approval or Industrial Approval. FG recognizes that the local area has created historical tourism themed infrastructure and promotional materials and sees the extensive work completed for this EA as contributing greatly to the documented history and understanding of the local area.

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