HIGHWAY 113
ENVIRONMENTAL ASSESSMENT REGISTRATION

PROJECT: ES-99-002

FINAL REPORT

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FINAL REPORT

Submitted To:

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EXECUTIVE SUMMARY

The Nova Scotia Department of Transportation & Public Works (TPW) is proposing the construction and operation of a four-lane, controlled access highway (Highway 113) connecting Highway 102, near Exit 3 (Hammonds Plains), and Highway 103, just west of Exit 4 (Sheldrake Lake). The highway will be 9.9 kilometres in length and is therefore deemed to be a Class I undertaking as defined by "Schedule A" of the ***Environmental Assessment Regulations*** made under the ***Environment Act*** (1995).

The purpose of the proposed Highway is to provide a more efficient means of travel for motorists between Highway 103 and Highway 102, that bypasses the Halifax urban core. The proposed Project is part of an overall TPW strategy that addresses the transportation needs of the province and the local community. In addition, the proposed highway will alleviate much of the current traffic congestion experienced on Hammonds Plains Road.

It is important to identify and preserve a corridor for Highway 113, although TPW does not expect to begin construction of the highway for 10 to 15 years. Residential development is occurring at an increasingly fast pace in the areas of Sheldrake Heights, Kingswood, Kingswood South, and Kearney Lake Road. Continued development in these areas will result in a case where a highway corridor can not be acquired, without significant property disruption and prohibitive cost.

Assuming environmental approvals in mid-2000, the earliest possible date to begin Project construction is Spring, 2002. Nonetheless, construction will likely be phased over the next 10 to 15 years, based on available funding and priority among other TPW initiatives.

This report presents the results of an environmental assessment conducted to assess the concerns associated with the construction and operation of the proposed highway.

The determination of the environmental effects associated with the proposed highway was conducted by teams of specialists representing various disciplines. The teams included specialists in civil engineering, urban and rural planning, transportation engineering, groundwater assessment, geological modelling, hydrogeology, wildlife biology, botany, fisheries biology and habitat assessment, and heritage resources.

The technique of Beanlands and Duinker (1983) was employed in the review to assist in the design and conduct of the assessment. This approach emphasizes the use of "Valued Environmental Components" (VECs) as the focal points for impact assessment.

Two approaches were taken to identify the VECs. The first involved the identification of those parameters for which provincial or federal regulations are in place. The second approach used for the identification of VECs involved a scoping exercise based on experience gained during other comparable impact assessments, supplemented by available information on the environment surrounding the proposed highway route.

In certain instances, specific background information was not available at the required level of detail, and field work was conducted to address data deficiencies.

VECs identified during the study included the following: human health and safety; air quality; large mammals; herpetiles, birds, plants and vegetative communities; environmentally sensitive areas; sensitive and critical habitat; groundwater; shallow bedrock; erodible soils; brook trout and gaspereau; fish habitat; ongoing management activities; surface water quality; hydrology/flood plains; hydrogeology; property development; public services; visual resources; forestry resources; woodlot management; and recreational activities.

Regulated or recommended allowance levels for deviation from the background environment were used as a basis against which to measure the significance of impacts. For instance, any drainage streams with potential to exceed guideline or regulated values were judged to have significant impact and appropriate mitigation measures were included in the report.

Any deviation from the background was also judged to be significant where it was predicted that the changes would cause a significant change in a process or state within the bounded area, resulting in a sustained depression of fitness or density below the naturally occurring levels. Where such changes were predicted, mitigation and monitoring have been recommended.

The impacts analysis has shown that the project will provide an increased level of relatively safe and free flowing direct access, by 100-series highway, between Highway 102 and 103. Local traffic in the Hammonds Plains Road area will experience less congestion resulting in greater commuter and pedestrian safety. Other benefits of the project include reduced travel time, an increase in local employment, local commercial activity through the construction period, an increase in commercial property values near proposed intersections and interchanges, increased access to backlands, and reduced vehicle emissions.

Predicted negative impacts associated with the project include a loss of terrestrial and wetland habitat in the area occupied by the highway and interference with land development and forestry operations.

Other impacts may be experienced by biophysical and socioeconomic components of the environment, however, those impacts have been determined to be insignificant in the context of causing a sustained depression or an impact in excess of legislation or guidelines. A summary of the impacts is provided in Table 1.

These predictions are contingent on proper implementation of the mitigative measures. If mitigative measures are improperly addressed during the construction and operation phases of the project, contingency plans will have to be enacted.

A detailed monitoring program will be defined in the Environmental Management Plan (EMP) which will be developed during the detailed design phase of the project. The EMP will include an Environmental Protection Plan (EPP), a detailed monitoring program, and a contingency plan which will be put in place based on the results of the monitoring program.

TABLE 1
Summary of Predicted Impacts

Negative Predicted Impact	No Predicted Impact	Positive Predicted Impact
Loss of Terrestrial Habitat	Air Quality	Economic Activity
Loss of Wetland Habitat	Noise	Commercial Property Value
Land Development	Wildlife	Transportation
Forestry Operations	Rare & Endangered Species	Improved access to Backlands
	Environmentally Significant Areas	Reduced travel time
	Aquatic Resources	Reduced vehicle emissions
	Wetland Function	Increased Public Safety
	Groundwater Supplies	
	Surface Water Quality	
	Human Heritage Resources	
	Residential Property Values	
	Accidental Events	
	Flooding	
	Visual Resources	
	Recreation	

Environmental Effects Monitoring (EEM) will be conducted to validate impact predictions, and to evaluate the effectiveness of and identify the need to alter or improve mitigative measures. As part of its EMP, TPW will be committed to and responsible for the development and implementation of a focused EEM program for the project. The process by which the EEM program will be developed will be outlined in the EMP.

An EEM program will be developed and implemented to meet the following primary objectives:

- to provide baseline data so the construction schedule can be refined to avoid conflict with VECs.
- to verify impact predictions;
- to evaluate the effectiveness of mitigation and to identify the need for improved or altered mitigation; and
- to provide an early warning of undesirable change in the environment.

Monitoring Programs will be developed for air quality; noise; sensitive terrestrial habitat; aquatic habitat; water quality; populations of fish and invertebrates; stream crossings; wetlands; heritage resources; and accidental events.

Specific activities will include:

- A detailed survey and sampling of all potentially affected water supplies;
- A pre-blast survey of all structures and water supplies within a predetermined distance of blasting activities, based on the blast design and approved by TPW;

- A detailed survey and sampling of dust and noise levels in areas potentially affected by construction;
- Ongoing detailed water sampling (for suspended sediment and general chemistry) of all potentially affected watercourses in proximity to the highway alignment;
- Pre- and post-construction monitoring of fish habitat in areas where blasting is to occur;
- Pre- and post construction monitoring of benthic invertebrate populations in watercourses crossed by the highway;
- A detailed pre-construction survey of four-toed salamander habitat in proximity to the highway alignment to identify the presence of nesting sites; and
- A detailed pre-construction survey and monitoring program to accurately delineate the presence or absence of archaeological resources in areas identified to have a high potential for the occurrence of such resources.

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1.0 INTRODUCTION

The Nova Scotia Department of Transportation & Public Works (TPW) is submitting this Environmental Assessment Registration Report to the Nova Scotia Department of the Environment (NSDOE) and requesting approval for the construction and operation of Highway 113. This is a new highway which will connect Highway 102, near Exit 3 (Hammonds Plains), and Highway 103, just west of Exit 4 (Sheldrake Lake).

1.1 Contact Persons Regarding This Assessment

This registration document is submitted by:

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1.2 Background to the Undertaking

TPW is proposing that Highway 113 will be a four lane, 100-series highway connecting Highway 102 (near Exit 3) and Highway 103 (just North of Exit 4) in Halifax County. This assessment is concerned with the entire length of the proposed Highway 113 from Highway 102 to Highway 103, including the Truck Connector, as shown in Figure 1-1.

The highway will be 9.9 kilometres in length and is therefore deemed to be a Class I undertaking as defined by "Schedule A" of the ***Environmental Assessment Regulations*** made under the ***Environment Act*** (1995). Nonetheless, this report has been prepared to meet the more stringent information requirements of Class II undertakings, as required by the same regulations and requested by TPW.

1.3 Organization of the Report

This report presents the results of an Environmental Impact Assessment (EIA) which was conducted to assess the environmental concerns associated with the construction and operation of the proposed highway. The purpose of this report is to communicate pertinent information about the Project planning process, the Project itself, and the environmental risks and benefits associated with the Project. The report includes the following major elements:

- Executive Summary
- Section 1.0 - Introduction;
- Section 2.0 - Project Description;
- Section 3.0 - Reason for the Undertaking;
- Section 4.0 - Other Methods for Carrying Out the Undertaking;
- Section 5.0 - Alternatives to the Undertaking;
- Section 6.0 - Description of Existing Environment;
- Section 7.0 - Valued Environmental Components;
- Section 8.0 - Predicted Impacts Upon the Environment;
- Section 9.0 - Advantages and Disadvantages to the Environment;
- Section 10.0 - Compliance and Effects Monitoring Program;
- Section 11.0 - Public Information Program;
- Section 12.0 - References; and
- Appendices.

1.4 Pertinent Legislation

The current pertinent Federal and/or Provincial legislation that will or may affect the undertaking include the following (note that the legislative environment may change prior to construction):

Government of Canada
- Environmental Protection Act;
- Canadian Environmental Assessment Act
- Fisheries Act;
- Indian Act;
- Migratory Birds Convention Act;
- Navigable Waters Protection Act;
- Water Act; and
- Wildlife Act.

Province of Nova Scotia
- Crown Lands Act;
- Conservation Easements Act;
- Ditches and Watercourses Act;
- Endangered Species Act;
- Environment Act;
- Expropriation Act;
- Fire Prevention Act;
- Fisheries and Coastal Resources Act;
- Forest Enhancement Act;
- Forests Act;
- Heritage Property Act;
- Land Titles Clarification Act;
- Litter Abatement Act;
- Marsh Act;
- Marshland Reclamation Act;

- Mineral Resources Act;
- Occupational Health and Safety Act;

FIGURE 1-1
GENERAL LOCATION
PLAN SHOWING
PROPOSED ROUTE AND
SURROUNDING AREA

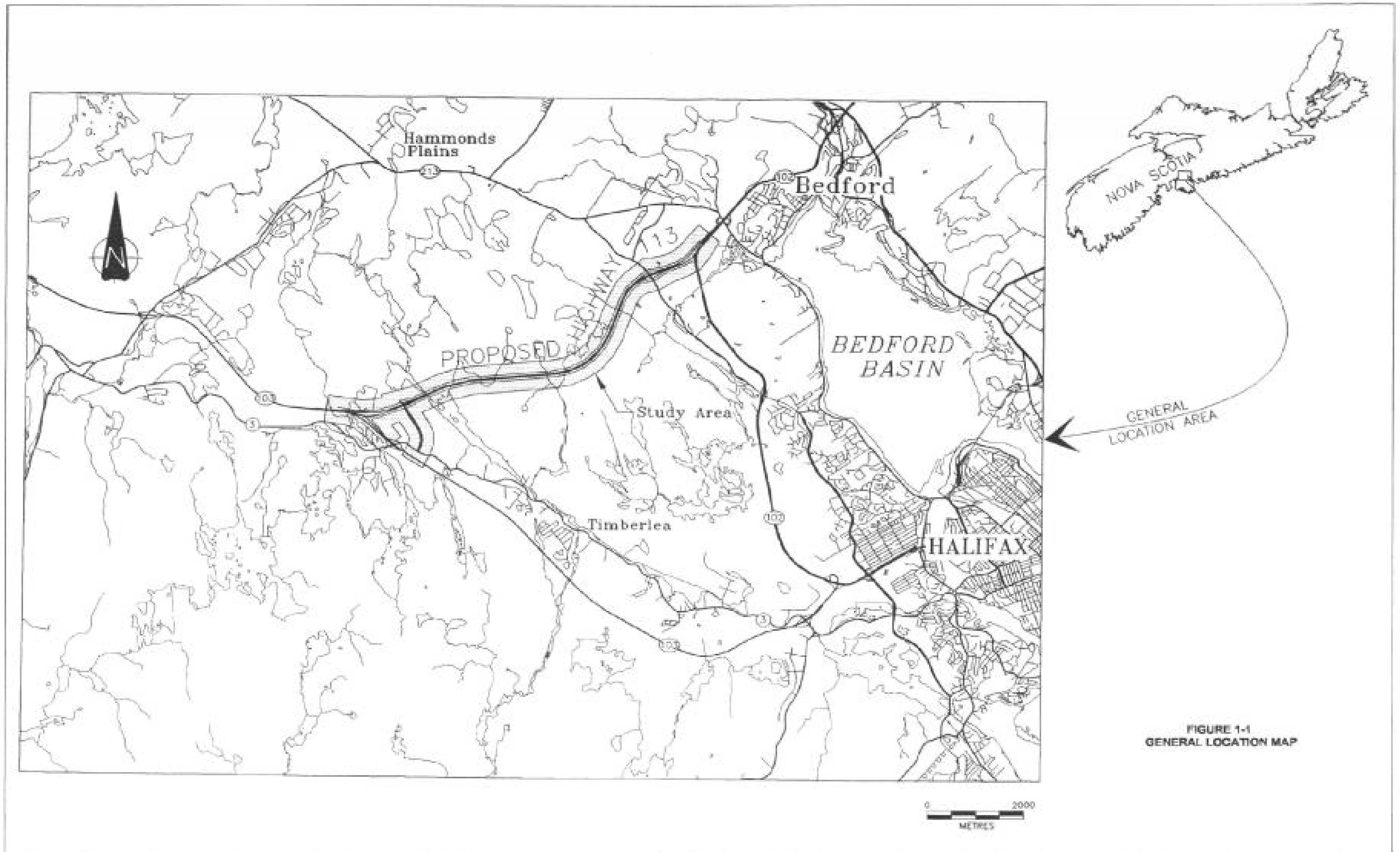


FIGURE 1-1
GENERAL LOCATION MAP

- Parks Development Act;
- Planning Act;
- Protection of Property Act;
- Provincial Parks Act;
- Public Highways Act;
- Quieting Titles Act;
- Special Places Protection Act;
- Trails Act;
- Weed Control Act;
- Wilderness Protection Act; and
- Wildlife Act.

Halifax Regional Municipality
- By-Law B-300 - Blasting;
- By-Law H-200 - Heritage Property;
- By-Law N-100 - Noise;
- By-Law N-200 - Noise;
- By-Law O-100 - Open Air Burning;
- By-Law S-300 - Streets;
- By-Law S-301 - Streets; and
- By-Law T-400 - Truck Routes.

In addition, numerous regulations, guidelines, policies and standards enforced by NSDOE, including the following, will or may guide the planning, construction, and operation of the proposed Project.
- Approval Process for Pits Containing Slates;
- Asphalt Paving Plant Guidelines;
- Contingency Plan Guidelines for Release of Dangerous Goods and Hazardous-wastes;
- Current Air Quality Objectives;
- Erosion and Sedimentation Control Handbook for Construction Sites;
- Guidelines for the Application and Removal of Structural Steel Protective Coatings;
- Guidelines for Development on Slates in Nova Scotia;
- Guideline for Environmental Noise Measurement and Assessment;
- Guidelines for Sampling of Domestic Water Supplies in Conjunction with Construction of Highways;
- Pit and Quarry Guidelines;
- Policy Guidelines on Watercourse Alterations;
- Procedure for Conducting a Pre-blast Survey;
- Watercourse Alteration Specifications; and
- Wetlands Directive.

1.5 Spatial and Temporal Context of the Assessment

The concept of bounding is not new for the environmental impact assessment of projects. The traditional approach involved assessing changes to the environment within the physical boundaries of development. Beanlands and Duinker (1983) determined that in order to properly evaluate impacts, physical and biological properties must be determined temporally and spatially. This approach has been taken for the determination of bounds for the assessment of the proposed highway.

1.5.1 Temporal Bounds

The temporal bounds for the Project can be roughly categorized as follows:
- preconstruction/construction; and
- operation.

Temporal bounding for the preconstruction and construction stages are estimated to extend over a three year period from the beginning of construction.

For the operations phase, the temporal bounds extend for about 25 years subsequent to completion of construction. However, with maintenance and repair/replacement, the highway will be functional for much longer.

1.5.2 Spatial Bounds

As with the temporal bounds, the spatial bounds of the assessment can be divided into two components. These will include bounds for both the biophysical and socio-economic assessments.

The spatial bounds selected for the biophysical assessment are essentially the immediate environs of the proposed Project activities, including adjacent water courses. Specifically, the spatial bounds for the biophysical assessment have been chosen on the basis of determining all possible biophysical impacts.

For the preconstruction, construction, and operation stages, the spatial bounds include the entire length of the Project and extend on either side of the highway centreline for a distance of up to 400 metres (m). For watercourses, bounding extends to all waterbodies that might be affected by drainage.

The spatial bounds selected for the socio-economic assessment include an expanded area to reflect the overall impacts in the immediate study area and adjoining communities in proximity to the Project, in particular the areas along Highway 103, Trunk 3, Kearney Lake Road, and Hammonds Plains Road where considerable development exists. The spatial bounds also include future development in the area since the construction of Highway 113 is anticipated to take place in 10 to 15 years. For example, the socio-economic impacts include those regarding the residents, businesses, institutions and associated infrastructure in the adjoining areas which will be affected by the undertaking. In addition, the spatial bounds for the socio-economic assessment include areas that may be influenced by economic activity generated by the Project and an assessment of the services and facilities available within the immediate area.

2.0 PROJECT DESCRIPTION

The proposed undertaking consists of the design, construction, and operation of a new highway (Highway 113) which will connect Highway 102, near Exit 3, and Highway 103, just west of Exit 4. The overall goal of the proposed undertaking is to enable through traffic from Highway 103 to Highway 102 (and *vice versa*) to bypass the Halifax urban core, thereby reducing travel time and alleviating traffic on the Hammonds Plains Road.

The following subsections provide a detailed description of the proposed undertaking, as well as general information related to typical highway projects of this nature.

2.1 Highway Corridor Location

The process followed by TPW to locate an acceptable corridor for Highway 113 considered many factors such as:

- current and future traffic patterns and volumes;
- current and future community development patterns;
- physical constraints such as topography (hills, valleys, etc.) and watercourses (rivers, lakes, wetlands, etc.); and
- various environmental features.

Critical evaluation of these factors by TPW, lead to the selection of several potential highway corridors which were then investigated with respect their ability to meet operational, environmental, and economic objectives.

The currently proposed Highway 113 corridor with which this report is concerned, was evaluated by TPW to be the most suitable alternative to meet the Department's objectives. The Departmental evaluation included completion of a preliminary environmental screening, consisting of contacting various stakeholder groups regarding the potential environmental issues surrounding the proposed alignment.

2.1.1 Location of Proposed Highway 113

As stated earlier, the proposed highway connects Highway 102, near Exit 3 (Hammonds Plains), and Highway 103, just west of Exit 4 (Sheldrake Lake). As shown in Figure 2-1, the proposed route travels east from Highway 103, north of Exit 4, between Upper Sheldrake Lake and Sheldrake Lake, east between Maple and Frasers Lakes, south of Ragged and Ash Lakes, north of Kearney Lake, across Kearney Lake Road, and connects to Highway 102 south of Exit 3 (Hammonds Plains). The total length of the proposed highway is 9.9 km.

The Stations (*e.g.*, 1+000) shown on Figure 2-1 represent the distance in metres relative to the start of the proposed alignment near Exit 4. For example, Station 1+000 equates to a location that is 1000 m from the beginning of the proposed alignment, near Exit 4.

2.1.2 Location of the Proposed Connectors and Interchanges

As part of the preliminary planning process for the Project, a functional analysis, preliminary environmental screening, and public consultation were completed. The functional analysis considered the proposed Highway 113 to be a four-lane divided, controlled access (entrances and exits at interchanges only) highway, with a design speed of 120 km/hr (posted at 100 km/hr to 110 km/hr). High speed “fly-overs” are proposed at both ends of the highway for connection to Highways 102 and 103. A half-diamond interchange and connector road to Trunk 3, west of Frasers Lake, is planned to enable area residents to access the proposed highway. A full-diamond interchange is planned for the Kearney Lake Road. Opportunity may exist for an additional interchange which would serve the Kingswood Subdivision. This interchange would require construction of a proper connecting road within the subdivision.

2.2 Proposed Design Standards

Design of the proposed highway will conform to the latest edition of the TPW ***Highway Design Standards***. In addition, the TPW ***Standard Specifications*** (1997) will provide general guidance and a basis for contract enforcement for the construction of all portions of the Project.

2.2.1 Overview of Design Procedure

The design standards are the basis for the preliminary and final designs and are maintained throughout the Project. It is, therefore, important that the basic design standards are carefully established with regard to the type of project being considered, from the perspective of both short and long term operating conditions. It is proposed to construct the new Highway 113 to the TPW design standards for a Type "B" Freeway.

2.2.2 Design Classification

The design classification of the highway is TPW Freeway Type "B". The design capacity for this type of highway is in excess of 20,000 vehicles per day (AADT). At the time of opening, the volume on Highway 113 is anticipated to range from 8,000 to 11,000 vehicles per day.

2.2.3 Horizontal Alignment

There is currently one highway alignment option under consideration which runs between Highway 102, near Exit 3 (Hammonds Plains), and Highway 103, just west of Exit 4 (Sheldrake Lake).

The TAC Standards indicate a minimum radius of 670 m is required for the proposed design speed of 120 km/h. Ramps will have a minimum 600 m radius and will be signed for a lower speed. Usual design practices recommend that the design speed of a highway be 10 km/hr above the posted speed limit.

2.2.4 Vertical Alignment

The vertical alignment of the proposed roadway was reviewed with respect to the design standards established for the Project. The Project area is quite hilly, with some steep slopes, as shown in Figure 2-2. The location of the proposed highway requires some large cuts and fills to maintain the vertical design standards. The proposed grades are typically in the 0.5 to 3.5 percent range. The maximum allowable grade for 100-series highways is 6 percent.

Figure 2-1
Detailed Location Map

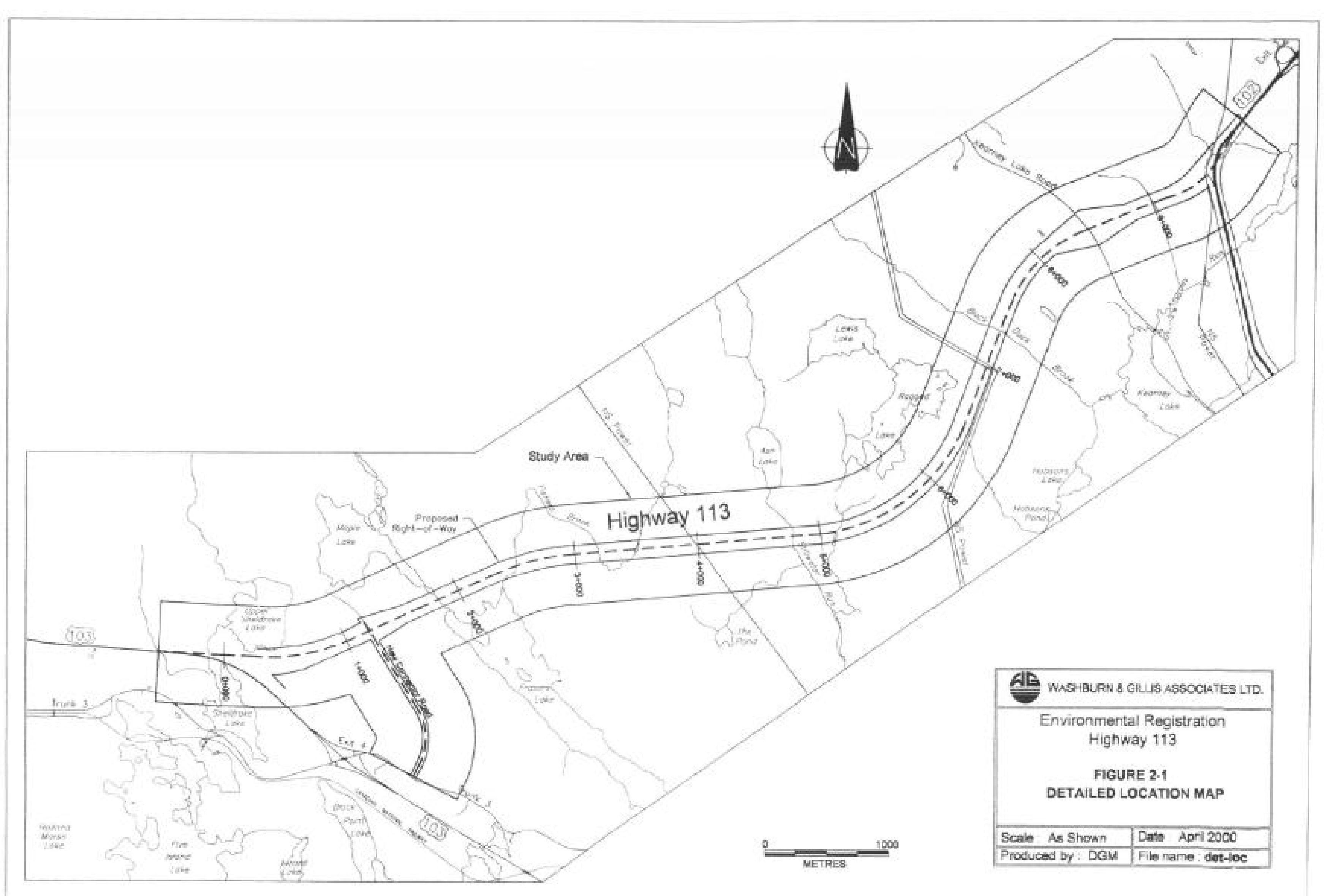
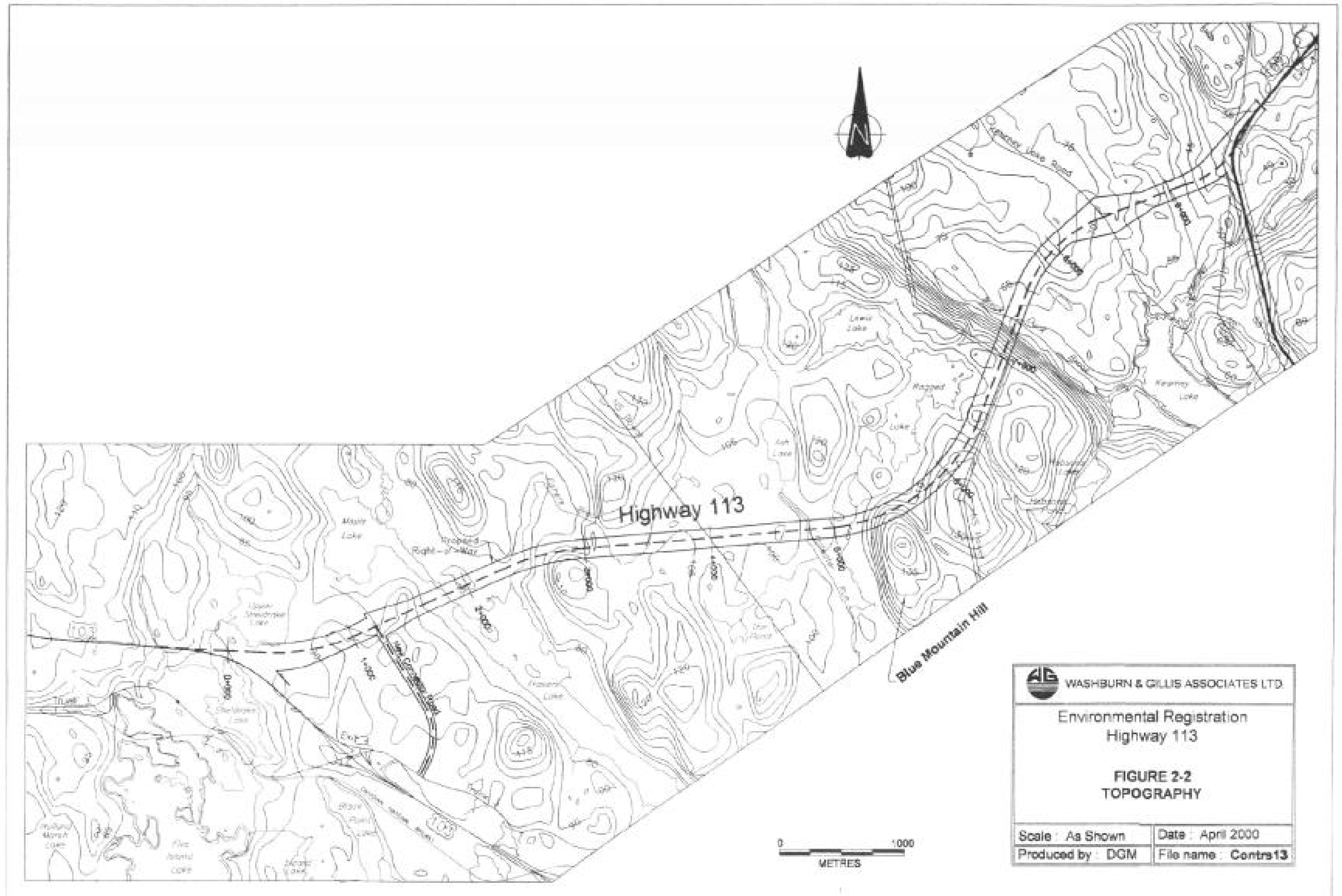


FIG 2-2 -
Contours



There are a number of controlling factors which affect the design grades on this Project. The proposed Highway 113 will require a grade separation for the proposed high speed "fly-over" connections at Highway 102 and 103 and for the Kearney Lake Road interchange. The proposed collector road interchange west of Frasers Lake will also require a grade separation.

A minimum vertical distance of approximately 7.0 m is usually required between the two finished grade surfaces of roadways.

The proposed vertical design of Highway 113 requires some large cuts and fills. Cuts of up to 14 m in depth and large fills of up to 19 m are present. If the type of material being excavated is of good quality, as may be the case (*i.e.*, solid rock), it may be advantageous to increase the depth of cut to reduce the amount of imported material required for embankments and increase the amount of material available for base and sub-base layers. It will also be more environmentally acceptable to try to reduce the number of pits required for fill material and sources of aggregate for sub-base, base and paving material. This could result in a Project which will be self sufficient in the quantity of aggregate material required for construction. Although increasing the depth of cuts can be more costly there are some other benefits as well. These include such factors as:

- a reduction in the amount of trucking on the local road systems;
- a reduction in the construction noise levels; and
- the reduction of required sources of materials from gravel and borrow pits.

This will be looked at in more detail in the design stage, where cuts and fills are balanced as much as possible.

2.2.5 Cross Section Standards

Typical cross sections showing dimensions, ditching, side slopes and clearing limits for the proposed highway are shown in Figure 2-3.

The riding surface characteristics are the same for both the highway and linkage sections of this Project. Generally, the riding surface will be 7.4 m wide (based on 3.7 m wide lanes). With shoulders, the resulting cross section width at the top of the roadway structure is 13.0 m. Embankments will be constructed with 4:1 to 2:1 side slopes, depending on material and embankment height, and 3:1 back slopes. Median slopes will be 4:1.

2.2.6 Runoff Control Design Criteria

TPW is responsible for ensuring that stormwater runoff from the highway right-of-way (RoW) is controlled in a manner such that physical downstream damage is avoided, as a result of flooding, erosion, etc. At the same time, the design is to ensure that surface water is safely and efficiently transmitted across the highway. To accomplish this, TPW will design all culverts and bridges to accommodate high intensity storm flows - the 100-year design storm.

2.2.7 Summary of Primary Design Criteria

Table 2-1 summarizes the design standards to be used for the proposed undertaking.

Figure 2-3 Cross Section

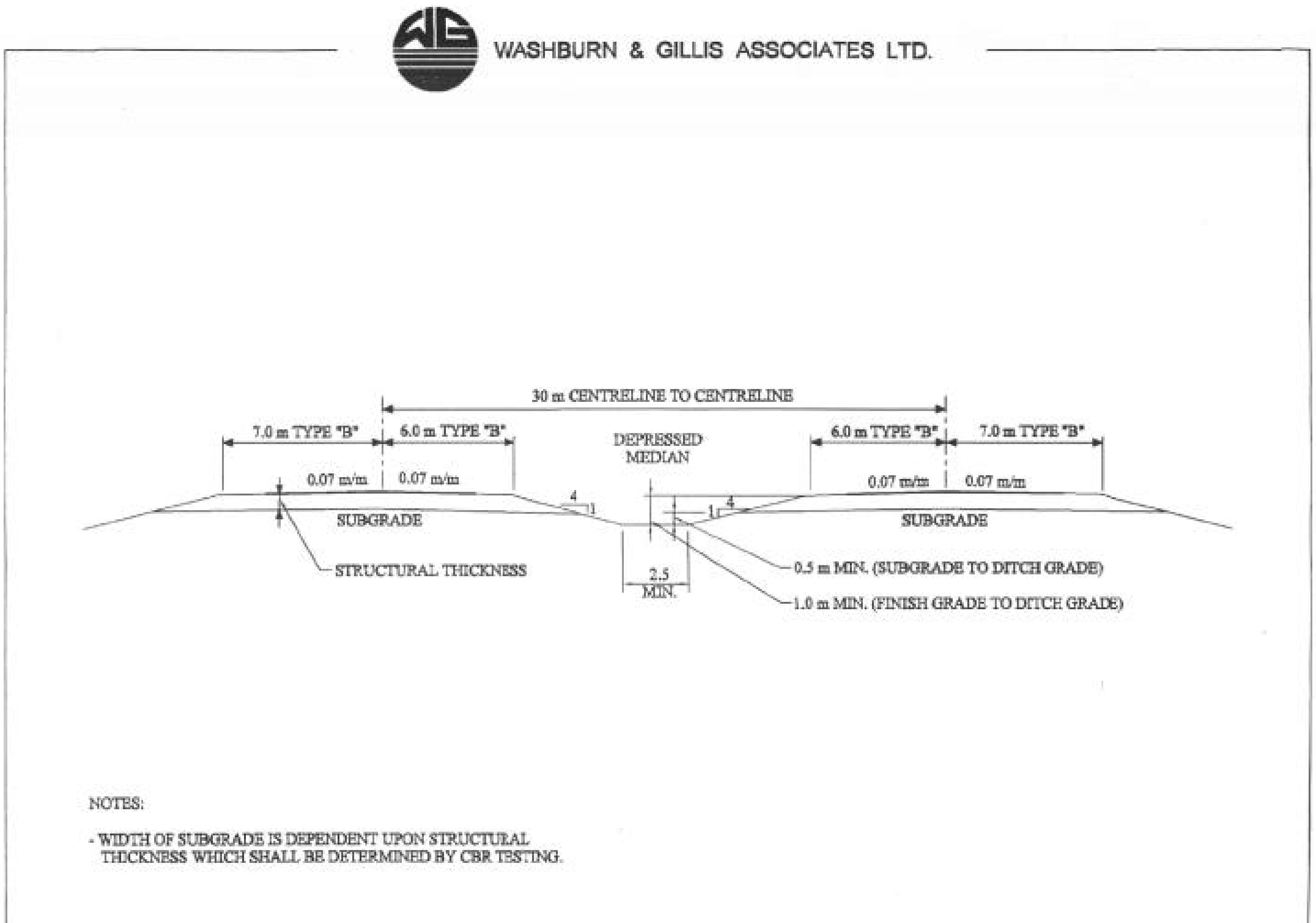


FIGURE 2-3
STANDARD CROSS SECTION
FREEWAY TYPE "B" WIDE MEDIAN

TABLE 2-1
Highway Design Standards

Parameter	Value
Design Year Traffic (AADT)	>20000
Design Speed Range (km/hr)	120
Maximum Gradient (%)	6
Surface Type	Paved
Lane Width (m)	3.7
Shoulder Type	Paved
Useable Shoulder Width, Inside and Outside, (m)	2.5
Shoulder Rounding (m)	0.8
Finished Top Width (m)	14.0
Side Slope	4:1 to 2:1
Back Slope	3:1
Design Speed (km/hr)	120
Maximum Posted Speed (km/hr)	110
Minimum Horizontal Curve Radius (m)	670
Minimum Stopping Sight Distance (m)	200 - 290
Minimum Vertical Sag Curve (k)	24 - 36
Minimum Vertical Crest Curve (k)	75 - 150
Minimum Passing Sight Distance (m)	800

Source: TPW and TAC Geometric Design Guide for Canadian Roads (1999)

2.2.8 Limits of Clearing

The current standard practice of TPW during projects of this nature is to clear the RoW for a distance of five metres beyond the toe of the fill slope or five metres beyond the top of the backslope, unless safety concerns for sight distance, etc, dictate otherwise. This minimizes the amount of clearing done and creates a variable clearing width that is more visually pleasing.

2.3 Project Scheduling and Construction Practices

2.3.1 Normal Construction and Operations Practices

This Project will be constructed according to TPW's most recent ***Standard Specifications***. Particular specifications to be used are prepared as part of the normal design/contract documentation process at the final design stage. Contracts for construction will also include standard environmental protection measures practiced by TPW and specific measures included in this document to be subsequently incorporated into the specifications for individual construction items of the Project.

Since final design for the Project has not been completed, precise clearing limits, areas of disposal of excavated material, and precise limits for cut and fill are not yet known. Such details will be finalized in the design stage which will follow approval of the Project by NSDOE.

2.3.2 Project Schedule

For the preconstruction and construction stages, the temporal bounds include the estimated number of years to complete all surveys, design and construction. Assuming environmental approvals in mid-2000, the earliest possible date to begin Project construction is Spring, 2002. Nonetheless, construction will likely be phased over the next 10 to 15 years, based on available funding and priority among other TPW initiatives. Construction will take approximately 3 years to complete.

2.3.3 Project Activities

This section provides an overview of Project activities associated with:

- preconstruction;
- construction; and
- operations.

2.3.3.1 Preconstruction Activities

The four principal preconstruction activities associated with this Project are: route selection, surveying, subsurface investigations and design.

Route Selection: The initial route selection was completed by the Needs and Programs Group of TPW. Issues taken into account during the route selection process included land use, topography, and environmental constraints. Additional analysis with respect to the proposed route and its effect on the total environment is included in this report.

Surveying: The final design of the Project will require surveying throughout the entire length of the proposed highway. Field surveying will be required to gather detailed data to enable the design team to complete the design for all sections of the Project including associated access roads and watercourse crossings. This activity includes the cutting of centrelines and cross-section offsets of sufficient widths to provide a clear line-of-sight for the surveyors. These centrelines are also required to provide access for subsurface survey (*i.e.,* soils testing) equipment. The width of line cut for purposes of surveying and access by geotechnical drilling equipment shall be kept to an absolute minimum. Woodcutting in the surveying area will leave merchantable timber in salvageable lengths. Standard TPW guidelines will be followed for this activity. Care will be given to ensuring that no cut brush and trees are left in watercourses where they may form artificial barriers for water or fish. Particular care and caution is required in the handling of fuel and oils associated with power saws.

Subsurface Investigations: It will be necessary to conduct field investigations using soils testing equipment, to determine the suitability of the "insitu" material for roadway, access road, and watercourse crossing construction and to establish the extent and nature of rock characteristics along the Project. Typically, this equipment is carried by means of crawler mounted (tracked) drill rigs. In some areas, this testing may be done by a drill mounted on a boom truck which will operate from the existing roads. Soils testing will be conducted along, and immediately adjacent to, the centreline of the highway and in the areas of associated access roads and watercourse crossings. This will include geotechnical testing required for the abutments and piers for all bridges and any other large drainage structures.

2.3.3.2 Construction Activities - Roadway

The following construction activities are presented generally in the sequence which they must be completed in order to construct a typical highway. Most of the items described are detailed in the ***Standard Specifications*** (1997).

Clearing: The first construction activity will involve clearing of existing trees, logs, brush and other vegetation along the alignment. Areas to be cleared will be noted explicitly on the plans or designated by the Engineer in charge of the Project. The limits shall be accurately identified so that all clearing and construction activity be strictly limited to the area required for the Project.

Clearing typically involves the use of chainsaws or whole tree harvesters for cutting. Trees are normally cut to within 0.3 m of the ground. Generally, all timber with a minimum butt diameter of 100 mm and a length of 2.5 m shall be considered merchantable timber. Merchantable material is transported to approved central stockpile areas using tractor-skidders. Trees may be limbed where they fall using chainsaws, or mechanically de-limbed at the stockpile areas. The merchantable timber will be utilized in accordance with normal TPW procedures. Trees, logs and brush and other perishable material, if not removed by cutting, will be chipped, mulched, or buried in pits or grubbing push-offs. Chips shall be used as temporary ground cover in areas immediate to the chipping operations. Disposal areas shall be identified by the Contractor, approved by the Engineer, and the areas prepared, utilized and cleaned up as identified in the specifications or in a Contractor/Landowner agreement.

Grubbing: Grubbing for roadway and associated infrastructure development involves the removal and disposal of organic material including root mat, stumps and topsoil. Areas to be grubbed will be shown on the plans or designated by the Project Engineer. Special care will be taken to limit the grubbing activity in areas adjoining watercourses. Grubbing is not required in areas under fill (embankments) of 1.5 m or more.

Grubbing is usually conducted with bulldozers used to scrape the organic material off the underlying soil and to push the material to an area for subsequent transport to disposal sites. Depending on conditions, the grubbed material may be removed by an excavator or loaded into trucks (or off-highway trucks) and transported to disposal areas as approved by the Engineer. Grubbing material may also be buried in pits or the toe of slopes or flattened adjacent to or in the RoW, as approved by the Engineer.

Grubbing activities present a concern for the natural environment because they expose the inorganic soils and thus create the potential for wind and water soil erosion. Appropriate care and attention is required to limit the amount of exposed soil. Where necessary, appropriate erosion control measures (including drainage and siltation prevention devices and settling ponds) must be implemented. Grubbing will not be performed within 100 m of watercourses (or another distance depending on topography) until appropriate culverts are installed.

Slash Gathering and Disposal: Slash consists of brush, small trees, and limbs of larger trees that are cut during the clearing operation. Slash will be disposed of through mulching, whereby the slash material is mechanically ground or chipped and used during landscaping or for erosion control. Large piles of chipped material will be avoided and chips will be disposed of where they shall not run into a watercourse or block ditches, culverts, drains, etc.

Roadway and Drainage Excavation: Development of the highway and access road(s) involve activities associated with the excavation of existing material and development of embankments upon which these facilities are to be constructed. This activity normally includes the preparation and construction of roadbed, embankments, slopes, side ditches, trenches, watercourses and appropriate intersecting roadways. These activities involve using material from within or adjacent to the RoW. It also involves removal of organic soils (retained for later use during landscaping) and other unusable materials in low lying areas. Typically, the roadway facilities are designed so that the amount of material required to build the embankment/fill components of the Project will approximately balance, in volume, the amount of material to be excavated from nearby sections. Where a deficiency in the excavated material occurs, the normal practice is to develop a "borrow pit" near the RoW. This pit would be used to provide a source of construction material for the embankments/fill areas. Conversely, if there is a surplus of excavated material, such material will be disposed of by the Contractor.

Subgrade and drainage development constitute a major portion of the construction activity associated with this type of project. Drainage along the RoW must be established such that the road surface drains easily and subsequent run-off from rainfall activity is directed into the natural drainage regime in an acceptable manner.

The proposed alignment will require extensive cut and fill operations to achieve the blend of horizontal and vertical alignment characteristics necessary to achieve the previously described design criteria. In particular, much of the highway construction process will involve sections of significant excavation, much of which is likely to be in rock. A summary of the areas requiring significant excavation is shown in Table 2-2. Areas requiring major cuts and fills are shown in Figure 2-4.

The results of the design stage geotechnical analysis will allow engineers to optimize the amount of cut and fill by adjusting slopes or making corresponding adjustments in the vertical and horizontal alignment. However, to date, efforts have been taken to minimize cuts and fills (particularly, excessive fills) and to blend the highway to the existing topography.

The three categories of excavation normally involved in projects of this nature include:
- solid rock excavation;
- common excavation; and
- swamp excavation.

Rock excavation is the excavation and removal of bedrock and large boulders measuring 1 cubic metre (m^3) or greater. Swamp excavation is the excavation and disposal of peat, black muck, or humus encountered in swamp or marsh. Common excavation involves the excavation and removal of material other than Solid Rock or Swamp. If Halifax Formation slates are encountered during excavation, the ***Guidelines for Development on Slates*** (NSDOE, 1991)

FIGURE 2-4
CUTS AND FILLS

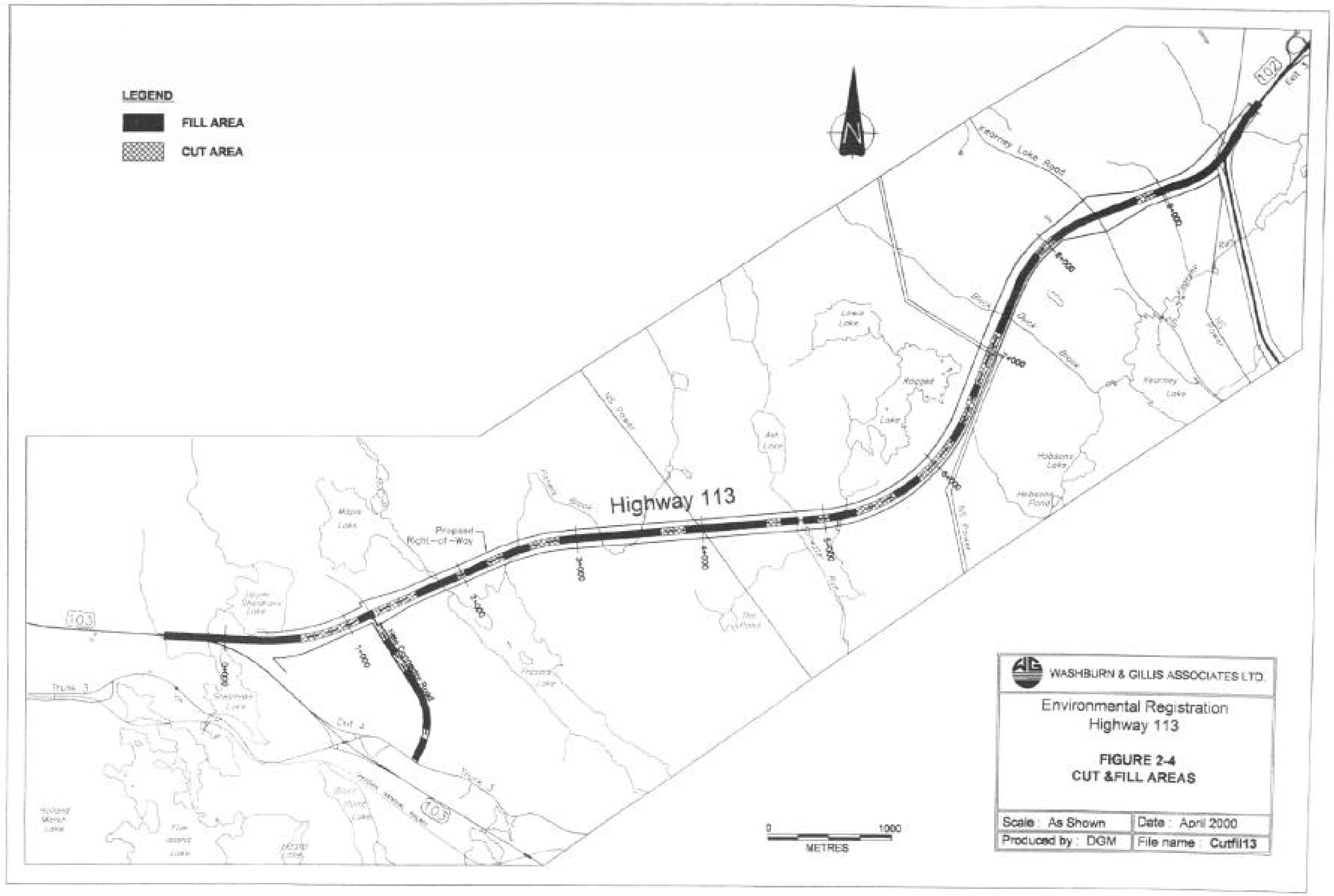


TABLE 2-2
Summary of Areas Requiring Excavation

Highway Section	Station (m)	Maximum Depth (m)
Highway 113	0+600 - 1+080	6
	1+220 - 1+580	8
	1+960 - 2+020	3
	2+210 - 2+340	2
	2+580 - 2+810	5
	3+080 - 3+180	6
	3+650 - 3+850	2
	4+500 - 4+620	2
	4+950 - 5+040	2
	5+250 - 5+580	11
	5+840 - 6+220	8
	6+380 - 6+600	6
	6+750 - 7+160	14
	7+900 - 8+060	6
	8+800 - 8+940	2
	9+460 - 9+550	1
Collector Road	0+000 - 0+225	1
	0+675 - 0+875	3
	1+025 - 1+175	4
	1+950 - 2+050	4
WestboundTwinning of Hwy 103	0+075 - 0+775	13
	1+025 - 1+225	3
	1+325 - 1+375	3
North Ramp at Kearney Lake Road	-0+500 - -0+475	5
	0+000 - 0+225	3
	0+375 - 0+450	2
South Ramps at Kearney Lake Road	-0+350 - -0+400	1
	-0+275 - 0+125	4

and the ***Sulphide Bearing Material Disposal Regulations*** of the ***Environment Act*** must be followed to prevent environmental degradation.

Solid Rock Excavation: Rock excavation will be carried out by drilling, blasting and transporting excavated material. Typically the transporting activity will be done by trucks or large off-road rubber wheeled vehicles. In areas where the rock is relatively soft and heavily fractured, rock excavation may be carried out by hydraulic or pneumatic rippers. In other cases, blasting will be required for which a permit issued by Halifax Regional Municipality will be necessary.

As long as the normal drilling and blasting activities associated with rock excavation are conducted according to the existing regulations, blasting will not create problems. It is important to stress, however, that because of the rugged topography along the proposed route, extreme care will be required to ensure that blast planning and execution restricts all potential impacts to the clearing limits. In addition to the wildlife and fish resource and habitat impacts, common adverse impacts of blasting include damage to water supply wells and to built structures caused by rock vibrations created from the blasting. If blasting is required near any residential buildings, a pre-blast survey will be conducted to establish the current conditions of the structures and supply wells.

Pre-blast surveys will be completed by Contractors in a manner consistent with the most recent version of the ***Procedure for Conducting a Pre-Blast Survey*** as approved by NSDOE. Pre-blast surveys will include: meetings with affected owners; descriptions of structures within a predetermined radius; and descriptions of water supplies within a predetermined radius. Limits of the pre-blast survey will include an appropriate distance from the construction as determined from the blasting design and approved by TPW. A copy of the pre-blast survey will be sent to each homeowner surveyed.

Acid drainage resulting from the excavation of mineralized rock is not a concern along the proposed highway alignment. None of the geological formations encountered along the easement are known to produce acid drainage when excavated or exposed to air and water.

Common Excavation: Typically, common excavation involves using excavators, front end loaders and trucks for moving the material. In some instances, depending on the conditions, the common material may be excavated and relocated using graders or scrapers. Scrapers are wide wheeled machines that excavate by scooping and scraping the soil into a large box component of the vehicle. The vehicle then carries the soil to the fill area and deposits it at that location. The choice between excavators, loaders and trucks or scrapers will be based on operational efficiencies which will be established based on the nature of the materials and the sizing of individual contracts. From an efficiency perspective, the contractors will obviously wish to minimize the haul distance associated with transporting material.

Swamp Excavation: Swamp excavation involves essentially the same type of activities as are involved in common and rock excavation. Designated wetland excavation will require special care to minimize wetland disturbance. NSDOE guidelines will be followed during excavation of wetlands as well as recommendations made in this report.

<u>Borrow</u>: Borrow activity involves supplying, loading, hauling and properly placing additional material necessary to complete embankments/fills to subgrade level. Borrow material is typically obtained from locations outside the limits of the RoW. The extent to which it will be necessary to use "borrow" material is unknown until the design has been completed. The preliminary horizontal and vertical alignment characteristics were developed with the stated objective of trying to balance cut and fill material. This minimizes the need to go off-site to obtain appropriate construction material which, in turn, minimizes the environmental impacts of developing borrow pits in the Project area.

If borrow material is required it shall be supplied by the contractor after the location and suitability of such material sources are approved. All borrow material and aggregate material must be approved by the Engineer. Borrow pits shall be rehabilitated and left in a neat and safe condition, free from overhanging banks and in accordance with all existing legislation regarding pits and quarries. Attention will be given to ensuring that run-off from borrow pits shall not enter directly into any watercourse. Proper siltation control measures to prevent sediment transport will be provided, as necessary. All off site borrow operations will conform to the latest version of the **Pit and Quarry Guidelines** (1988).

There are some potential sources of borrow material located near the proposed highway. These potential sources of borrow material are in drumlins and glacial till deposits located on both sides of the proposed Highway 113. The locations of these borrow sources are shown on Figure 2-5. Also, it should be noted that commercial quarries such as Gateway and Rocky Lake are located near the Project area.

Embankment Construction: Regardless of the type of excavation or borrow material, the fill embankments are constructed by spreading material that has been excavated and transported to the fill areas. Typically, spreading is done by bulldozers. After spreading, the material is compacted using a variety of dozer-towed or self-propelled rolling equipment (much of which is vibratory). A summary of the areas requiring significant fill is shown in Table 2-3. Areas requiring major fills are shown in Figure 2-4.

Culverts and Related Drainage System Development: An integral component of the subgrade activities relates to the creation of appropriate drainage ditches and culverts. Much of this work is carried out in conjunction with the grubbing operation. Parallel side ditches and cross culverts under the roadway will transport surface water from the uphill ditch to the downhill side of the highway. The final design will take careful consideration of the sizing and spacing of such facilities in order to minimize the impact on flooding, erosion, and siltation.

Because of the topography there will also be need for several bridge structures. Bridge construction activities are noted later and probable locations of such structures are identified in Table 2-4.

Construction work near or in watercourses shall be restricted to appropriate times to limit the damage to aquatic resources and habitat. Precautions will be taken to prevent the discharge of polluting substance to watercourses. All watercourse crossing work will be done in accordance with the ***Nova Scotia Water Approvals*** and in consultation with the Department of Fisheries and Oceans (DFO). Appropriate erosion control measures will be provided as required.

Some of the larger brooks will require significantly large culvert structures to allow the transport of water under the roadway. Appropriate erosion control structures shall be installed prior to commencement of grubbing operations and during follow-up excavation activity associated with the roadbed/subgrade development to minimize the amount of siltation that may occur in the brooks.

For culvert installation, the first step is the excavation for the structure and the construction of the culvert foundation which may be crushed rock, concrete or a combination of these materials. This is followed by placement of the culvert pipe on the foundation and covering the pipe with fill in accordance with a specified procedure.

TABLE 2-3
Summary of Areas Requiring Fill

Highway Section	Station (m)	Maximum Depth (m)
Highway 113	0+000 - 0+600	6
	1+080 - 1+220	3
	1+580 - 1+960	7
	2+020 - 2+210	4
	2+340 - 2+580	6
	2+810 - 3+080	7
	3+180 - 3+650	4
	3+850 - 4+500	2
	4+620 - 4+770	6
	4+810 - 4+950	3
	5+040 - 5+250	8
	5+580 - 5+840	8
	6+220 - 6+380	5
	6+600 - 6+750	1
	7+160 - 7+900	19
	8+060 - 8+800	6
	8+940 - 9+460	6
	9+550 - 9+900	9
Collector Road	0+350 - 0+675	1
	0+875 - 1+025	4
	1+175 - 1+950	10
Westbound Twinning of Hwy 103	0+925 - 1+025	2
	1+225 - 1+325	4
North Ramp at Kearney Lake Road	-0+426 - -0+500	6
	0+225 - 0+375	7
South Ramps at Kearney Lake Road	-0+400 - -0+275	2
	0+125 - 0+600	8

Upon completion of the culvert installation and backfilling, appropriate protection is placed at the inlet and outlet for erosion control.

The sizes, materials, and design details of the culverts will be determined during the design stage. After appropriate stream flow analysis is conducted, the culverts will be designed to maximize the efficiency of drainage and minimize environmental implications. Inlets and outlets of culverts shall be designed to prevent erosion of soil materials at either end.

FIGURE 2-5
BORROW AREAS

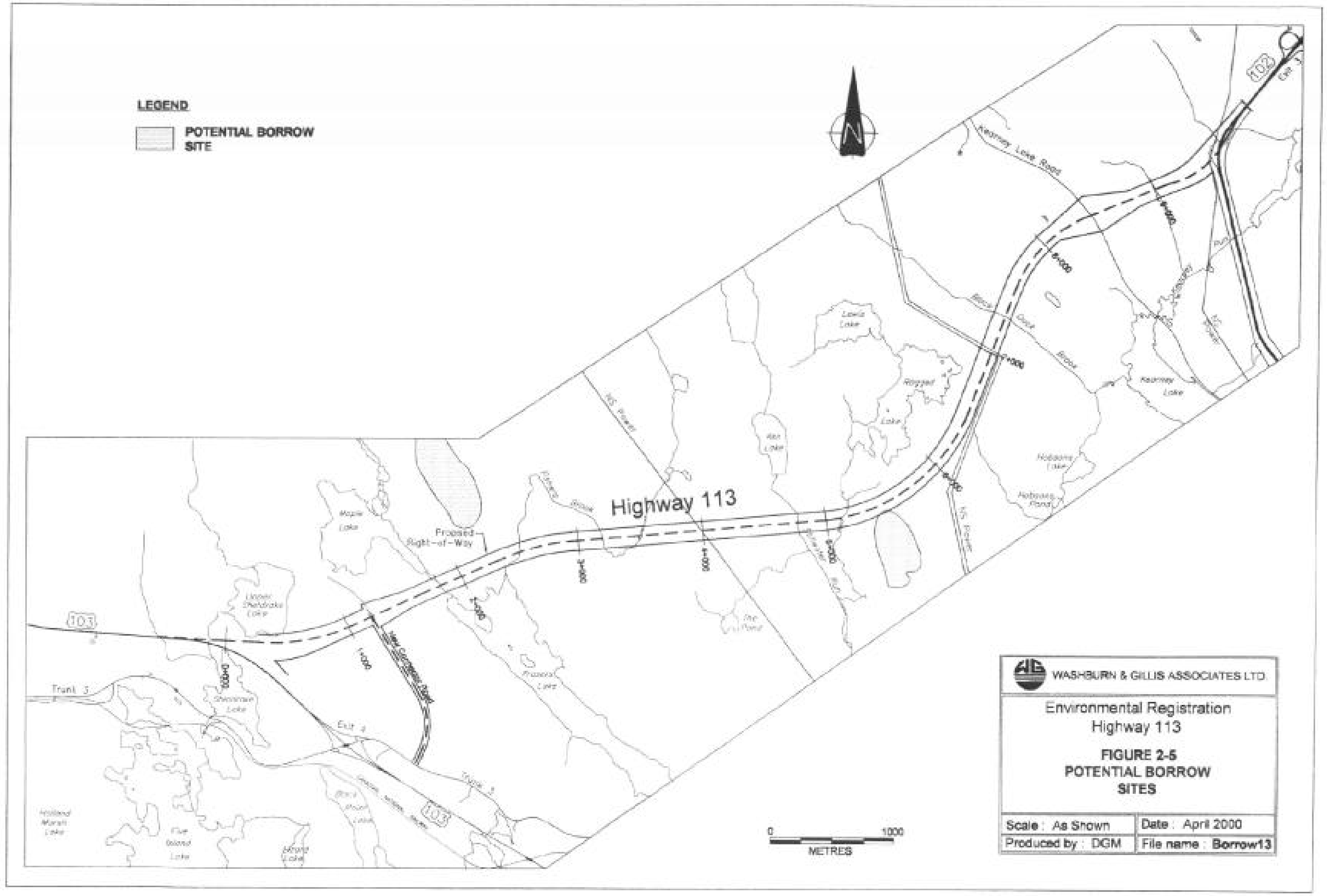


TABLE 2-4
Summary of Watercourse Crossings

Watercourse Name and Station	Approximate Size of Drainage Area (ha.)	Probable Structure	
		Bridge	Culvert(s)
Tributary Connecting Upper Sheldrake and Sheldrake Lakes (Sta. 0-127)	100		X
Tributary between Maple and Frasers Lakes (Sta. 1+814)	2500	X	
Fishers Brook (3) (Sta. 2+490, 3+200, 3+500)	300		X
Stillwater Run (Sta. 4+768)	200		X
Outlet of Ragged Lake (Sta. 5+150)	200		X
Black Duck Brook (Sta. 7+300)	300	X	
Tributary to Kearney Run (Sta. 9+010)	30		X
Tributary to Papermill Lake (Sta. 9+670)	100		X

Appropriate design considerations utilizing larger size rocks to create headwalls at the inlets and outlets will be undertaken at the design stage. Similarly, the design and construction of drainage channels will be done in a manner to minimize channel erosion. Culvert design will also incorporate provisions for fish passage (fish ladders, etc.) where necessary.

To reduce siltation, susceptible exposed material will be stabilized against erosion as soon as structures are completed and subgrades are reached. This work will be done in accordance with the details provided in the specific Project specifications.

Erosion Control Structures: All excavation and drainage work presents a risk of environmental impacts. Common excavation and filling exposes the natural soil materials to wind and water which may erode the soil. Wind erosion is not seen as a major potential problem. On the other hand, water erosion could be significant. Consequently, careful attention to work in and around watercourses is a primary concern on this Project. The final design shall include specific consideration for the installation and maintenance of erosion control structures in accordance with the plans and as directed by the Engineer.

The types of erosion control structures which may be used include:

- diversion ditches;
- sediment flow checks and sedimentation ponds;
- riprap erosion control for ditches; and
- sediment control fences.

All erosion control structures shall be built in accordance with the ***Erosion and Sediment Control Handbook for Construction Sites*** (NSDOE, 1989) and TPW ***Standard Specifications***.

Sediment control flow checks slow the flow of water and allow time for settling out of particles. They are developed as part of the grubbing operation and will be maintained during the subgrade and drainage development operation noted in this Section. It will also be the responsibility of contractors to maintain the erosion control structures once they are in place.

All structures shall be inspected at least daily during periods of prolonged rainfall. If these facilities are found to be damaged they shall be repaired immediately so that proper functioning is resumed to the satisfaction of the Engineer. When sediments reach certain levels, they shall be removed and disposed of in accordance with normal acceptable practices. These erosion control structures shall be maintained in functional condition until the vegetation on slopes is sufficiently established to be an effective erosion deterrent, or as otherwise directed by the Engineer.

Removal of Erosion Control Structures: When temporary erosion control structures are no longer necessary, these facilities shall be removed in accordance with procedures established by the Project Engineer. Care shall be taken that all erosion control materials and any retained sediments are excavated with minimal disturbance to the underlying ditches or slopes. Accumulated sediment shall be disposed of before sediment control fences and flow checks are removed. Removed materials and sediments shall be disposed of at a location away from watercourses and approved by the Engineer. After removal of the erosion control materials and retained sediments, the affected ditches and slopes shall be shaped to match the adjacent final ditch and slope grades and immediately protected from erosion.

Mulching: Mulching consists of the application of hay, straw, or processed site materials as mulch on slopes and other exposed ground. This shall be done in accordance with the Project plans and specifications. Generally, this activity is done as a temporary measure to prevent erosion of the exposed ground and siltation of the watercourses.

Hydroseeding: Hydroseeding prevents environmental damage and erosion of soil by wind and water by applying a mixture of mulch, seed, fertilizer, binder and water on prepared areas. Final dressing of slopes shall be done as cuts and fills are completed to enable seeding to be done as work progresses.

Erosion Control Blanket: Erosion control blankets are fabrics, usually made of straw and/or a synthetic material, with a typical width of approximately 2 m and a length of 25 m. The blankets are laid up and down slope on sidehills or channels, in the direction of the flow of water, and overlapped with adjacent fabrics to totally protect the ground by reducing the erosive force of wind or water. There are also erosion control blankets which are sprayed onto slopes, providing a uniform cover. As with other "coverings" erosion control blankets will be installed as work progresses.

Sediment Control Fences: Sediment control fences will be used to retain suspended soil particles from water run-off passing through the fence. Typical sediment control fences approved by the province shall be utilized and maintained according to established procedures and practices. Retained sediment shall be removed when it has accumulated to a pre-determined level as specified by the manufacturer. When deemed to be no longer required, the sediment control fences shall be removed and the contractor shall excavate any remaining sediment and dispose of it at an approved location. This will be followed by dressing and seeding the area of the removed fences and sedimentation, to the satisfaction of the Engineer.

Sediment fences do not stop erosion. They are designed to prevent sediment from leaving the site. They are a "last chance" effort to prevent the sedimentation of nearby watercourses and as such will not be relied upon as the primary method of sediment control.

Foundation Excavation: Foundation excavation involves excavation of materials and dewatering for construction of structures such as culverts and bridges and includes the excavation and satisfactory disposal of material necessary for installation of highway and drainage structures in accordance with the details shown on construction drawings. Typically, it includes the installation of watertight cofferdams to aid in excavation. All work must be completed in accordance with the contract documents and environmental protection specifications, similar to previously described excavation sections.

Subbase and Base Materials: The subbase is the first (lowest) layer of materials which constitute the pavement structure of the roadway. This work item consists of supplying, loading, placing and spreading, shaping and compacting on the subgrade material, either gravel or rock subbase material obtained from a pit or rock quarry or as a by-product of grading and/or crushing of material excavated from the clearing limits.

This is the first of the primary pavement structure layers of graded and/or crushed material above the subgrade. Each layer of graded material has unique particle size distribution characteristics, reducing the potential for moisture accumulation under the pavement wearing surface, and providing the structural load-bearing capacity required to give the strength necessary to carry the vehicles which will use the highway. The subbase layer is covered by a base course which is then overlaid with the asphaltic concrete or Portland cement concrete wearing surface. Both the base and subbase courses are placed immediately above the subgrade material. These two courses of material are of a superior quality to that which is generally used for the subgrade component of the roadway.

Rock crushing, required to create appropriate base course material, will necessitate establishment of a rock crusher within reasonable proximity to the Project. This involves either quarrying rock from an adjacent location or simply crushing the rock and appropriate material excavated from other portions of the Project. The precise requirement for this aspect of the construction program will depend on results of the geotechnical surveys conducted at the design stage.

For base and subbase items, construction activity involves movement of graded aggregate by trucks and then spreading with graders and subsequently compacting the material using self-propelled vibratory rollers.

Crushing and Screening: The crushing and screening activity involves the processing of approved materials through a crusher and screen system to obtain materials which conform to the specifications for the different material to be used in the Project. Gravel or rock shall be supplied by the contractor and shall be composed of clean, hard, sound and durable particles which meet requirements contained in the specifications.

All on-site crushing and screening operations shall be done in a manner so as to safeguard the air and water resources by controlling or mitigating environmental dust pollution in accordance with the ***Environment Act*** . Other relevant legislation including the NSDOE noise guidelines will also be complied with. All relevant environmental permits and/or approvals for this operation must be obtained by the contractor.

As is the case for off-site borrow material, after completion of the Project any pits used to derive such material must be rehabilitated to a state that ensures future productive use of the land/site and left in a neat and safe condition, free of overhanging banks. The pits must also be left in such manner that they comply with the ***Pit and Quarry Guidelines***.

<u>Asphaltic Concrete</u>: Asphaltic concrete (AC) is widely used as a surfacing material for highways. AC pavement is often referred to as "flexible" insomuch as it may deform and not completely recover under sustained or repeated loads.

The placing of AC involves the spreading of petroleum based primer on the granular base and the spreading and compacting of asphaltic concrete which forms the wearing surface of the pavement structure. This operation includes the supplying of aggregates, production, loading, hauling, placing and compacting of conventional hot mix asphaltic concrete for pavement construction.

AC paving involves the operation of an asphalt plant and related facilities. Such operations shall be done in a manner so as to safeguard the air and water resources by controlling or mitigating environmental pollution in accordance with the ***Environment Act*** and other relevant legislation including the ***Asphalt Paving Plant Guidelines*** administered by NSDOE. All relevant environmental permits and/or approvals for this operation must be obtained by the contractor.

AC has the potential to incorporate many recycled materials in the mix design such as rubber from discarded tires and crushed glass. AC itself is also easily recycled *insitu* during surface and base recycling and central plant recycling activities where part or all of the AC structure is removed, reworked, and reapplied to the roadway. The recycling of waste materials and AC is reported to be an efficient and economic means of highway resurfacing.

<u>Concrete (Portland Cement)</u>: Another commonly used surfacing material is Portland Cement Concrete (PCC). PCC is used extensively throughout the United States and Canada as a highway construction material. PCC highway construction requires similar if not more exacting requirements when constructing the underlying support structure, in comparison to AC. PCC is often referred to as "rigid" pavement. If the slab becomes unsupported as a result of a base course failure, it will bridge the underlying void until loads are too large or too frequent and failure occurs from fatigue.

Generally PCC highway construction involves the preparation of a subgrade, granular subbase and base, placing of reinforcing steel and load-transfer devices, and placing and finishing of a PCC surface to a specified thickness, smoothness, and density. Materials required in the preparation of PCC include an aggregate (sand and gravel - similar to AC), a portland cement binder (similar in function to the bitumen in AC), fresh clean water, and specialized additives. In most cases the cement is mixed at a batch plant and delivered to the site in trucks.

The opportunity to use recycled materials is limited in PCC. Sound and durable materials (waste concrete, etc.) that can be crushed to the appropriate size could be used as aggregate in place of gravel.

Several sections of highways in Nova Scotia have been surfaced with concrete on a trial basis, to gauge performance under local conditions. Most recently, the construction of two sections of Highway 104 (Truro to Amherst) have included PCC as the driving surface.

Chipsealing: Chipsealing is an approach to surface treatment for roadways which involves placing and compacting (ie. rolling) a thin layer of finish grade aggregate over sprayed asphalt. Normally, two layers are applied. The application involves spreading a coat of liquid asphalt on the travelled lanes portion of the roadway. A thin layer of crushed aggregate is then spread over the surface and rolled into the asphalt. This process is repeated for the second layer, which normally is applied the year after the first coat.

Shouldering: Shouldering involves the placement, spreading, and compaction of crushed gravel on the shoulders of the road to a specified width and thickness. Shouldering shall proceed along with the paving. At no time shall shoulder completion fall more than 3 days or 5 km behind paving.

Finishing Activities: The finishing activities involve installation of various traffic management and safety features including installing signage and guard rails and painting lines on the travelled surface. These activities are carried out at the end of the construction period. Little environmental impact risk is associated with these activities provided non-toxic materials are used.

2.3.3.3 Activities Common to Construction and Maintenance

Disposal Areas: Areas to be used for disposal of construction waste and/or surplus material shall be approved by the Engineer and the Halifax Regional Municipality and located outside the RoW, away from all watercourses. Disposal areas shall be located so they do not block the natural drainage of any watercourse or cause siltation from run-off. Due to the timing of the environmental registration (well in advance of the highway construction) a survey of potential disposal areas would be impractical, especially in view of the continuing area development.

However, of prime importance is the clean-up treatment associated with disposal areas. All future disposal areas shall be left in a neat and finished appearance and be stabilized immediately to prevent erosion.

Storage, Handling and Transfer of Fuels and Other Hazardous Materials: The storage and handling of fuels and hazardous materials used during construction and maintenance shall be the responsibility of the contractor and the operator and shall be in accordance with the appropriate Acts and Regulations. Gasoline, diesel fuel, grease, and oil are needed for equipment operation. Similarly, explosive materials will likely be required when rock has to be removed. Solvents may be used for cleaning. All necessary precautions shall be taken to minimize the spillage, or loss of fuels and other hazardous materials used during construction and maintenance operations.

Handling and fuelling procedures shall be such that contamination of soils and/or water shall not occur. Storage and utilization of all fuels and hazardous materials shall be done in accordance with the ***Dangerous Goods Management Regulations*** of the ***Environment Act*** and the TPW ***Standard Specifications***. Similarly, explosives shall be stored, handled and used in accordance with both Federal and Provincial regulations and necessary permits.

Construction Work Camps: Although temporary work camps are not normally specified, or paid for, on highway construction projects, this section is included in the event that contractors may wish to use work camps on this Project. If such is the case, they shall be located outside the highway RoW. If contractors choose to install and operate temporary work camps in areas outside the RoW for their employees during construction, they will be required to obtain all appropriate permits from government agencies which have any influence on the operation of such camp facilities. Such permits include, but are not necessarily limited to, those relating to solid and liquid waste disposal, water supply, sewage treatment, development control and crown lands.

If construction camps are utilized, the area to be cleared for temporary construction camps shall be the absolute minimum necessary and shall utilize existing cleared areas wherever possible.

2.3.3.4 Construction Activities - Roadway Structures and Bridges

The main activities associated with the construction of major highway structures include:
- potential detours and temporary facilities needed to access components of the structures;
- culvert installation;
- erosion control;
- construction of piers, abutments and foundations;
- pile driving; and
- superstructure construction.

A summary of the activities associated with each of these major construction activities is as follows:

Detour Construction: Temporary detours, fill, and support structures may be required at several locations. Such detour facilities and associated structures will be designed to reflect the specific conditions at each location regarding watercourse hydrology, construction timing, fish passage, stream channel material, and bank material. The type of temporary structure to be utilized will be specified prior to initiating any activity in the field.

Approaches to any temporary detour structures shall be stabilized against erosion by the use of geotechnical fabrics, riprap, plastic sheets or a combination of these materials. The final design will examine the needs for geotechnical fabric to reduce mixing of existing ground material with fill material, to facilitate removal of fill material, and help restore the site after the detour/temporary access is no longer required.

Culvert Installation: All culverts shall be designed to meet the requirements of TPW , NSDOE, and DFO. The major environmental considerations in culvert design relate to fish passage and flooding impacts. Every effort shall be made to maintain and enhance fish habitat. A specific design will be prepared for all watercourse crossings. These designs shall include consideration of diverting the watercourse around the construction, or constructing a new facility and then diverting the watercourse through the new facility and a properly prepared stream. All embankments, slopes and stream channel slopes shall be stabilized against erosion by the use of riprap, rock filled wire baskets, geotechnical fabric, seeding, mulching or a combination of erosion control practices. All instream work will be done during periods of low flow between June 1 and September 30 when impacts on fish are minimized.

Erosion Control: The erosion control concerns and measures identified with respect to the roadway sub-grade and drainage development are also applicable to bridges and culverts. Consequently, the same measures of mulching, seeding, construction of sediment traps, construction of sediment ponds and staging construction operations will be necessary for the large culvert and bridge structure construction activities.

Construction of Piers, Abutments and Foundations: When foundations for roadway structures are located on land, the environmental concerns associated with excavated construction material and pollutants are more easily prevented from entering a watercourse. However, foundation work in a watercourse creates a greater concern because of the risk of pollution. This risk varies depending on the nature of the construction and the specific methods utilized.

Bridge abutment and pier construction generally includes the erection of forms and reinforcing steel and placement of concrete produced from off-site sources. The bridge abutments are built in conjunction with earth and rock embankments, or on bedrock foundations prepared as part of the roadway subgrade and drainage system development activities.

The excavation required for foundations of bridge piers, abutments, or other structures in a watercourse will be done so as to minimize the amount of siltation and potential contamination of water with petroleum products used to power and/or lubricate construction equipment. This may require use of cofferdams, silt screens, silt fences, special pumping procedures, and/or special excavation equipment.

Pile Driving: From an environmental perspective, the method of providing access to a pile driving site in a watercourse can be a concern. Excavating material from within a sheet pile cofferdam and pre-excavation before sheet pile driving are also environmental concerns. The detailed design of the structures at each of these locations shall take into consideration the potential environmental concerns and ensure they are properly addressed during the design stage.

Superstructure: During construction of bridge superstructures (*i.e.*, the bridge girders and deck structure and associated parapet walls/sidewalks), care must be taken in terms of the temporary support structures which may be required, depending on the final design of the structure. Care must also be taken to prevent accidental spills of pollutants into the watercourse during construction. Pollutants which might be exposed to the watercourse during construction include fresh concrete, asphaltic concrete, and paint. Appropriate catchment devices shall be used to intercept accidental spills during construction.

2.3.3.5 Construction Vehicle Operations Summary

Vehicle operations during roadway construction will primarily be those associated with subgrade and pavement construction. Throughout the construction season, most vehicles operate continuously during the daylight hours - typically 12 hours per day, although 24 hour continuous construction is common. Construction will be restricted during sleeping hours near developed area. Trucks used to deliver materials to the construction site will be restricted to travel on paved roads and approved access roads in the area, in compliance with seasonal weight restrictions.

Subgrade Construction: During subgrade construction, the vehicle types will include excavators, dozers, off-highway trucks, graders and supervisory staff vehicles including half-tons and small 4 x 4 trucks. Wheel tractor scrapers and various types of compactors (many of which are vibratory) may also be utilized. Most of the vehicles will operate on diesel fuel although some may be powered by gasoline engines, and all will require some form of daily maintenance.

For the most part, activity during the subgrade construction will be limited to on-site operations. Off-highway trucks will likely be used to transport material along the roadway corridor and between the corridor and the sites used to dispose of waste materials. Similarly, if borrow material is required, the vehicles will transport material from the borrow site to the highway corridor.

Pavement Construction: During the pavement construction phase, the vehicles used in transport of construction material are primarily pneumatic tired and steel drum rollers, graders, highway trucks, and asphalt pavers. The highway trucks will be utilized to transport the granular pit run and crushed materials as well as the asphaltic concrete and/or PCC. Depending on the location of the asphalt or concrete plants and suitable sources of aggregate materials used for the pavement mix and the road base construction, there will be trucking activity between the material storage and asphalt/concrete plant locations and any associated short connecting access roads to the roadway corridor. All other activity will occur along the highway corridor. This phase of construction may also involve the delivery of liquid asphalt and diesel fuel to the Project site from external sources.

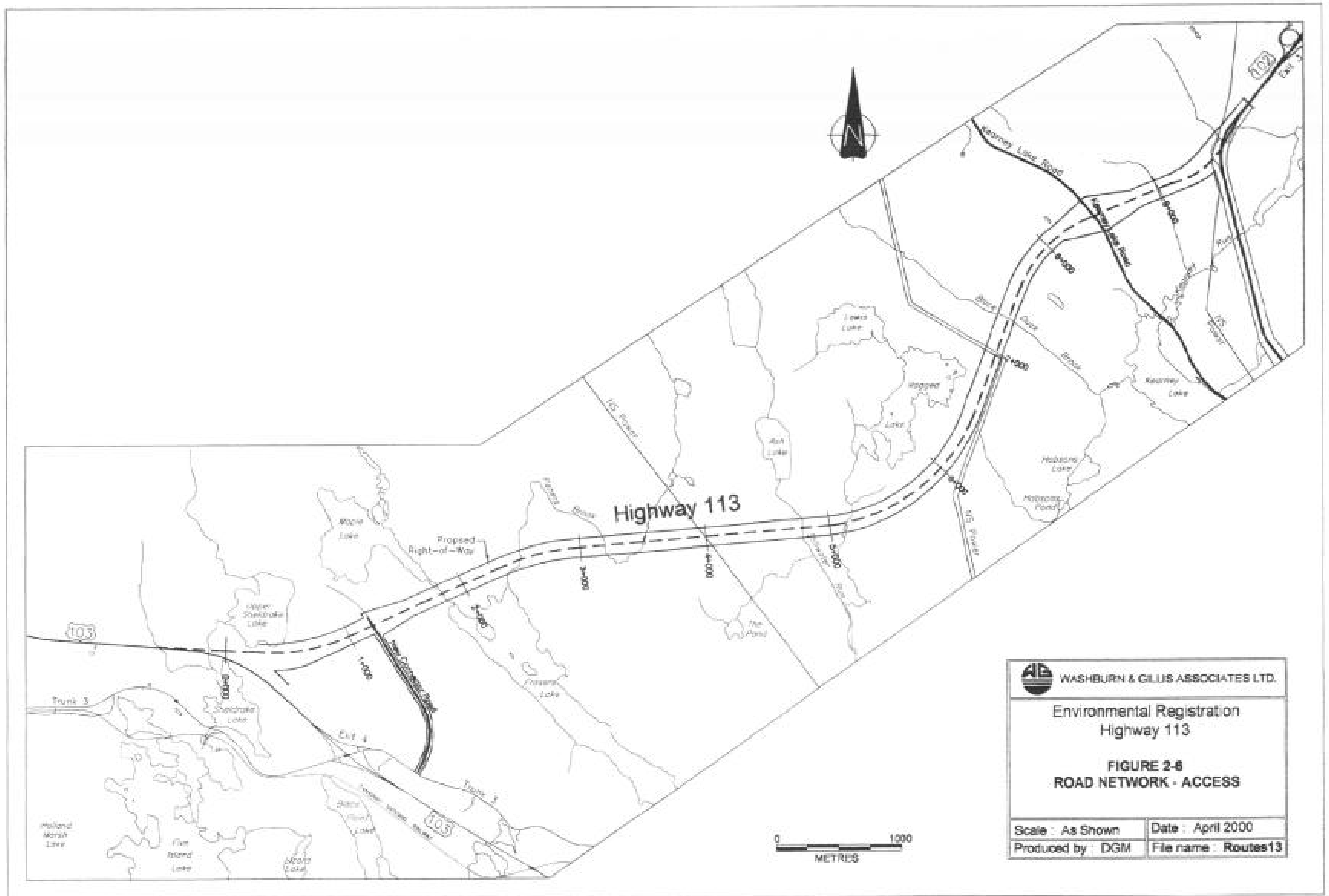
General Servicing Activities: The primary concern regarding all equipment operation associated with this Project, whether it relates to subgrade or pavement construction, is the possibility for accidental petroleum product spills. These spills can occur during equipment refuelling and servicing. Leakage from vehicles can also lead to contamination of the ground, groundwater and surface run-off. Contingency plans for accidental spills will be required from the Contractor.

2.3.3.6 Transport Network/Access Requirements

Access Roads Required During Construction: The existing road network in the Study Area is illustrated on Figure 2-6. The main access points to the Project will be at the east and west extremities. Due to the timing of the proposed highway construction (to begin in 10 to 15 years), the need for supplementary access roads, if required, will be determined during the detailed design stage.

At that time, it will be possible to establish the precise nature of all contract limits and their associated access requirements. Such requirements will be based on the overall coordination of all individual contracts throughout the Project, with efforts being focussed on minimizing negative impacts along existing woods roads and such temporary access roads, as might be required.

FIGURE 2-6
ROAD NETWORK - access



When construction is complete, all temporary access roads will be terminated, or developed as in the case of the connector. Such facilities will be treated in a similar manner as the treatment of "disposal areas" and "construction work camps" after completion. Similarly, the intersection of these construction access roads shall be rehabilitated to ensure future productive use and shall be graded and revegetated as required.

Access During Operations: Access roads will be constructed as required to access private property cut off by construction of the highway. The details of these roads will be finalized during the design stage and constructed at the same time as the main highway.

2.3.3.7 Operations Activities

Normally the operations of highway dominated infrastructure are broken into the three categories of summer, winter, and bridge maintenance activities. By the time the operational stage commences, all temporary construction accesses, if required, will have been closed. The only access will be along the highway during operation.

Summer maintenance activities are routinely carried out to ensure that roadways provide the level of service, both in terms of comfort and safety, for which they were designed. Bridge maintenance activities are necessary to ensure the safety and structural integrity of the bridge structures.

Summer Maintenance Operations: The specific activities associated with summer highway maintenance are:

Patching and Levelling (Resurfacing): Pavement surface deterioration will occur as the facility is used, the extent determined by the volume and characteristics of the traffic.

Normal resurfacing functions related to asphaltic concrete include patching and levelling of the pavement structure wearing surface. This may involve excavation or removal of existing pavement and subgrade levelling, patching, sealing and paving. These activities are similar to the pavement surfacing activities during the initial construction phase.

The maintenance operations will be short term and infrequent in nature. In the long term, there may be need for somewhat more extensive periodic repair which may include aspects of the roadbed (*i.e.*, subgrade reconstruction). This may also include work with respect to maintaining the shoulder structure of the roadway. Such activities could involve addition of fill/embankment materials and associated levelling.

Ditching/Drainage: It will be necessary to provide periodic maintenance of the highway drainage system to ensure that it continues to function in the intended manner. This will involve the repair and replacement of culverts and re-establishment of the drainage network. In some areas this will require removal of standing vegetation and siltation which might result from erosion of side slopes. This normal ditching activity is undertaken to rectify deficiencies which occur over time as a result of ditch erosion, non-conformity in grade, line, or cross section of the ditch, water ponding on roadway, and/or restrictive vegetation growth.

Culvert Replacement and Repair to Drainage Structures: It will be necessary to maintain culverts, property accesses, off-takes, catch basins, drop inlets and roadbed and ditch subdrains to ensure they are properly cleaned and maintained in the manner required to ensure their proper operation.

Mowing and Brush Cutting: Control of vegetation within the initial clearing limits will eventually be required to maintain safe sight distances, to prevent drainage obstructions, and to improve roadside appearances. The effort required for brush control will be mitigated by selection of vegetation which will limit this activity as much as possible.

Vegetation Control using Herbicides:: TPW, as the land owner of highway RoWs is required under the ***Weed Control Act*** to destroy all noxious weeds identified under the Act which are likely to spread to cultivated or pasture land. TPW has, for the most part, stopped using herbicides and uses mowing for vegetation control. Spot spraying of herbicides is used to control some vegetation, such as Sweet Clover. All spraying on 100-series highways is completed by TPW staff according to terms of a permit issued by NSDOE. The chemical used most frequently for weed control on 100-series highways is "Garlon 4" supplied by Dow Elanco. Garlon 4 has a very low toxicity to most organisms. For example, if ingested by mammals, the active ingredient, triclopyr, will pass through the body within 3 days with no accumulation in the body organs (Dow Elanco, 1991).

Sign and Guard Rail Maintenance: All regulatory and supplementary directional and signage shall be erected and maintained as required to control and facilitate the safe movement of traffic. Guard rails shall be located in accordance with standard procedures for installation.

<u>Winter Maintenance Operations</u>: The specific activity associated with winter highway maintenance is:

Snow Removal and Ice Control: Snow removal and ice control is necessary during winter months to ensure the required level of service (Level I) is effectively maintained. This typically involves plowing and the application of salt (sodium chloride) in predetermined quantities. In the area of the proposed undertaking, salt is applied at a rate of approximately 20 Te/km/yr of 100-series highway. During the past five years total salt application rates have varied between 13 and 43 Te/km/yr on Halifax suburban roads and 100-series highways (Denis Rushton, TPW, personal communication, 1999). The application rate can vary and is dependant on the number of storms during the winter months, the temperature, and the driver's personal judgement of how much salt is needed.

TPW purchases salt from the Canada Salt Company in Pugwash, NS. Canada Salt adds an anti-caking agent (Sodium Ferrocyanide {$Na_4[Fe(CN)_6]\cdot 10\ H_2O$} - also known as Yellow Prussiate of Soda) to the salt to provide a more effective product. The concentration of Sodium Ferrocyanide in applied highway salt is approximately 100 ppm. Sodium Ferrocyanide is known to release free cyanide if exposed to ultraviolet light and to produce HCN if exposed to powerful acids (Degussa Chemical, 1979).

Bridge Maintenance: Maintenance of bridges involves the following types of activities:

Superstructure Maintenance: The superstructure maintenance activities generally involve repairing and replacement of damaged or deteriorated bridge components above the travelled surface. This work is necessary to ensure the structural integrity of the bridge structure.

Bridge Deck Maintenance: Bridge deck maintenance involves the on-going activity necessary to ensure that bridge deck drains, weepholes, catch basins, and drainage pipes are installed, cleaned and/or repaired as necessary to prevent deterioration due to water damage. This work is also necessary to achieve drainage from the bridge deck surfaces for safety reasons.

Chipsealing: As bridges age, a chipseal surface is sometimes applied to the bridge deck and approaches to improve skid resistance on the deck surface and extend the life of the deck. Typically, chipsealing is applied to bridge decks in conjunction with chipsealing of several kilometres of highway.

Substructure Maintenance: Substructure maintenance relates to the repair and replacement of damaged or deteriorated bridge components below the travelled surface.

Bridge Cleaning: Bridge cleaning is undertaken to prevent the accumulation of dirt and debris which may restrict normal movement of the structure (ie. expansion activity) and/or retain moisture which will lead to bridge component deterioration.

Protective Coatings: Protective coatings are periodically applied and removed from bridge components and beams to prevent steel corrosion, and improve appearance. Appropriate measures shall be taken, as directed by the ***Environmental Protection Guidelines for the Application and Removal of Structural Steel Protective Coatings*** (NSDOE, 1997) to ensure the material and associated residue do not enter the watercourse to the extent that may cause environmental problems.

Slope Protection: Slope protection is necessary adjacent to the bridge abutments and piers. Slope protection could involve the application of armour stone, hydroseeding, etc., as an effective means of stabilizing the slope.

Channel Maintenance: Channel maintenance is undertaken infrequently to remove debris from the channel and bridge openings, to reshape the channel to maintain stream alignment, and to repair damage resulting from scour, erosion and/or siltation.

Grouting: Grouting of the bridge structures may be necessary to ensure that voids under approach slabs and inside abutments and piers, are filled with concrete grout or other fillers to protect them from moisture and associated deterioration.

Stockpiling Materials: All materials used for bridge maintenance activities will be stockpiled outside of the Project study area.

All of the above routine maintenance activities shall be done in accordance with the accepted environmental standards and protocols and shall comply with all pertinent legislation and guidelines.

3.0 REASON FOR THE UNDERTAKING

The reason for the proposed construction of Highway 113 is to provide a more efficient means of travel for motorists between Highway 103 and Highway 102 that bypasses the Halifax urban core. The proposed Project is part of an overall TPW strategy that addresses the transportation needs of the province and the local community.

In addition, the proposed highway will alleviate much of the current traffic congestion experienced on Hammonds Plains Road. Frustration was expressed at the Open House (see Section 11.0) by residents of the Hammonds Plains area about the present level of traffic congestion experienced by motorists on the Hammonds Plains Road. The Hammonds Plains area is an expanding residential area and congestion is expected to increase over time.

It is important at this time to identify and preserve a corridor for Highway 113, although TPW does not expect to begin construction of the highway for 10 to 15 years. Residential development is occurring at an increasingly fast pace in the areas of Sheldrake Heights, Kingswood, Kingswood South, and Kearney Lake Road. Continued development in these areas will result in a case where a highway corridor can not be acquired, without significant property disruption and prohibitive cost.

The proposed Highway 113 would form part of the provincial 100-series highway network. As such, the highway would be designed as a four lane freeway with a wide median, fully controlled access, entrances and exits at interchanges only, and a posted speed of 100 to 110 km/hr.

3.1 Traffic Volume and Capacity

Through traffic currently travelling on the provincial 100-series highway network from Highway 103 along the south shore to Highway 102 north of Bedford, must travel into the central core of Halifax Regional Municipality. The only alternate road bypassing the Halifax area is Hammonds Plains Road (Route 213). Through truck traffic is prohibited on Hammonds Plains Road.

TPW traffic count records for the period between 1994 and 1998 show that approximately 32,000 and 12,000 vehicles per day presently travel on Highway 102 and Highway 103, respectively, in the vicinity of the proposed Highway 113. Approximately 12,000 vehicles per day currently travel on Hammonds Plains Road (Route 213) between the Highway 102 interchange and the Lucasville Road. Highway 113 will significantly reduce the through non-truck traffic on Hammonds Plains Road. Traffic modeling (TPW, 2000) indicates that there would be up to a 55% reduction in the number of vehicles (6,500 vehicles per day) on portions of Route 213 in the year 2016.

3.2 Safety

Construction of Highway 113 would divert the through traffic from Hammonds Plains Road onto the new highway, thereby reducing accident risks and occurrence on the Hammonds Plains Road.

TPW accident records show that the segments of Hammonds Plains Road between the Highway 102 interchange and the Lucasville Road and between the Lucasville Road and the Highway 103 interchange experienced 5-year annual average vehicular accident rates of 95.2 and 101.0 accidents per 100 million vehicle-kilometres (HMVK), respectively, for the period from 1994 to 1998. The average accident rate for two-lane rural route highways in Nova Scotia was 107.6 accidents/HMVK, over that same period. The provincial average accident rate for four-lane access-controlled wide-median 100-series highways, over the period from 1994 to 1998, is 34.7 accidents/HMVK.

3.3 Efficiency of Travel

The Proposed Highway 113 would reduce the travel distance from Highway 103 to Highway 102 by approximately 13 km. This represents a potential travel time savings of 8 to 10 minutes and associated fuel costs and wear and tear costs.

Provision of an interchange at Kearney Lake Road, constructed as part of this Project would improve access to the 100-series highway network for the expanding development of the area.

4.0 OTHER METHODS FOR CARRYING OUT THE UNDERTAKING

Other methods of carrying out the undertaking include the following:
- alternative route alignments;
- adjusting the median width; and
- other construction techniques.

4.1 Alternative Route Alignments

Physical constraints related to topography (lakes, rivers, hills etc.) and community development dictate where a highway can be constructed to meet economic and operational objectives.

An alternative route alignment to the currently proposed Highway 113 was investigated by TPW. The alternative route bypassed north of Hammonds Plains Road and connected Highways 103 and 101. Traffic travelling from Highway 102 to Highway 103 would be routed through Highway 101.

The alignment bypassing north of Hammonds Plains Road would be considerably longer and, correspondingly, a more expensive alternative. It also entailed an expensive and difficult connection to Highway 103. In addition, traffic modelling performed by TPW indicated that a connection between Highways 101 and 103 would be significantly underutilized. Regardless, that option is currently blocked by development.

4.2 Adjusting the Median Width

Narrowing the median width would result in a reduced land requirement for the highway RoW. Such a modification to the Project description would result in a reduced Project “footprint” and a smaller area disturbed by construction activities.

Reducing the median width could be accomplished by designing the highway such that the lanes are positioned closer together with a narrower grassed median or by aligning the lanes so that they are directly adjacent to each other, separated by a concrete barrier (*i.e.*, Jersey barrier). Jersey barriers are normally used to provide lane separation where land is not available for the construction of medians.

Benefits of a reduced median width include a reduced potential for environmental impacts and reduced financial resources required to purchase the highway RoW.

Disadvantages of a reduced median width include maintenance problems associated with snow removal and vegetation control, a decreased level of public safety associated with a greater likelihood of vehicle accidents, and a reduced design speed of 100 km/hr.

A reduced median width is not considered appropriate for the design of Highway 113 because of the disadvantages described above and contravention of TPW policy regarding the construction of new divided highways.

4.3 Other Construction Techniques

Typical techniques for construction of Highway 113 are described in Section 2.0. The Contractor will choose the method of construction, however, it is not expected to differ significantly from that described earlier.

The final surfacing for the highway will consist of either AC of PCC, as described in Section 2.3.3.2. TPW will specify AC or PCC, based on performance requirements and cost considerations at the time of construction.

The environmental impacts of using AC or PCC are not expected to differ significantly in the Project area, irrespective of which is chosen for use on the highway.

5.0 ALTERNATIVES TO THE UNDERTAKING

Alternatives to the undertaking, include the following:
- other modes of transportation;
- upgrading Hammonds Plains Road; and
- the null or "do nothing" alternative.

5.1 Other Modes of Transportation

Other modes of transportation include increased use of mas transit (*e.g.* rail and bus). Increased use of mass transit would reduce traffic on Hammonds Plains Road and urban sections of Highways 102 and 103. A reduced accident rate along Hammonds Plains Road and decreased travel time between Highway 102 and 103 would likely result because of fewer vehicles on the roads in the area. Nonetheless this method of reaching the objective is not seen as feasible due to the following:
- the origins and destinations of much of the traffic on Highways 102 and 103 is to and from locations distant to the urban core where mass transit is not and will likely not be available in the foreseeable future; and
- truck travel and the transportation of heavy goods is not addressed by mass transit.

5.2 Upgrading Hammonds Plains Road

Upgrading the Hammonds Plains Road to a 100-series, controlled access highway and allowing truck through traffic would result in a comparable design and service level as that which would be provided by the proposed Highway 113. This would also likely result in a reduced accident rate, fewer vehicles on the urban sections of Highways 102 and 103, and decreased travel time between Highways 102 and 103.

Upgrading Hammonds Plains Road to meet the future traffic demand and allow truck traffic would require a minimum construction standard of a two-lane, controlled access, 100-series highway. This would necessitate the construction of two 3.7 m wide lanes and 2.5 m wide shoulders separated by a raised concrete median with passing lanes in the appropriate locations.

This option is not viewed as viable as it would necessitate extensive reconstruction in a developed area including the following:
- construction of storm sewers with curb and gutter for drainage control, to replace the existing ditches;
- loss of direct individual access to the road by residential and commercial property owners;
- construction of access roads behind existing properties, to provide access control along the 2-lane widened highway;
- encroachment on most residential and commercial properties along the road for RoW requirements, due to the fact that much of Hammonds Plains Road has only a 20 m of RoW;
- extensive acquisition of developed properties for the road and interchanges that would pose considerable difficulties and disruption of private land uses and land owners.

5.3 Null Alternative

The null or "do nothing" alternative involves projecting traffic growth into the future, while assuming that the existing highway facilities will remain unchanged.

Traffic growth is predicted to increase by 2.5% per annum on highways in the study area, based on historic data. Additionally, traffic growth along Hammonds Plains Road is likely to increase annually at a substantial rate due to the rapid development in the area. This will likely result in an increase in the number of accidents and travel delays, if the highway system is left unchanged.

Through traffic travelling on the provincial 100-series highway network between Highway 102 and 103 will continue to travel into the Halifax urban core to access the Highways. Hammonds Plains Road will continue to be the only alternate route bypassing the Halifax area for passenger vehicles. Through truck traffic will continue to be prohibited on Hammonds Plains Road. Accident levels will increase, as a minimum, in proportion to traffic growth and travel time delays will continue to increase. This will result in increased driver frustration and fuel inefficiencies over the highway network and increased vehicular wear from stop and go driving conditions on the Hammonds Plains Road.

6.0 DESCRIPTION OF EXISTING ENVIRONMENT

A description of the existing environment is necessary for two reasons:

- to determine which resources may be at risk from the proposed Project; and
- to provide a baseline for identifying environmental change in the future.

The description of the existing environment is based upon available resource information from existing data and resource managers. Field work was carried out as necessary to augment the existing information base.

6.1 Atmospheric Environment

Included in this section is information describing the following components of the atmospheric environment:

- Climate;
- Air Quality; and
- Noise.

6.1.1 Climate

In general, the study area is situated within a cool, temperate climatic zone which is influenced by the marine environment and prevailing westerly winds. Winters have been traditionally cold with frequent snowfall. Average snowfall amounts have been in the order of 200 cm on an annual basis. In recent years, winters have become milder, resulting in less snowfall and more freezing precipitation. Spring is generally late (early May), cool and cloudy. Summers are historically short in duration, warm and somewhat humid. Total annual precipitation is approximately 1400 mm (including snowfall), with annual sunshine reported to be in the order of 1950 hours. Annual records of days with freezing precipitation, fog and thunderstorms are reported to be approximately 15, 120, and 10, respectively.

The meteorological elements that have the most direct and significant effects on the distribution of air emissions are wind speed and direction, solar radiation, stability and precipitation. Climate normals (30-year average period) are available from Environment Canada for two principal weather stations located within the general study area: Halifax International Airport (HIA); and CFB Shearwater. A summary of the climate normals are presented for the two stations to provide a thorough understanding of baseline meteorological data for the study area.

6.1.1.1 Temperature

Climate normals are estimates of the true mean. A 30-year period is used to characterize climatic elements and eliminate any year-to-year variations. Temperature normals (1961-1990) for HIA and CFB Shearwater weather stations are presented in Table 6-1. The annual daily mean temperature is 6.1^{o}C at the HIA station and 6.5^{o}C at the Shearwater station. The annual mean daily maximum temperatures are 10.7^{o}C (HIA) and 10.6^{o}C (Shearwater). The annual mean daily minimum temperatures are 1.4^{o}C (HIA) and 2.3^{o}C (Shearwater).

TABLE 6-1
Temperature Normals

Month	Halifax International Airport Weather Station			CFB Shearwater Weather Station		
	Daily Max. (ºC)	Daily Min. (ºC)	Daily Mean (ºC)	Daily Max. (ºC)	Daily Min. (ºC)	Daily Mean (ºC)
January	-1.5	-10.3	-5.8	-0.3	-8.9	-4.6
February	-1.5	-10.6	-6	-0.6	-9.1	-4.8
March	2.6	-6.1	-1.7	2.9	-5	-1
April	8	-0.9	3.6	7.8	-0.2	3.9
May	14.7	4.1	9.4	13.3	4.3	8.9
June	20.1	9.3	14.7	18.4	9.2	13.9
July	23.4	13.2	18.3	21.8	13.1	17.5
August	23	13.2	18.1	22.1	13.7	17.9
September	18.7	9	13.8	18.7	10	14.4
October	13	4	8.5	13.3	5.2	9.3
November	7	-0.6	3.2	7.8	0.6	4.2
December	1.2	-7.2	-3	2.3	-5.8	-1.7
Annual Mean	10.7	1.4	6.1	10.6	2.3	6.5

Notes:

1. Normals is the term commonly used for values of climatic elements averaged over a fixed, standard period of years. A 30-year period is used as the standard period and in this instance is from 1961 - 1990.
2. Source: Canadian Climate Normals, 1961 - 1990, The Atlantic Provinces, Environment Canada, 1993.

The daily mean temperature remains below 0ºC for the months of December through March. The annual number of days where the maximum temperature was below 0ºC is 60 days at the HIA station and 50 days at Shearwater. Extreme temperatures over the period of record, ranged from an extreme minimum of -26.1ºC in January at Shearwater and February at HIA to an extreme maximum of 34.4ºC in August at HIA.

6.1.1.2 Precipitation

Precipitation constitutes an effective cleansing process of pollutants in the atmosphere. It provides a washing out or scavenging mechanism for large particles by the falling action of raindrops or snowflakes (*i.e.*, washout). It can also accumulate small particles in the formation of raindrops or snowflakes in clouds (*i.e.*, rainout). Gaseous pollutants are also removed by dissolution and absorption. Washout of large particles is considered the most effective and prevalent of these three processes, particularly in the lower layer of the atmosphere, where most of the pollutants are released. Precipitation normals are summarized in Table 6-2. The total annual mean for the HIA station is 1473.5 mm and 1370.7 mm for Shearwater. The total annual mean is defined as the total water equivalent of rainfall plus snowfall. The rainfall, snowfall and precipitation amounts shown in the Table represent an average accumulation for a given month or year.

TABLE 6-2
Precipitation Normals

Month	Halifax International Airport Weather Station			CFB Shearwater Weather Station		
	Average Rainfall (mm)	Average Snowfall (cm)	Total Precipitation (mm)	Average Rainfall (mm)	Average Snowfall (cm)	Total Precipitation (mm)
January	86.5	64.2	146.9	81.5	48.9	128.9
February	62.2	59.9	119.1	60	46.4	107.4
March	79.8	44.4	122.6	78.4	32.3	110.8
April	100.6	22.1	124.4	94.5	14.1	110.1
May	107.2	3.1	110.5	102.3	2.2	105
June	98.4	0	98.4	104.1	0	104.1
July	96.8	0	96.8	97.8	0	97.8
August	109.6	0	109.6	102.6	0	102.6
September	94.9	0	94.9	91.5	0	91.5
October	126.2	2.7	128.9	119.8	1.8	121.7
November	141.1	14.4	154.4	130.9	9.7	139.9
December	119.4	50.6	167	114.5	37.2	150.8
Annual Mean	1222.7	261.4	1473.5	1178.1	192.6	1370.7

Notes:

1. Normals is the term commonly used for values of climatic elements averaged over a fixed, standard period of years. A 30-year period is used as the standard period and in this instance is from 1961 - 1990.
2. Source: Canadian Climate Normals, 1961 - 1990, The Atlantic Provinces, Environment Canada, 1993.

The total annual mean snowfall for the HIA station is 261.4 cm and 192.6 cm for Shearwater. The heaviest snowfall accumulations are recorded in the months of January and February. A review of month-end snow cover values indicates a range of 10 to 18 cm (Dec. to Feb.) at the HIA station and a range of 6 to 8 cm for the same months at Shearwater. Extreme daily snowfall amounts for the period of record ranged from 47.5 cm (Dec.) in HIA to 50.8 cm (Feb.) in Shearwater.

The total number of days with freezing precipitation was recorded at 16 days (HIA) and 13 days (Shearwater) for an annual period, occurring between the months of December and April. Thunderstorms were noted 10 days (HIA) and 11 days (Shearwater) during an annual period. Measurable precipitation is recorded at 170 days for the HIA station and 158 days at Shearwater during the course of an annual period.

6.1.1.3 Wind

Wind is the motion of the air relative to the earth's surface. This motion derives from the unequal heating of the earth's surface and the adjacent air, which in turn gives rise to a horizontal variation in temperature and pressure. The variation in pressure constitutes an imbalance in forces so that air motion from high toward low pressure is generated. The total effect of these various circulations (for a particular area) establishes the hourly, daily and seasonal variation in wind speed and direction.

Figures 6-1 and 6-2 present wind rose diagrams for the HIA and Shearwater stations. Winds are predominately from the south and west directions. During the summer months, winds are predominately from the south and southwest directions. In winter, winds frequently move from the northwest and north directions. During storm events, winds from the southwest, southeast and south tend to dominate. Generally, winds from the easterly directions have the lowest frequency of occurrence.

Table 6-3 provides wind speed and direction data for the HIA and Shearwater stations. Average annual wind speeds (all directions) range from 16 km/hr at Shearwater to 18 km/hr at the HIA station. Winds are generally the strongest in winter. Maximum hourly speeds of 97 km/hr and 89 km/hr were recorded in February and maximum gust speeds of 150 km/hr and 132 km/hr were documented in December at Shearwater and HIA stations, respectively.

TABLE 6-3
Wind Speed and Direction Data

Halifax International Airport, NS (1961-1990)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
Wind Speed (km/hr)	19	19	20	19	18	17	16	15	15	17	18	19	18
Wind Direction	NW	NW	NW	N	S	S	S	S	S	SW	NW	NW	S
Max. Hourly Speed & Dir.	80 SW	89	77 SW	71	64 S	64 N	79 SE	56 SW	64 S	68 SE	69 SE	85 SE	
Max. Gust Speed & Dir.	117 S	127 SW	126 SW	115 SE	92 S	97 N	130 S	89 N	93 S	109 SE	111 S	132 SE	
Shearwater, NS (1961-1990)													
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual
Wind Speed (km/hr)	19	19	19	18	15	14	12	12	14	15	17	19	16
Wind Direction	NW	NW	NW	N	S	S	S	SW	SW	W	NW	NW	NW
Max. Hourly Speed & Dir.	83	97	78 SW	85 NE	72	77 N	87 SE	60 NE	97 N	80 NE	89 SE	89 SE	
Max. Gust Speed & Dir.	127 S	146 S	148 SW	122	106 W	111 N	114 S	93 SW	126 N	132 S	121	150 SW	

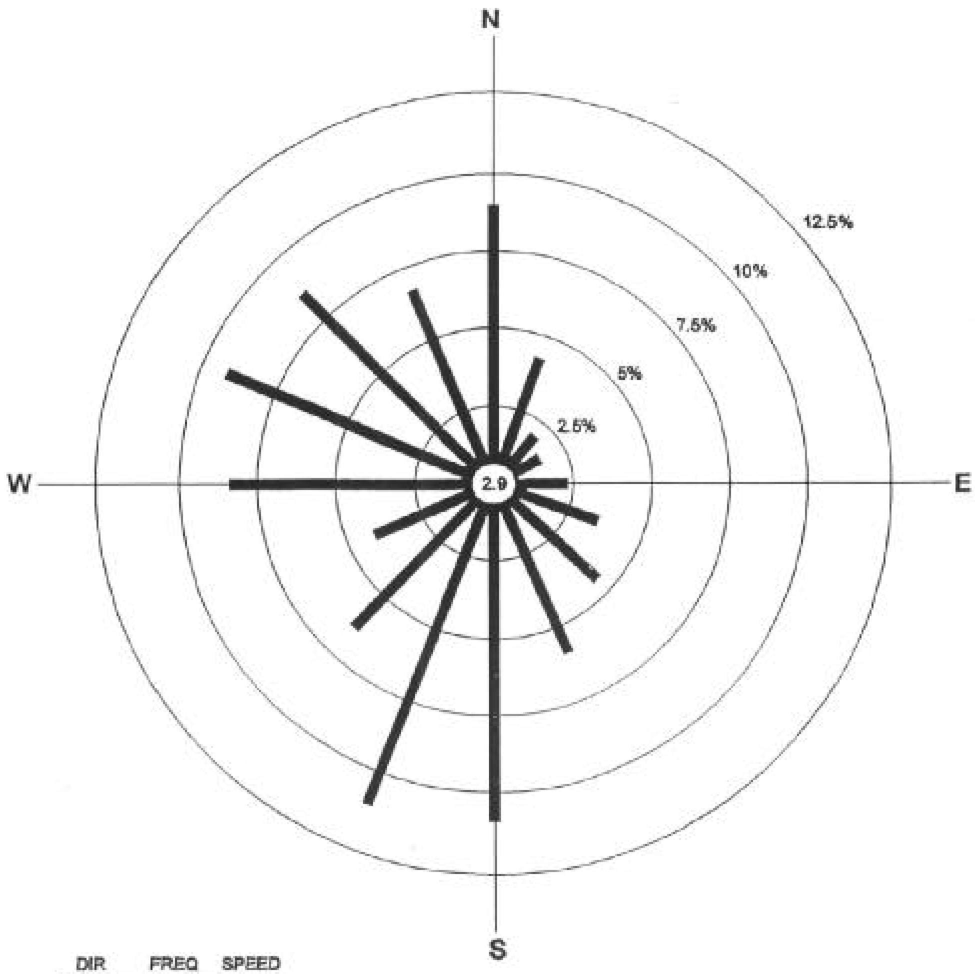
Source: Canadian Climate Normals, 1961 - 1990, The Atlantic Provinces, Environment Canada, 1993.

6.1.1.4 Climate Change

During the last few decades, concerns has been voiced concerning the concentration of greenhouse gases in the atmosphere that may result in a change in climatic conditions.

Figure 6-1 WIND ROSE 1

WASHBURN & GILLIS ASSOCIATES LTD.



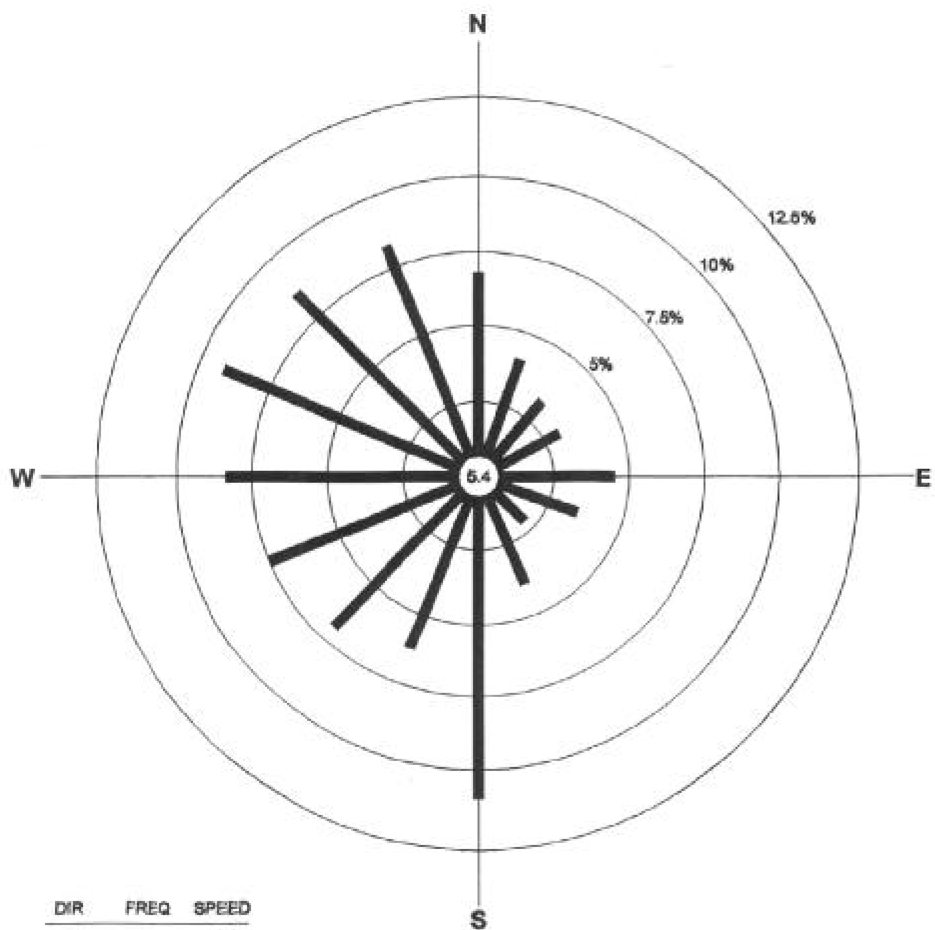
DIR	FREQ	SPEED
N	8.4	18.2
NNE	3.9	16.3
NE	2.1	14.5
ENE	1.3	15.2
E	2.4	17.2
ESE	3.3	19.9
SE	4.8	18.1
SSE	6.0	18.0
S	11.1	18.9
SSW	11.2	21.2
SW	6.5	19.0
WSW	4.7	16.5
W	8.0	17.4
WNW	8.6	19.3
NW	8.1	19.0
NNW	6.7	19.1
Ca	2.9	

SOURCE: Environment Canada Atmospheric Environment Service

FIGURE 6-1
WINDROSE
HALIFAX INTERNATIONAL AIRPORT

Figure 6-2 WIND ROSE 2

WASHBURN & GILLIS ASSOCIATES LTD.



DIR	FREQ	SPEED
N	7.1	19.2
NNE	4.0	19.8
NE	2.9	16.6
ENE	3.0	19.8
E	4.8	21.0
ESE	3.2	20.0
SE	2.4	17.4
SSE	4.1	18.4
S	8.4	17.9
SSW	6.7	19.4
SW	7.3	18.4
WSW	7.5	17.0
W	8.0	18.7
WNW	9.1	18.9
NW	8.1	16.8
NNW	7.9	17.8
Ca	5.4	

SOURCE: Environment Canada Atmospheric Environment Service

FIGURE 6-2
WINDROSE
C.F.B. SHEARWATER

Various government agencies including Natural Resources Canada and Environment Canada forecast long-term changes in climatic conditions including the frequency of extreme climate events that could have serious impacts on our environment, economy, society and our way of life.

The temperature on Earth is partially regulated by the "greenhouse effect". Greenhouse gases in the atmosphere, primarily water vapour, carbon dioxide, methane and nitrous oxide, trap the heat of the sun, preventing radiation from dissipating into space.

Concentrations of greenhouse gases have increased significantly since the industrial age and some scientific evidence shows that human activities may be accelerating climate change.

Environment Canada (1999) states that global temperature could rise by 1 to 3.5°C over the next century. In Canada, it could mean an increase in annual mean temperature in some regions between 5 and 10°C over the next century. Natural Resources Canada indicates that corresponding with current global warming, alpine glaciers have retreated, sea levels have risen, and climatic zones are shifting.

6.1.2 Air Quality

Topographic, meteorological and land-use characteristics of specific areas within an airshed will vary. The social and economic development of an area will also result in different degrees of air pollution and the demands for air quality. Standards have been developed or adopted for specific areas to ensure protection of human health.

The types of air pollutants associated with transportation are related to the original materials used for combustion, the impurities they contain, the actual emissions, and the reactions in the atmosphere. Primary pollutants (*i.e.*, those found in the atmosphere in the same form as they exist when emitted from the source) include sulfur dioxide, nitrogen dioxide, hydrocarbons, carbon monoxide, particulate matter (smoke); and, to a lesser degree, aldehydes and organic acids. Secondary pollutants are those formed in the atmosphere as a result of reactions such as hydrolysis, oxidation and photochemistry (*i.e.*, photochemical smog).

Most combustible materials are composed of hydrocarbons. Inefficient combustion produces unburned hydrocarbons, smoke, carbon monoxide, aldehydes and organic acids. The use of automobile catalytic converters in recent years, to control carbon monoxide and hydrocarbon emissions, have caused a minor increase in sulfates and sulfuric acid emissions. Also, the elimination of lead from gasoline has, in some cases, led to the substitution of manganese for antiknock purposes, with the consequent release of manganese compounds.

Impurities in combustible hydrocarbons include sulfur, and when combined with oxygen, will produce sulfur dioxide (SO_2) when burned. The SO_2 may then form sulfuric acid and other sulfates in the atmosphere. Oxides of nitrogen, from high-temperature combustion in motor vehicles, are released mostly as nitrogen dioxide (NO_2) and nitric oxide (NO). The source of nitrogen is principally the air used in combustion. Sulfur and nitrogen oxides play a significant role in the formation of acid rain. In addition, photochemical oxidants (including ozone and formaldehydes) can be produced in the lower atmosphere as a result of the reaction of oxides of nitrogen and volatile organics in the presence of solar radiation.

Table 6-4 provides a summary of Nova Scotia's Ambient Air Quality standards for regulated air contaminants. These contaminants can lead to a variety of health and environmental effects depending upon the nature of the pollutant, its concentration, the exposure period, the presence of other pollutants, and receptor sensitivity.

TABLE 6-4
Ambient Air Quality Regulations for Nova Scotia

Air Pollutant	Averaging Period	Maximum Permissible Ground Level Concentration	
		$\mu g/m^3$	pphm [(1)]
Carbon Monoxide (CO)	1 Hour 8 Hour	35000 15000	3100 1300
Hydrogen Sulphide (H_2S)	1 Hour 24 Hour	428	30.6
Nitrogen Dioxide (NO_2)	1 Hour 24 Hour Annual	400 – 100	21 – 5
Ozone (O_3)	1 Hour	160	8.2
Sulphur Dioxide (SO_2)	1 Hour 24 Hour Annual	900 300 60	34 11 2
Total Suspended Particulate (TSP)	24 Hour Annual	120 70	– --

Notes:
1. Parts per hundred million.
2. Source: NSDOE, 1995.

Currently, the general air quality within the study area is monitored continuously by both Provincial and Federal governments. Air quality monitoring is carried out to determine the concentration of various contaminants and to compare these levels to accepted standards. The parameters continuously monitored by these stations are sulphur dioxide, nitrogen dioxide, carbon monoxide (CO), ozone (O_3) and total suspended particulate matter (TSP). The information in this section is based on monitoring data from nearby monitoring stations operated by the National Air Pollution Surveillance Network (NAPS) of the Environmental Protection Service of Environment Canada and the Air Quality Branch of the Nova Scotia Department of the Environment.

6.1.2.1 Sulfur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a strong, pungent, suffocating odour at elevated levels. Most people can detect its acidic taste when ambient concentrations reach between 0.3 and 1.0 parts per million. SO_2 emissions dissolve rapidly in water, eventually forming sulfuric acid and are considered a major cause of acid rain. The primary source of SO_2 is from the burning of fossil fuels.

The effects from exposure to elevated SO_2 can be magnified in the presence of other pollutants (*e.g.*, suspended particulates). In general, a decrease in respiratory function is the normal human response to SO_2 concentrations in excess of acceptable level objectives. Elevated levels in air can also be damaging to plant foliage, as well as toxic to fish.

As indicated, sulfur is one of the impurities in combustible hydrocarbons (coal and oil), and when combined with oxygen, produce SO_2 emissions during combustion. The SO_2 then may form sulfuric acid and other sulfates in the atmosphere. In Nova Scotia, imported oil and local coal supplies are used extensively for energy production and space heating. Emissions of sulfur dioxide in Nova Scotia totalled approximately 170,000 tonnes for 1995.

A review of the total SO_2 emissions for Nova Scotia (1995) indicates that stationary fuel combustion sources contributed 88.7% of the total, industrial sources (oil refineries and pulp and paper mills) 9.7%, with a minor contribution from the transportation sector (1.6%). Nationally, SO_2 emissions in Canada have declined dramatically over the past two decades, largely the result of tighter regulations. The total of 6.7 million tonnes in 1970 has fallen to a total of 3.7 million tonnes in 1985, with overall SO_2 emissions in the Year 2005 projected to be over 56% lower than the 1970 value (3 million tonnes/year).

A review of 1995 SO_2 monitoring data from the Halifax-Dartmouth area indicates the following:

- 1-hour maximum concentrations ranged from 1.0 part per hundred million (pphm) at Lakeside to 17.9 pphm at Albro Lake in Dartmouth, with no exceedances of the 1-hour objective recorded;
- 24-hour concentrations ranged from 0.8 pphm at Lakeside to 5.2 pphm at Water St., with no exceedances of the 24-hour objective recorded; and
- Annual mean concentrations ranged from 0 pphm at Lakeside to 1.1 pphm at Barrington Street in Halifax.

6.1.2.2 Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a brown to reddish-brown gas with a sharp, pungent, irritating odour, detectable by humans at about 10 pphm. NO_2 reacts with hydrocarbons in the presence of sunlight to form ground-level ozone and contributes to the formation of acid rain and visibility-reducing haze (*i.e.*, smog). The majority of NO_2 detected in the environment is not the result of direct emissions, but from nitric oxide (NO) emissions. Nitric oxide is emitted by many combustion sources, especially those which operate at high temperatures and pressures. The NO emissions react rapidly with the oxygen in the atmosphere to form NO_2. Motor vehicle emissions are a major source of NO, as well as electrical generating stations and large heating boilers.

The effects of exposure to elevated NO_2 concentrations include irritation of the eyes and throat (above 150 pphm). Asthmatics may exhibit mild symptoms at 50 pphm. Injury to vegetation occurs at above 200 pphm. NO_2 emissions can also act as a source of nitrogen that can increase the nutrient value of water bodies and promote eutrophication.

In Nova Scotia, emissions of nitrogen oxides (NO_x) totalled approximately 70000 tonnes per year, based on 1990 data. A review of the total NO_x emissions for Nova Scotia indicates that the transportation sector contributed 52% of the total, industrial sources 13% and stationary fuel combustion sources 35%. Ambient levels of NO_x in Nova Scotia do not pose a risk to human health or the environment. However, controls on NO_x emissions, at both the national and international level, are being pursued due to the link between these emissions and smog formation.

A review of 1994 NO_2 monitoring data from downtown Halifax (Barrington St.) and CFB Shearwater indicate that ambient levels (4 to 8 pphm) were well within acceptable levels (21 pphm) on an hourly basis. The CFB Shearwater site represents a non-urban environment where vehicle emissions were not as significant a factor on local air quality. Annual levels at both sites are typically below 2 pphm, below the acceptable level of 5 pphm. The long term trend for NO_2 levels in the Halifax-Dartmouth area is relatively constant and well within the desirable range (NSDOE, 1994).

6.1.2.3 Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas that is formed from the incomplete combustion of carbon compounds. Major emission sources include motor vehicles, home heating systems and refuse burning. High levels of CO can be found in congested city traffic, especially in winter (*i.e.*, vehicle engines produce more pollution in colder weather). Also, drivers and passengers in vehicles are generally exposed to higher levels of CO than pedestrians in city streets. In a non-urban environment, CO is generally not a problem pollutant in the outdoors.

The effects from exposure to persistent CO concentrations above 30 ppm include cardiovascular symptoms in angina patients, as well as central nervous system effects. The presence of more than a trace of CO in water is a hazard to fish, while CO in air is relatively harmless to plant life.

In Nova Scotia, emissions of carbon monoxide totalled approximately 320,000 tonnes per year, based on 1990 data. A review of this total indicates that the transportation sector contributed 62% of the total, industrial sources 15%, incineration 6% and stationary fuel combustion sources 17%. Carbon monoxide levels in Atlantic Canada for the early 1990s appear to have been marginally lower than comparable levels from the mid-1980s. Studies indicate CO levels have improved in Canada as a result of the general reduction in motor vehicle exhaust emissions (NSDOE, 1995).

A review of 1995 CO monitoring data from downtown Halifax (Barrington St.) indicate that levels were within desirable levels. One-hour concentrations are below 5 ppm, compared to the 1-hour objective of 31 ppm. An annual objective for CO has not been adopted by the Province.

6.1.2.4 Ground Level Ozone

Ozone is a reactive, colourless, unstable form of oxygen; often found at relatively high concentrations during hot, hazy summer weather. This haze can build up over a period of days into a “photochemical smog”. The ozone itself is invisible, but the fine particles in the smog tend to produce a yellow or brown colour in the environment.

Ground-level ozone is not emitted directly, but is formed in the lower atmosphere from other pollutants, specifically NO_x and hydrocarbons. Significant contributors to ozone pollution include vehicle exhaust and industrial emissions. High temperatures and strong sunshine tend to accelerate the formation of ozone in a polluted atmosphere, with ozone episodes likely to occur in hot summer weather.

Nova Scotia is not a significant source of the emissions which cause ground level ozone to form, but rather a receptor of ground level ozone that is transported (long-range) from major urban and industrialized centres in the north-eastern United States and central Canada.

When pollutants are carried by the winds for hundreds and thousands of kilometres, it is referred to as trans-boundary pollution. Emissions of SO_2, NO_x, ground-level ozone and occasionally particulate matter travel through the atmosphere reacting with other chemicals, moisture and sunlight; producing acid rain and smog. Trans-boundary pollution is considered a serious threat to human health, the environment and economy.

Ground-level ozone can restrict human and animal respiratory function, with human lung function related to the concentration of ozone in the atmosphere and the level of activity of the individual. Minor effects on human respiration include decreased performance of the individual, while major effects include increased irritation causing coughing and asthmatic attacks. Ground-level ozone is viewed as the most important pollutant affecting vegetation and crops. Ozone also causes damage to rubber products, plastics, fabrics and paints.

Exceedances occurring between the early evening and the following early morning hours in Nova Scotia are indicative of “imported” ground-level ozone carried by prevailing south-westerly winds. A review of 1995 ozone monitoring data from the Halifax-Dartmouth area indicates no exceedances of the 1-hour objective (8.2 pphm) were recorded. The 1994 data shows 5 exceedances of the 8.2 pphm objective in Halifax. Meteorological conditions during the ozone season (April to September) will significantly affect the magnitude and the frequency of ozone exceedances experienced in Nova Scotia in the future.

6.1.2.5 Total Suspended Particulates

Particulate is a general term meaning “existing in the form of minute separate particles”, either solid or liquid. These minute particles in the air may be of natural, industrial or other man-made origin. Suspended particulate refers to those particles in the air such as smoke, soot and dust, that remain suspended in the air and do not settle out easily. Total suspended particulate (TSP) has been a standard pollution measurement for many years. This method provides no distinction between natural particles (*i.e.*, pollen, spores, etc.) and particles which are emitted from vehicles, stacks, chimneys and other point sources. It also does not provide information on the size of the particles. It may include particles as large as 50 µm in diameter but generally includes particles less than 30 µm.

Particulate concentrations vary regionally, and with time and weather conditions. Summer haze in eastern Canada and the United States is mainly due to particulates composed of sulphates, nitrates, carbonates and some organic compounds. These particles are very efficient in scattering light and can cause substantial reductions in visibility. High concentrations of sulphate and nitrate particles are largely a consequence of industrial and vehicle emissions of sulfur dioxide and nitrogen oxides. Haziness in industrialized regions is strongly influenced by sulfur dioxide emissions. Regional haze caused by man-made emissions can cover large areas and may be transported long distances, depending on weather patterns.

The effects of larger suspended particles greater than 10 µm in diameter are usually restricted to materials and vegetation damage. Increased levels will cause reduced visibility and soiling. In recent years, interest in PM_{10} (*i.e.*, particulate matter less than 10 µm) monitoring has grown due to the increased evidence that these smaller size particles are responsible for respiratory effects. The smaller particles may be drawn into the lungs where they can cause varying degrees of upper and lower respiratory complications. There is also strong evidence that it is the ultra fine particles (particulate matter less than 2.5 µm) which are the most significant in terms of health impacts. Acid aerosols are the finest solid or liquid particles suspended in the atmosphere and include smoke particles, fly ash, soil dust, sea salt, and other particles generated from chemical reactions in the air.

There are a multitude of both natural and human-influenced sources of suspended particulate. Local winds and other meteorological factors have a significant effect on the composition of particulate matter in the local airshed. Based on 1990 emission estimates, there were approximately 48000 tonnes per year of TSP emitted by anthropogenic sources in Nova Scotia. A review of this total indicates that industry contributed the most significant portion (62%); followed by stationary fuel combustion sources (28%); with minor contributions from the transportation sector (7%), incineration (2%) and miscellaneous sources (1%). Significant reductions from the 1985 estimate of 72000 tonnes occurred in the steel industry, coal production, mining and quarrying operations in the Province.

A review of 1995 TSP and PM_{10} monitoring data from the Halifax-Dartmouth area indicates there was only one exceedance of the 24-hour objective, that being in Pictou where the recording station was influenced by temporary nearby activities. The variation between monitoring sites throughout the Province is generally consistent from year-to-year, reflecting differences of TSP levels in residential, commercial and industrial areas where the monitoring sites are located. Results from PM_{10} monitoring recorded a maximum concentration of 52 $\mu g/m^3$ with a mean of 14 $\mu g/m^3$ at Barrington Street in downtown Halifax.

6.1.3 Ambient Noise Levels

Due to the timing of the environmental registration (*i.e.*, 10 to 15 years in advance of highway construction) an ambient noise survey at this time would be impractical, especially in view of the continuing area development. It would be impossible to predict representative baseline noise levels for the study area due to the variability of the continuing development and the difficulty in predicting noise sensitive sampling locations prior to final development.

An earlier highway assessment (WGA, 1995) recorded ambient noise levels in areas similar to those encountered along the proposed alignment of Highway 113. Those noise reading varied between 41 and 66 dBA. Similar noise readings would be expected along the proposed alignment.

Common noise levels and typical reactions are summarized in Table 6-5. Table 6-5 indicates that noise typically generated from highway traffic noise is approximately 70 dB when measured at 15 m. At 65 m from the edge of the highway lane (*i.e.*, the edge of the ROW) the traffic induced noise would likely be less than 60 dB, due to the attenuating affect of distance (*i.e.*, every doubling of distance results in a 3 dB decrease in the noise level), topography, and vegetation.

TABLE 6-5
Common Noise Levels and Typical Reactions

Sound Source	Noise Level (dB)	Apparent Loudness	Typical Reaction
	135		Painfully loud
Military jet	130	Sixty-four times as loud	Limit amplified speech
Jet takeoff at 50 m	120	Thirty-two times as loud	
	110	Sixteen times as loud	Maximum vocal effort
Jet takeoff at 500 m	100	Eight times as loud	
Heavy truck at 15 m / Busy city street	90	Four times as loud	Very annoying - Hearing damage (8 hr)
	80	Twice times as loud	Annoying
Highway traffic at 15 m	**70**	**Base reference**	**Telephone use difficult**
	60	Half as loud	Intrusive
Noisy office	50	Quarter as loud	Speech interference
Public library	40	Eighth as loud	Quiet
Soft whisper at 5 m	30	Sixteenth as loud	Very quiet
	10	Sixty-fourth as loud	Just audible
Threshold of hearing	0		

Source: 'Road Traffic Noise Effects on Housing', published by the Canadian Mortgage and Housing Corporation (CMHC), 1981.

CMHC guidelines for new house construction recommend the equivalent 24 hour sound level should not exceed 55 dBA outside at the building face and levels in the 55 dBA to 75 dBA range are normally unacceptable unless adequate sound insulation is provided to reduce noise levels inside. Outdoor recreational space may have to be sheltered as well at these levels.

The Nova Scotia Department of the Environment ***Guidelines for Environmental Noise Measurement and Assessment*** has established the following criteria:

- an L_{eq} of 65 dBA between 0700 to 1900 hours;
- an L_{eq} of 60 dBA between 1900 to 2300 hours; and
- an L_{eq} of 55 dBA between 2300 to 0700 hours.

6.2 <u>Terrestrial Environment</u>

Included in this section is information describing the following components of the terrestrial environment:

- Physiography and Area Geography;
- Geology and Hydrogeology;
- Flora;
- Fauna; and
- Human Heritage / Archaeological Resources.

6.2.1 Physiography and Area Geography

The study area is located within the Atlantic Interior Region with the Granite Uplands District to the east and the Quartzite Barrens to the west (Nova Scotia Museum, 1996).

The topography of the study area varies including gently undulating to steeply dipping land. Elevations range between 30 m and 115 m along the proposed route.

Several small streams are bisected by the proposed new highway. In addition, the study area encompasses parts of seven lakes including: Kearney Lake, Ragged Lake, Ash Lake, Frasers Lake, Maple Lake, Sheldrake Lake, and Upper Sheldrake Lake.

6.2.2 Geology and Hydrogeology

6.2.2.1 Soils

The Soil Survey of Halifax County (MacDougall and Cann, 1963) indicates that the native soils underlying the proposed highway belong to several different Series' as indicated below, and as shown in Figure 6-3:

Derived from Moderately Coarse-textured Parent Materials
- Gibraltar Series - a brown sandy loam over strong-brown sandy loam derived from granite; and
- Halifax Series - a brown sandy loam over yellowish sandy loam derived from quartzite.

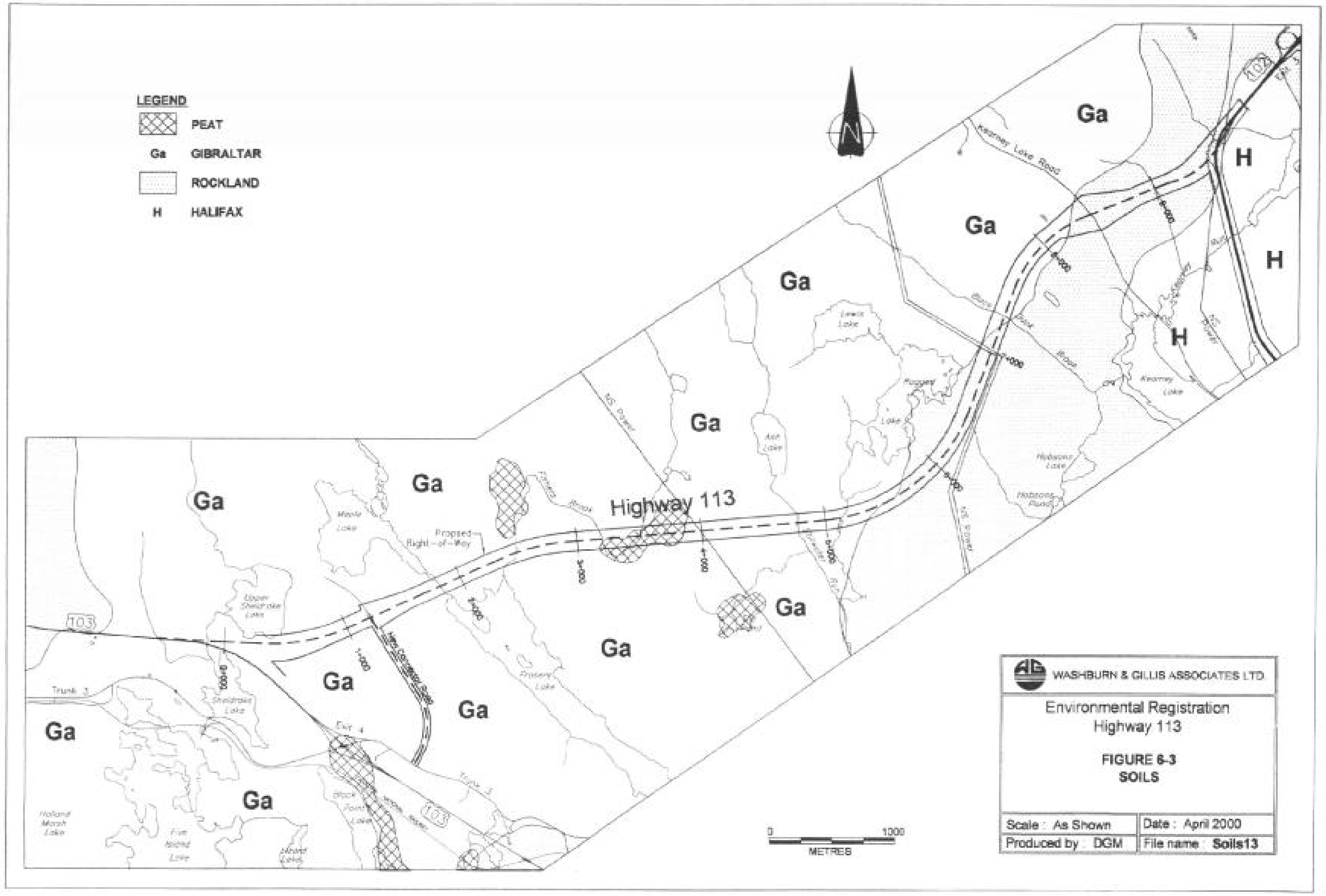
Miscellaneous
- Peat - mostly sphagnum; and
- Rockland - areas where at least 60 percent of the land is exposed bedrock or the till is extremely stony.

The majority of the corridor is of the Gibraltar (GA) soil series (Stations 0+000 to 5+500 and 6+600 to 9+000) with gently undulating to gently rolling topography and good to excessive drainage.

A small section of corridor near Kearney Lake is composed of Rockland and Halifax soil series (5+500 to 9+800 and 9+800 to 9+900, respectively).

The Halifax Soil Series (Hx) is located just outside the study area, the topography is gently undulating to gently rolling with good to excessive drainage.

Figure 6-3
Soils



The Rockland (R) topography and drainage is variable. There are small sections of Peat (P) in the central portion of the corridor (3+200 to 3+900). The topography is level to depressional and poor drainage is characteristic of the soil type.

The risk class for water erosion occurring on the bare, unprotected mineral soils in the area is categorized as "severe" by Agriculture Canada (1991), meaning they are very susceptible to erosion if disturbed, left unprotected, and acted upon by precipitation or runoff.

6.2.2.2 Surficial Geology

The available geological mapping and information (Stea & Fowler, 1979 and Finck & Graves, 1987) indicates that the overburden glacial deposits in the area of the Highway 113 alignment consists of a sandy glacial sheet and a clay glacial sheet which was derived from the local bedrock types, as shown in Figure 6-4.

The sandy glacial sheet is granite till and the clay glacial sheet is bedrock or thin till veneer which reflect the underlying bedrock from which it is derived. These till deposits are unwashed materials deposited directly by the glacier and consist of varying proportions of sand, gravel, silt, clay, and cobbles.

The largest part of the highway alignment is underlain by granite till A & B (0+000 to 5+750). This material is greyish orange to yellow-brown in colour, loose to compact sand till with angular, pebble to bolder size granite clasts. The average thickness of the granite till in this area is two metres with maximum depths up to five metres. Approximately 85% of the clasts of this material are granite rocks of granite and granodiorite. Generally speaking, the grain size analyses show about 80% of the components in the sand range, 15% silt, and 5% clay.

Bedrock or thin till veneer is found in the eastern section of the corridor near the Hammonds Plains Exit (5+250 to 9+900). Bedrock exposure and boulders make-up 40 percent of this area.

Other deposits of interest in the area, adjacent to the east of the Highway 113 alignment, are quartzite till (7+450 to 10+000). The quartzite till is blueish-greenish grey, loose cobbley, silt sand with some red clay inclusions. Generally speaking, the grain size analyses show about 80% of the components in the sand range, 15% silt, and 5% clay. The thicknesses of the quartzite till in this area average about three metres but may be as deep as 20 metres. Quartzite clasts normally comprise more than 85% of the course fraction of the till.

Of note are the sands and gravels which are potential sources of borrow for use during construction.

6.2.2.3 Bedrock Geology

The Energy, Mines and Resources Canada, Geological Survey of Canada, (MacDonald, M.A., and R.J. Horne, 1987) indicates that the bedrock underlying the proposed highway belongs to five different geological units as indicated below, and as shown in Figure 6-5:

<u>Devono-Carboniferous</u>

- Halifax Peninsula Leucomonzogranite - a light whitish grey to pinkish, medium to predominantly coarse-grained bedrock that contains variable contents of biotite (4-6%), cordierite (4%), muscovite (1-2%), and alkali feldspar megacrysts (5-50%);
- Sandy Lake Monzogranite - a light to medium grey, medium to coarse grained and megacrystic bedrock with Biotite as the dominant mica, constituting 10-12% of the rock, minor cordierite and muscovite is present;
- Granodiorite - a medium grained and equigranular with less than 5% alkali feldspar megacrysts with biotite content approaches 15% and muscovite is present in trace amounts only; and
- Tantallon Leucomonzogranite - a light to medium buff-orange, pink, red, light to medium whitish grey, fine to medium grained bedrock that contains biotite (trace 6%), muscovite (1-4%), cordierite (0-3%) and large alkali feldspar phenocrysts.

<u>Cambro-Ordivician</u>

- Goldenville Formation - a greenish-grey metagreywackes bedrock with minor interbedded slates.

The bedrock underlying the western half of the Highway 113 study area consists predominantly of Halifax Peninsula Leucomonzogranite from 0+000 to 5+875. A small area of the proposed highway passes through Tantallon Leucomonzograite between 5+150 and 5+550. This bedrock underlies the Blue Mountain Hill, a block of Crown land. Sandy Lake Monzogranite underlies the centre of the study area from 5+875 to 6+375.

Rocks of granodiorite composition occur along the granite/metasediment contact from Halifax to near Hammonds Plains Road and underly a small section of the alignment from 6+375 to 6+800. The Goldenville Formation underlies a section of the eastern study area from station 6+800 to 9+900.

These rocks do not contain the same mineralization that cause acidic conditions more commonly associated with the sulphide-rich slates of the Halifax Formation. The underlying quartzite in the Goldenville Formation is a very suitable material for crushed rock aggregate, as well as the fine to medium grained granite of Blue Mountain.

The rock types which are likely to form karst terrain are within the Windsor Group, and the overlying Watering Brook Formation of the Canso Group. The Windsor and the Canso Group do not underlie the proposed highway. Therefore karst terrain is unlikely within the study area.

The terrain in Goldenville Formation area is controlled to a large degree by the undulating nature of the shallow bedrock surface. The tops of the ridges are often exposed as outcroppings that are resistant to erosion. The areas between the ridges are often filled with glacial till.

6.2.2.4 <u>Hydrogeology</u>

The bedrock and surficial geologic materials in the area along with accompanying hydraulic conditions provides a relatively narrow range of opportunities for developing groundwater supplies.

Figure 6-4 Surficial

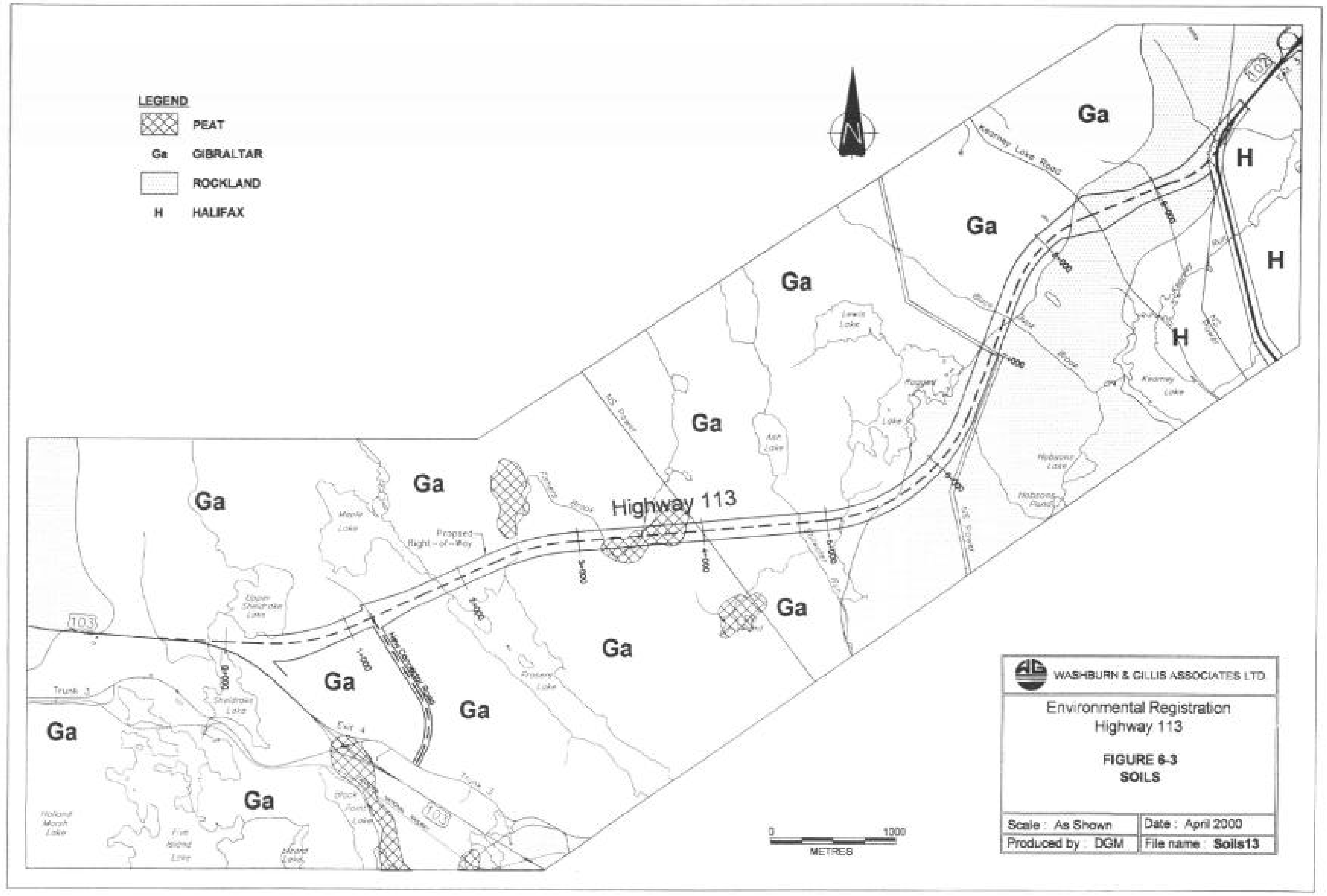
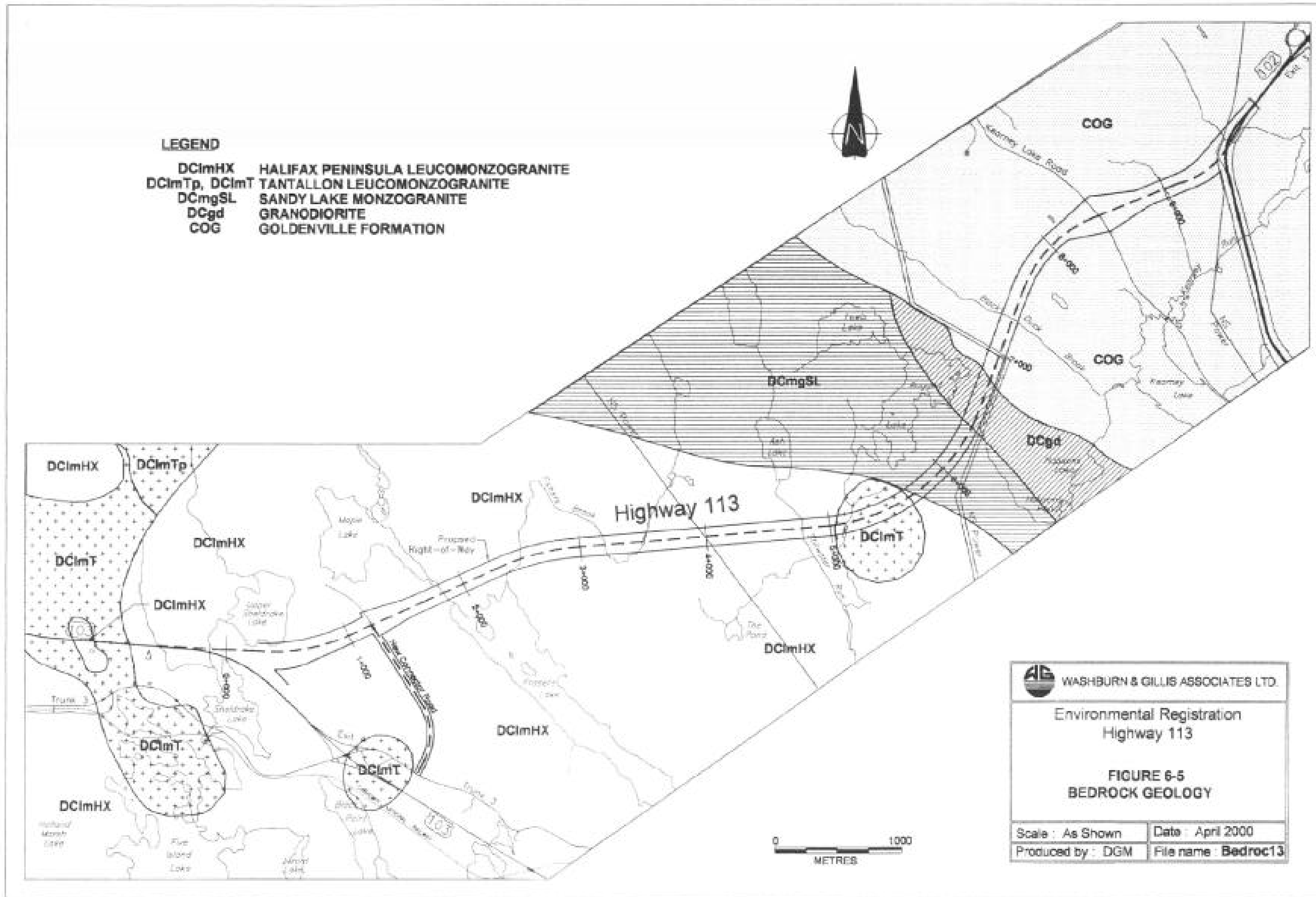


Figure 6-5
Bedrock



In the study area, the nature of the geologic materials and the associated water yielding characteristics allow classifying them as marginal aquifer host rocks.

The surficial deposits in the area are classified as non-stratified glacial deposits of till. Dug wells constructed in till under shallow water table and high saturated thickness conditions provide adequate water supplies in most cases for domestic purposes. However, on topographic highs, the natural water level fluctuations during periods of drought sometimes leads to the dry well phenomena. A summary of water well data for communities in the study area is presented in Table 6-6.

TABLE 6-6
Summary of Water Well Data for Communities Near the Study Area

Name/Lot	Date Drilled	Depth (ft)	Depth to Bedrock	Yield (gpm)
Sheldrake Heights/Sheldrake Lake/Sheldrake Estates				
Lot # 7 Sheldrake Estates	90/04/01	100	8	12
Lot # 8, Sheldrake Heights	92/05/21	240	17	0.7
Lot # 13 Sheldrake Heights	95/07/03	165	3	12
Lot # 14 Sheldrake Lake	97/07/14	160	4	3
Lot # 24A, Sheldrake Lake Subdivision	89/06/15	145	28	12
Lot # 30 Maple Lake Road, Sheldrake Heights	98/08/03	367	12	1
Lot # 31 Sheldrake Heights	96/08/10	160	11	2
Lot # 32 Maple Lake Road Sheldrake Heights	97/07/21	222	9	1.2
Lot # 33 Maple Lake Road Sheldrake Heights	97/10/14	300	10	0.5
Lot # 51 Merganser Av., Sheldrake Heights	94/02/21	307	6	0.5
Lot # 52 Merganser, Sheldrake Heights	88/11/29	146	4	4
Lot # 79, Sheldrake Lake	86/08/14	400	5	1.5
Kearney Lake Estates				
Lot # 5	98/10/05	200	6	15
Lot # 8	97/08/27	200	8	4
Lot # 11	96/11/14	120	15	5
Lot # 16	97/03/09	140	4	3.5
Kingswood Subdivision				
Lot # 33	97/04/24	240	40	3
Lot # 204	97/06/05	140	1	7
Lot # 906	96/04/25	240	4	1
Lot # 916	96/07/22	300	20	0.2
Lot # 956	96/09/16	300	5	0.5
Lot # 957	96/09/13	200	9	6

TABLE 6-6 (continued)
Summary of Water Well Data for Communities Near the Study Area

Name/Lot	Date Drilled	Depth (ft)	Depth to Bedrock	Yield (gpm)
Kingswood Subdivision (continued)				
Lot # 967	96/08/12	300	4	0.2
Lot # 1004	96/08/28	300	8	0.1
Lot # 1030	97/01/16	220	12	1
Lot # 1037	96/07/25	260	8	0.5
Lot # 1039	96/08/07	100	10	9
Lot # 1042	96/07/18	300	30	0.30
Lot # 1046	96/08/16	300	7	0.1
Lot # 1058	97/11/13	320	3	0.5
Lot # 1063	98/02/24	140	2	2
Lot # 1069	96/07/14	300	4	0.3
Lot # 1070	98/01/21	300	7	0.7

Source: NSDOE Well Log Database, 1999

Bedrock wells penetrating the granites and quartzites generally yield sufficient water for domestic supplies. Wells constructed in the glacial tills can produce sufficient volumes of very good quality water for domestic purposes. Drilled wells into the granites and Goldenville Formation can provide sufficient water supplies for small commercial ,industrial, and municipal purposes. However, the water quality from drilled wells is often encumbered with undesirable amounts of iron and manganese.

Surficial Aquifers

The glacial deposits of unstratified tills in the Five Islands Lake to Mill Cove area along the proposed Highway 113 have been mapped (Stea and Fowler, 1980). A small percentage of water supplies have been developed in these deposits. No hydraulic testing of these materials for their groundwater supply capability has been carried out, or at least reported in the NSDOE databases. These materials are not well sorted, nor water washed, which severely limits their water yielding capabilities.

The area from Five Island Lake to Blue Mountain Hill is underlain by granite till. Thicknesses are reported to range generally from 1 to 10 metres and average 3 metres. The reliability and quantity of water from wells constructed in these materials will depend on the depth to the water table, and saturated thickness of the aquifer encountered. Production wells constructed in these materials in other parts of the Province indicate generally good quality with Transmissivity (T) values generally less than 1200 imperial gallons per day per foot (igpd/ft). Because of the limited saturated thickness of these aquifers, yields are therefore limited to less than 10 igpm. Depths of dug wells in these till deposits also vary from approximately 10 to 25 feet. The depth to the water table also varies considerably depending on the topography and location of the well with respect to the local groundwater flow system. Water levels in wells constructed in groundwater discharge zones may be at ground level, whereas in groundwater recharge areas water levels can be lower than 25 feet beneath the surface.

The study area from Blue Mountain Hill to Mill Cove is underlain by Quartzite Till. These materials are also reported to vary in thickness up to 10 metres and average 3 m in depth. Groundwater supplies developed in these materials throughout Nova Scotia are reported to have similar yield and quality characteristics as those developed in the Granite Tills discussed above.

Domestic water supplies in the area depend on wells for limited supplies of generally poor quality water. Bedrock wells are the most common source of water on which people depend. The less common dug wells are not able to supply household demands during the summer months due to the limited saturated thickness of these materials and the low permeability of the high silt clay content in the drift material.

Bedrock Aquifers

The bedrock aquifers in the study area consist of fractures in otherwise non-porous and impervious rock units. Therefore, the storage and movement of groundwater in these units is entirely dependent on the occurrence, distribution, and hydraulic characteristics of fractures. Random wells drilled in these rock units for domestic water supply purposes normally yield less than fifteen gallons per minute (McBeath, Black ,Rose, 1988). Other wells drilled for industrial, municipal, or commercial water supplies may yield up to 100 igpm or more. Twenty such wells drilled in the general area of the Proposed Highway 113 for other than domestic water supplies ranged in depth from 52 to 448 feet deep with yields ranging from 0.2 to 51 igpm. Table 6-7 provides a summary of the available drilled well pumping test data.

These data show that wells drilled into the Goldenville Formation (quartzites, graywacke ,and slate) have depths ranging from 199 to 448 feet and yields from 1.5 to 51 igpm. Wells drilled into the Granites ranged in depths from 52 to 300 feet with yields from 0.2 to 35 igpm.

6.2.3 Flora

Vegetation communities along the alignment were assessed from existing literature sources and were verified during field investigations. Three prominent references characterize the vegetation of the study area. Rowe (1972) classifies most of the Maritime provinces as part of the Acadian Forest Region. This region is characterized by stands of red spruce, balsam fir, maple and yellow birch. Within this region the study area is contained in the Atlantic Uplands Sub-region. This sub-region comprises most of mainland Nova Scotia, including the tilted plain rising gradually from the Atlantic shore. The sub-region is one of the more humid areas of the Maritimes, receiving moisture laden air from ocean winds.

Loucks (1962) classifies the area as the Fisher Lake-Halifax District of the Clyde River-Halifax Ecoregion. This Ecoregion is characterized by red spruce, hemlock, white pine, balsam fir and red maple, interspersed with red oak. The local flora has been widely affected by fires (resulting in numerous barrens) and hurricanes (creating extensive wind damage).

TABLE 6-7
Water Supply Well Pumping Test Data
Selected Wells In The Study Area

Location [1]		Aquifer [2]	Well Depth (ft.)	Depth to Water (ft.)	T (igpd/ft.)	Q_{s20} (igpm)	Drill Data
11D 12 C 56	Allen Heights Subdivision	Granite	220	20	16	1.0	Aug. 1978
11D 12 C 56	Allen Heights Subdivision	Granite	202	19	4	0.2	July 1978
11D 12 A 66	Birchlee Trailer Court	Granite	240	29	64	4.4	March 1978
11D 12 C 34	Boutlier Point	Granite	300	62	20	1.6	June 1972
11D 12 A 38	Brookside	Granite	140	94	40	0.3	Sept. 1982
11D 12 A 38	Brookside	Granite	75	4	31	0.5	Jan. 1978
11D 5 A 78	Crystal Crescent Beach	Granite	150	5	56	2.4	Dec. 1973
11D 12 C 46	Five Island Lake	Granite	52	15	- [3]	-	July 1972
11D 12 D 10	Lakeside	Granite	170	4	293	15.0	Oct. 1976
11D 12 D 36	Timberlea	Granite	245	18	465	35.0	April 1971
11D 12 D 36	Timberlea	Granite	300	9	55	5.4	Oct. 1973
11D 12 D 14	Timberlea	Granite	165	23	105	4.5	March 1974
11D 12 D 14	Timberlea	Granite	180	16	96	4.9	March 1974
11D 12 D 14	Timberlea	Granite	87	8	99	1.8	July 1975
11D 12 D 14	Timberlea	Granite	300	15	151	14.6	June 1976
11D 12 C 96	Hammonds Plains	Quartzite	250	48	128	8.3	June 1972
11D 12 D 87	Hammonds Plains	Quartzite	448	1	98	15.5	April 1976
11D 12 D 62	Kearney Lake	Quartzite	277	10	17	1.5	Feb. 1981
11D 12 D 81	Mill Cove	Quartzite	290	10	540	51.0	Aug. 1970
11D 12 D 58	Birch Cove	Quartzite	199	21	86	4.0	July 1969

Note: 1. Location grid based on National Topographic Series maps (accuracy to nearest mining tract).
2. Water yields from fractures in the given rock types.
3. " – " indicates data not available.

Source: NSDOE Pumping Test Database

Roland (1944) distinguishes the ecoregion as containing a distinct group of flora more abundant here and in southern Maine then elsewhere in Canada, including highbush blueberry, ink berry and greenbrier. The Fisher Lake-Halifax District is composed of a long granite portion of the Atlantic Uplands. Common vegetative species on unburnt soils include white pine, red spruce, and hemlock. Exposed slopes and hilltops support beech, sugar maple, and red oak. Where fire has affected the flora, stands of red oak, red maple, white birch, white pine, and black spruce are abundant. Poorly drained soils often support balsam fir and black spruce.

Th Nova Scotia Museum (1996) confirms Loucks characterization of the study area, adding that the presence of maple and red oak suggests that the district may be returning to a mainly coniferous forest. Barrens and semi-barrens are reported to be common. Coastal plain species are often found along stream banks in this district. Peat bogs and black spruce and fir swamps typically lie at the upper end of the numerous lakes and ponds in the district.

Old Forest were not reported to exist within the study area. There are some softwood stands within the Blue Mountain Crown Block which are potential old growth stands. These stands are found along Fraser Lake, south of the study area. (Doug Archibald, NSDNR, personal communication, 1999).

6.2.3.1 Plants Species of Special Status

Plant species of special status include those species which have been identified by botanical experts as endangered, threatened, vulnerable, or rare. The status of a species reflects either its natural and/or local (or regional) distribution. For instance, species designated as endangered on a national basis may be locally common in a given area. Or conversely, a species may be locally rare, but common throughout a larger geographic area. For this reason, both national and provincial special status listings were reviewed to determine the particular species which may have status in the area of the proposed Highway easement.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is a multi-jurisdictional, non-regulatory national body. These categories of special status have been adopted for the purposes of this study, as the COSEWIC listing provides the most comprehensive evaluation of species at risk in Canada. The primary mandate of COSEWIC is to develop a national listing of Canadian species at risk, based on the best scientific evidence available, for vertebrates, invertebrates, plants and lichens. Species are listed in the following categories:

- extinct: no longer exists on the planet;
- extirpated: no longer existing in a specific location, but found elsewhere;
- endangered: threatened with imminent extinction or extirpation;
- threatened: likely to become endangered unless situation changes; and,
- vulnerable: at risk because of low numbers or restricted occurrence

Once status designations are made, it is up to the respective provincial and territorial jurisdictions where the species occurs to take whatever actions are appropriate to address the threats and limiting factors placing a species at risk. Table 6-8 lists those species of plants designated in Nova Scotia as being endangered, threatened or vulnerable. COSEWIC has no legislative or management role or authority (COSEWIC, 1999).

TABLE 6-8
COSEWIC Designated Plant Species in Nova Scotia

Endangered	Eastern Mountain Avens	*Geum peckii*
	Pink Coreopsis	*Coreopsis rosea*
	Thread-Leaved Sundew	*Drosera filiformis*
Threatened	Water Pennywort	*Hydrocotyle umbellata*
	Plymouth Gentian	*Sabatia kennedvana*
	Golden Crest	*Lophiola aurea*
	Sweet Pepperbush	*Clethra alnifolia*
	Red Root	*Lachnanthes caroliana*
Vulnerable	Longs Bullrush	*Scirpus longii*
	Lilaeopsis	*Lilaeopsis chinensis*
	New Jersey Rush	*Juncus caesariensis*

Other existing listings of plant species of special status in Nova Scotia serve as an indication of regional biodiversity and provide guidance for voluntary protection of species. To provide a more regional context for the assessment, the additional designation of rare has been added for this study. Rare plants include those species that are known to grow, uncultivated, in only a few locations, or are thought to be represented by a small number of individuals in the region (Roland and Smith, 1969). Most rare plant species in Nova Scotia are species present at the edge of their geographic/climatic range and represent an extremely small portion of the plant biomass of the province (Nova Scotia Museum, 1996; Wilson, 1992).

Maher et al. (1979) lists 222 of the province's approximately 1500 vascular plants species as rare. A more recent document , Pronych and Wilson (1993), as well as staff of the NS Museum of Natural History were consulted to determine the rare vascular plants which may potentially be found within the area of the proposed development. Table 6-9 lists those species which have previously been reported in the same general area of NS.

TABLE 6-9
Rare Plants Previously Reported from General Study Area

Common Name	Latin Name	Habitat Required
Mountain sandwort	*Arenaria groenlandica*	granite ledges and gravel, on coasts at higher elevations
Dwarf Blueberry	*Vaccinium cespitosum*	rocky cliffs, rock crevices, dry or acidic sites
Evening Primrose sp.	*Oenothera tetragona*	old fields, thicket edges, road sides; on dry open sandy soil
Goldenrod sp.	*Euthamia tenufolia*	dry sandy soils, beaches
Goldenrod sp.	*Euthamia galitorum*	lake shores, sandy gravelly beaches, damp peaty soils
Horsetail sp.	*Equisetum variegatum*	stream banks, bogs, wet thickets

Source: Pronych and Wilson, 1993; Zinck, 1998

None of these species have previously been reported in the area potentially affected by the proposed development.

The preliminary environmental screening document indicated the possibility of Blood-milkwort (*Polygala sanguinea*) as a potential rare inhabitant of the area; but review of more recent evidence (Pronych and Wilson, 1993; NS Museum of Natural History records) indicated it was not likely to be present in the study area.

Topographic mapping and aerial photography were used to identify areas of high potential to support plant species of special status, including habitat fitting the requirements of those species listed in Table 6-8 and 6-9 and any unique, uncommon or sensitive habitat types. Eight sites in the study area were identified to have potential to support plant species of special status. Five of the eight sites were ruled out, due to general habitat information and photographs collected during field investigations for the wetlands and watercourses for the Project. The three sites that were assessed include:

- along the proposed highway alignment, east of Kearney Lake Road;
- along the southern boundary of Ragged Lake, close to the highway corridor and;
- along Black Duck Brook, at the proposed highway alignment.

Field investigations were conducted in August 1999. No plant species of special status were identified during field investigations. Field investigations indicated that study area habitat did not have very high potential to support plant species of special status.

6.2.4 Fauna

To determine the diversity of wildlife and characterize wildlife habitat in the area of the proposed highway, it was necessary to:

- characterize study area habitat, through review of pertinent, maps and aerial photos;
- interview knowledgeable resource personnel from various agencies;
- interview local naturalists; and
- review faunal habitat requirements.

There were no wildlife management areas or ecological reserves noted in the study area. However, a variety of wildlife resources exist throughout the province and within the study area. Many species provide important recreational hunting and fishing opportunities, as well as site-seeing, bird-watching, and ecotourism benefits to the province.

The following discussion describes the fauna potentially utilizing the study area habitat, with a particular emphasis on those species and/or habitat requirements which may be particularly sensitive to disturbance as a result of project development *(i.e.*, species of special status; unique or sensitive habitat).

6.2.4.1 Mammals

There are 57 species of terrestrial mammals that exist in Nova Scotia (Marian Zinck, NS Museum, personal communication, 1999). Due to the variety of habitat conditions along the proposed alignment and surrounding areas, it is reasonable to expect that mammals utilizing habitat distributed throughout the proposed corridor will include herbivores (*e.g.*, deer, moose), insectivores (*e.g.*, bats), carnivores (*e.g.*, bobcat), and omnivores (*e.g.*, bear, fox), as well as many other species.

The Nova Scotia Museum (1992) reports a low diversity of small mammals in the area, but a high concentration of white-tailed deer. Provincial records do not indicate deer yarding in the area, although deer sign (hoof prints and droppings) are abundant (Doug Archibald, NSDNR, personal communication, 1999). Numerous deer are noted to have been killed by vehicle collisions on Highway 103 - near Exit 4 and Highway 102 - Exit 3 (Doug Archibald and Jenny Costello, NSDNR, personal communications, 1999). Indications of moose sign are also abundant and the area reportedly serves as a home range for a remnant moose population on the mainland.

Other commonly reported species' signs include hare, bear and bobcat. Insectivores, bats, the majority of rodents, and, to a certain extent, the snowshoe hare inhabit diverse habitat types, likely to be present in the study area. Beaver and muskrat, both valuable as fur-bearing mammals are restricted to wetland and aquatic environments of the study area. Carnivores in tend to be restricted by the availability of appropriate food species and/or den sites.

NSDNR has also received complaints about bears from residents in the Hammonds Plains Road and Timberlea areas. Additionally, the Integrated Resource Management Committee (IRM, 1998) of NSDNR reports the area between Fraser Lake and Hammonds Plain Road as an important wildlife corridor.

Mammal Species of Special Status

Two species of mammals are identified by COSEWIC as potential inhabitants of Nova Scotia. The Southern Flying Squirrel is considered vulnerable. The Eastern cougar has not been confirmed in Nova Scotia. Its status was down-graded from endangered to indeterminate in 1999. The status of the species is uncertain, and no sitings have been confirmed in the province. The species lives in forested areas with abundant prey species (*i.e.*, white-tailed deer) (Dilworth, 1984).

Several rare mammal species could potentially utilize study area habitat (Anonymous, 1995): pygmy shrew; eastern pipistrelle; red bat; hoary bat; and southern flying squirrel.

The study area does not contain unique or critical habitat for any of these species.

6.2.4.2 Birds

Approximately 236 resident and migratory avian species are reported to inhabit Nova Scotia at some time during the year (Tufts, 1986). Avian species diversity in temperate regions is, in part, a function of foliage height diversity (*i.e.*, the greater the height diversity, the greater the number of species utilizing the habitat) (MacArthur and MacArthur, 1961). This is particularly true in deciduous woods, while coniferous stands tend to provide a diversity of habitat conditions within the foliage of each tree (*i.e.*, inside and outside of canopy). Species diversity is also related to floral species diversity (Morrison, 1992). Thus, grasslands would support limited species diversity, while a successional deciduous forest may support a high species diversity.

Bird mortality is reported to be greatest during the first year of life (Prince, 1968). Therefore, breeding and fledgling populations and habitat are considered the avian features most sensitive to detrimental impacts. A total of 174 species regularly breed in the province (Tufts, 1986). Of these, 118 species, or 68% of the species breeding in the province, are thought to utilize breeding habitat in the general study area (Erskine, 1992).

Forest harvest activity increases available edge habitat and provides opportunity for natural regeneration of forest and shrub species. Forest and edge habitat represents the most significant breeding bird habitat in the study area. Open land breeding habitat represents a much less significant amount of habitat in the area. Freshwater wetland habitat is found scattered throughout the study area.

The majority of the breeding birds noted to use area habitat are transitional range species; that is, they are neither at the southern or northern extent of their natural ranges. The Acadian Forest Region typical of the study area is transitional in nature and thus may support a wide variety of birds at the limit of their geographic range. This is consistent with the findings of Erskine (1992), which stated that there is no abrupt transition between southern and northern avifauna within the region. As a result, Erskine concludes that environmental changes, loss or deterioration of breeding habitat, while eliminating or reducing breeding opportunities, will not result in the extinction of any bird species in our area, since there are no species exclusively endemic to the region. The region is characterized as containing habitat transitional between the widespread temperate, boreal and sub-arctic regions, with species breeding in the Maritime region also breeding farther south or north, or both.

<u>Bird Species of Special Status</u>

No COSEWIC designated species have been reported to breed in the study area (COSEWIC, 1999; Erskine, 1992). COSEWIC designated species potentially present in similar habitat in Nova Scotia include:

- Endangered: Harlequin Duck (*Histrionicus histrionicus*)
- Vulnerable: Short-eared Owl (*Asio flammeus*)

Several species of birds known to breed in the general study area have been designated as rare in Nova Scotia (Anonymous, 1995) including: pied-billed grebe; hooded merganser; greater yellowlegs; merlin; northern saw-whet owl; great crested flycatcher; northern mockingbird; house finch; scarlet tanager; and northern oriole.

All raptors, including eagles, osprey, hawks, and owls are protected under the ***Wildlife Act***. Raptors are known to use habitat in the study area for a variety of purposes. Osprey are reported to utilize foraging and nesting habitat in the general study area, however, no sensitive nest sites have been reported in proximity to the proposed highway alignment. During field investigations conducted as part of this study, three red-tailed hawks were noted flying over Kearney Lake Road within the study area, however the location of a nest was not obvious. A large stick nest was noted to exist north of the study area, on power lines, near Ragged Lake.

6.2.4.3 Herpatiles

A total of 24 species of amphibians and reptiles live in Nova Scotia (Towers, 1980). Herpetile populations and distributions are often underestimated due to a lack of concentrated field investigations for individual species (John Gilhen, NS Museum, personal communication, 1999). Based on known species distributions and habitat requirements, 20 herpetile species may potentially inhabit the study area.

Herpetile Species of Special Status

COSEWIC has designated the wood turtle as vulnerable (the species is also noted as rare by Anonymous, 1995). The wood turtle is known to exist in northern Nova Scotia. It utilizes sandy high river banks for nesting and is particularly vulnerable to stream bank flooding and disturbance of instream hibernation habitat.

Several rare species may potentially inhabit the study area, including: blue-spotted salamander; red-banked salamander; and four-toed salamander.

The previous screening report suggests that four-toed salamander may potentially utilize study area habitat. Recent field investigations related to the Sable Offshore Energy Project has further defined habitat preferences for this species (SOEP, 1998). The species requires hummocky sphagnum bogs immediately adjacent to woodlands, near open water for breeding. It can also be found in the peaty margins of streams and lakes (Clayden, *et al.*,1984). The results of wetland habitat surveys indicate that suitable potential habitat exists in wetlands potentially affected by the proposed development. Additional suitable habitat may be found nearby, as well. While its status is not currently under review, recent survey results in other parts of Nova Scotia indicate that this species may be more widely distributed in Nova Scotia than originally proposed (John Gilhen, personal communication 1999).

6.2.5 Human Heritage / Archaeological Resources

An extensive literature review and field program was undertaken to characterize actual and potential human heritage and archaeological resources along the proposed highway alignment. This involved a pre-field determination of areas of high potential based on predictive modelling and background research, followed by a walk-through and surface reconnaissance of the RoW for a distance of 50 m on both sides of the proposed centreline. Judgmental shovel testing of high potential areas had been anticipated, although no sections within the proposed route warranted such investigation, due to the shallow soil deposits and exposed bedrock.

Background research was conducted prior to fieldwork to identify recorded sites within the study area. Archival, and museum databases were consulted. A number of individuals were contacted based on their knowledge and heritage interest in the study area. These included Museum personnel, Government officials, historical society members, and Native contacts.

Due to the extent of the study area and limited available information on heritage resources, predictive modelling was used to identify areas of elevated potential. The modelling criteria adapted from Cox (1989), is based on historical, cultural, and environmental factors frequently associated with the occurrence of heritage sites.

Using 1:50,000 mapping as a working base, the 9.9 km long corridor was divided into 500 m long sections, as shown in Figure 6-6. Weighted criteria, based on the cultural and environmental data outlined above, were applied to each section. Then the 500 m sections were ranked according to resulting scores.

The proposed route passes in the vicinity of several lake systems, which increases the potential for archaeological resources. The rocky nature of the shorelines are not typical encampments or canoe landing areas. However, the lakes and streams in the area of the proposed alignment provide sources of fish, especially the thoroughfare between Frasers and Maple lakes and may have offered food resources to pre-Contact groups. Points of high elevation such as the Blue Mountain Hill area would have provided a vantage point (look off) for sighting large game within the surrounding areas including several of the major lakes.

The following presents the results of the archaeological assessment conducted from September 10 to September 14, 1999, under Heritage Research Permit A1999NS43.

The Nova Scotia Museum reported that although there are no known pre-Contact sites within the proposed corridor, a recorded Susquehanna Period (BeCw-1, ca. 4000 years before present BP) grooved axe was found in a stream bed in Bedford 10 km northeast of the study area. The discovery of the Bedford Barrens petroglyphs (BeCw-2), 3 km northeast of the study area, suggests similar sites could be present on exposed bedrock outcrops (David Christianson, NS Museum, personal communication, 1999).

On A. F. Church's 1865 map of the area, a paper mill (BeCw-3, c.1818) was located near Paper Mill Lake to the east of the corridor (Figure 6-6). Moss covered cut stumps indicative of timber harvesting were found throughout the study area.

No sections of the proposed route showed evidence of land alteration from previous agricultural activity. Shallow soil development, wetlands, and uneven terrain would have rendered the area undesirable for crop farming.

The predictive model identified four areas as having elevated potential for heritage resources, including:

- a 500 m section south of Upper Sheldrake lakes;
- a 1 km section between Maple Lake and Frasers Lake;
- a 1 km section along the northern slope of Blue Mountain Hill; and
- a 500 m section northeast of Ragged Lake.

Three archaeologists conducted a surface reconnaissance and walk through of the entire proposed alignment. Focussing upon the centre line and expanding the survey at points of high potential (streams, lake shores, vantage points), the three crew members were spaced at 25 m to 35 m abreast, covering an area 75 m to 105 m in width. Exposed rock faces were examined for the possible location of petroglyphs or lithic raw material source. Sections of lake shorelines (Upper Sheldrake, Maple, Frasers, and Ragged), which occurred less than 300 m from the presumed centre line of the alignment, were surveyed.

No artifacts were observed during the heritage resource assessment. Based on a surficial investigation, the study area was evaluated as being low potential for heritage resources.

No potential impact to heritage resources was identified during the surficial survey of the study area. The slope of Blue Mountain Hill, however, possess elevated potential for pre-contact resource because of the vantage (view) provided of the lakes and surrounding areas. Although the surficial examination of area did not identify suitable locations for testing (bedrock with very little soil development) there remains potential for impact on potential hunting or camp sites on isolated ridges or terraces on the hill slope.

The poor soil development over bedrock prevented adequate shovel testing in areas deemed as high potential. The exposed bedrock and rocky nature of the terrain is rarely associated with cultural activity.

The archaeological assessment and background historical research did not identify any heritage resource, archeological or national historic sites, old burial grounds/cemeteries, heritage rivers or fossils within the study area.

In general, the area was evaluated as having too low potential for heritage resources. Certain areas, however, may have been used as vantage or “lookout” points (Blue Mountain Hill) or travel routes (thoroughfare between Maple Lake and Frasers Lake).

A full report detailing the findings of the archaeological assessment of the study area is included in Appendix A.

6.3 Aquatic Environment

Included in this section is information describing the following components of the aquatic environment:

- Surface Water Resources;
- Hydrology and Flooding;
- Water Quality;
- Aquatic Resources;
- Fishery Resource Utilization; and
- Fish Habitat.

Aquatic environments may be characterized as either marine, freshwater, or estuarine (i.e., transitional areas between marine and freshwater environments in which salinity ranges between freshwater and seawater; Moyle and Cech (1982)).

There are no marine or estuarine areas crossed by the proposed highway alignment. Therefore, related features such as protected beaches, marine habitat and salt marshes are not addressed by this report. The nearest marine environments exist approximately 1.5 kilometres east at the Bedford Basin and approximately 7.5 kilometres west at Shad Bay.

6.3.1 Surface Water Resources

The proposed highway alignment intersects 8 freshwater watercourses (one of which, Fishers Brook, it crosses three times). Additionally, the Project may potentially influence 2 downstream lakes located in the study area, as indicated in Figure 6-7, and Table 6-10.

Figure 6-6
Archaeology

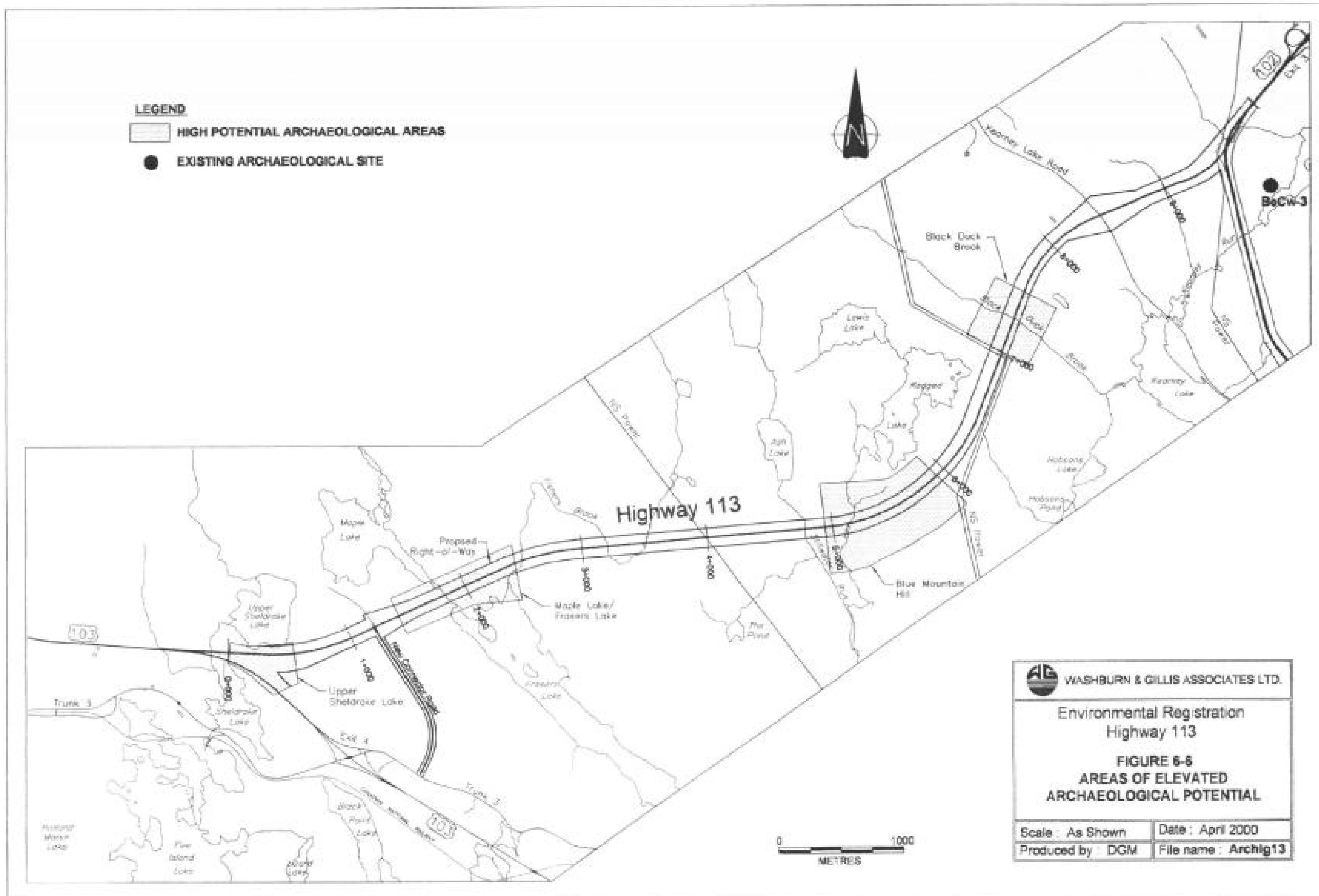


Figure 6-7
Watercourses

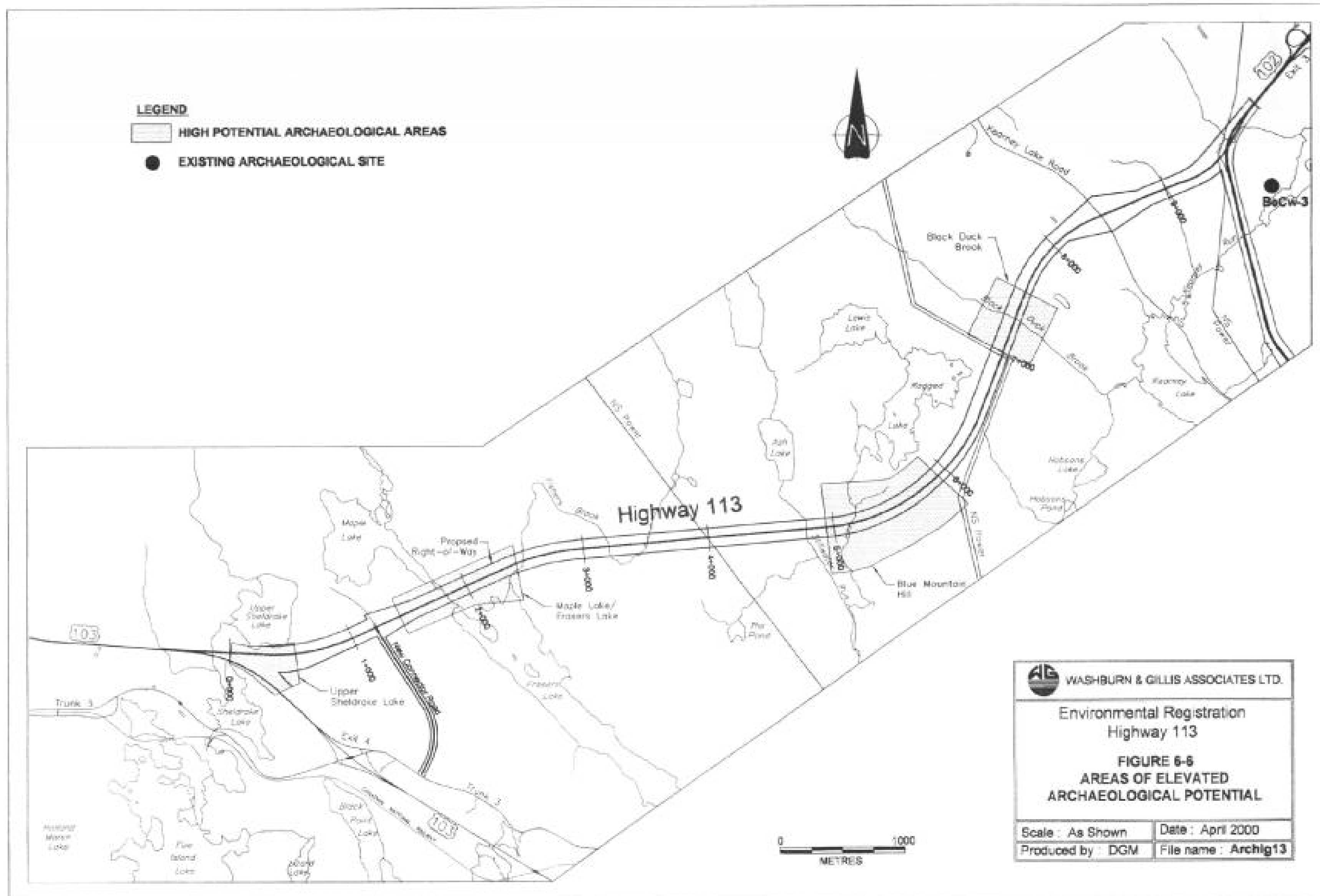


TABLE 6-10
Freshwater Streams and Lakes Within the Study Area

Watercourse No.	**Watercourse Name**	**Watershed**
1	Tributary to Sheldrake Lake	Shad Bay
2	Tributary between Maple and Frasers Lakes	Shad Bay
3A	Fishers Brook	Shad Bay
3B	Fishers Brook	Shad Bay
3C	Fishers Brook	Shad Bay
4	Stillwater Run	Shad Bay
5	Outlet of Ragged Lake	Bedford Basin
6	Black Duck Brook	Bedford Basin
7	Tributary to Kearney Run	Bedford Basin
8	Tributary to Papermill Lake	Bedford Basin
Lake Number	Lake Name	Surface Area (ha)
1	Sheldrake Lake	12.9
2	Frasers Lake	70.7

A review of existing information sources such as the preliminary environmental screening report, stream profiles, and Project specifications, was conducted prior to field work to familiarize the Project Team with the study area.

Water samples were collected from selected watercourses crossed by the proposed alignment, to document baseline water quality conditions. Spot-check electrofishing surveys, including identification of fish species captured, were also conducted for each watercourse crossed by the alignment.

Fish population dynamics, water quality, sediment quality, and invertebrate communities all have the potential to change before the start of highway construction, and a detailed description of current conditions does not provide a baseline of information with which potential impacts related to highway construction and operation can be evaluated. Therefore, preliminary, rather than detailed field investigations, were conducted, during September 1999, as part of the assessment to provide only an indication of the current environmental condition.

Preliminary field surveys were limited to habitat evaluations and spot check electrofishing on each watercourse, throughout a reach extending 200 m up and downstream of the highway corridor centreline. Habitat suitability for various life stages of commercially and recreationally important fish species was assessed within each surveyed area. A variety of habitat characteristics were documented, including wetted perimeter and channel width, water depth, percent vegetative and non-vegetative cover, the condition of surrounding habitat, potential fish passage obstructions, bank conditions, and substrate composition. Percent substrate composition was assessed subjectively according to the classifications provided in Moreau and Moring, 1993.

6.3.2 Hydrology

The historical hydrological data of streams near the study area, the potential for flooding and a detailed review of the hydrology of Fishers Brook is addressed in the following sections.

6.3.2.1 Historical Hydrology Data

Historical hydrological data is not available for streams inside the study area. However, data from two stations near to the proposed study area were reviewed. The stations include #01EJ002 at Kearney Run/Millview, east of the study area and #01EH003 at East River/St. Margarets Bay, west of the study area. The hydrologic characteristics recorded at these two stations is summarized in 6-11.

TABLE 6-11
Summary of Hydrologic Characteristics of Streams near the Study Area

	Kearney Run at Millview	East River at St. Margarets Bay
Drainage Area (km^2)	36	26.9
Years of Data	1971-1973	1925 - 1995
Mean Monthly Discharge (m^3/s)		
January	1.50	1.00
February	2.93	0.788
March	2.25	1.04
April	2.03	1.47
May	2.12	0.931
June	1.54	0.529
July	0.627	0.290
August	1.45	0.280
September	0.524	0.304
October	0.537	0.536
November	1.88	0.973
December	1.80	1.09
Mean Annual Flow (m^3/s)	1.6	0.796
Maximum Annual Flow (m^3/s)	1.95	1.1
Minimum Annual Flow (m^3/s)	1.64	0.435

Source: Canadian Hydrological Data (c) 1997 Environment Canada Station. 01EJ002 Kearney Run at Millview and 01EH003 East River at St. Margarets Bay Road.

It should be noted that the data collected at Kearney Run spans a period of only two years, and as such should be considered non-representative of long-term hydrological trends.

Generally maximum flows occur during the period from March to May, presumably due to spring thaw. Maximum discharges in Spring are approximately five times greater than the summer minimum. As well, considerable discharge rates are noted during December. Minimum discharge rates occur during the period from July to September.

6.3.2.2 Flooding

Spring flooding of the streams and wetlands crossed by the proposed alignment could occur at times of maximum snowmelt and "break-up" of winter ice. The proposed alignment crosses five watersheds with varying potential for flooding. During the course of this study, observations were made by the study team that support the fact that flooding is generally not a problem in areas adjacent to the proposed highway alignment. Additionally, there are no designated floodplains in the study area (Allen Kindervater, Environment Canada, personal communication, 1999).

6.3.2.3 Hydrology of the Fisher's Brook Wetland Area

The seasonal water level pattern, or hydroperiod, is the most important hydrological characteristic of a wetland. Different wetlands have characteristically different hydroperiods that determines their ecosystem and biological processes, such as visible surface biota, and decay and accumulation rates. The hydroperiod of a wetland is determined by its water balance. Water input to a wetland includes surface water inflow, groundwater inflow, and precipitation. Output from a wetland includes surface water discharge, groundwater recharge, evaporation, and transpiration. When there is a net input into a wetland the water level of the wetland rises. When there is a net output from a wetland, the water level decreases.

There are two wetlands (Wetland #3 and #4) along Fishers Brook located entirely or partially within the study area. Wetland #3 is located entirely within the study area and consists of an area of approximately 3.9 ha. It was observed in the field investigation and from the aerial photographs that a dominant portion of the wetland is of shrub-swamp type and only flooded seasonally. A small portion of the wetland is of shrubby bog type, where the water table is expected to be at or near the ground surface annually. Standing water is expected during the flood periods in this wetland.

The narrow tail portion of Wetland #4 is located in the study area. This portion of Wetland #4 is observed to be of the shrubby bog type. The water table in this portion of Wetland #4 is also expected to be at or near the ground surface, with standing water during the flood periods.

Fishers Brook is expected to be the most important factor in maintaining the hydrological relationships of the wetlands along Fishers Brook. The rise and fall of water levels in the wetlands, or their hydroperiods, are expected to be related to the seasonal variation of the stream flow in Fishers Brook.

Fishers Brook drains a watershed area of approximately 1.5 km^2 at the proposed crossing location of Wetland #3. The watershed has an elongated shape which indicates relatively long flood path, compared with watersheds of similar sizes, and provides opportunities for flood alleviation through channel processes, including temporary storage. Upstream of Wetland #3, Fishers Brook drains through a small lake and two wetlands with a combined area of approximately 12 ha., or eight percent of the watershed area. These lake and wetland areas function as temporary storages during flood events, reducing peak flood flow.

The surficial geological map of the area indicates that bedrock is very close to or at the ground surface for most of the watershed area. Average annual precipitation of the area is in the order of 1400 mm.

A dominant portion of Fishers Brook watershed is under forest cover. Development in Fishers Brook watershed includes Kingswood subdivision. Runoff from the subdivision is collected by surface drainage ditches. It is noted in a field investigation that some of the surface runoff from the subdivision is discharged into Wetland #4 through a drainage ditch. Development in a watershed causes increase in surface runoff and peak flood flow. In fact, much of the hydrology of the Fishers Brook Wetland is influenced, to a large degree, by the upstream Kingswood Subdivision. Upon examination of drainage plans for Kingswood, it was determined that approximately 140 hectares (ha) of land drains into the wetland via three culverts located on the southern extremity of the subdivision.

Fishers Brook has a typical width in the order of 1.5 m downstream of Wetland #3. Some sections of Fishers Brook stream channel are lined with boulders or overgrown with vegetation. There are no signs of stream channel erosion noted during the field investigations that could have resulted from flood flow.

Fishers Brook discharges into Fraser Lake 2 km downstream of Wetland #3. There are two additional wetlands along Fishers Brook prior to its entering Fraser Lake. The storage capacity of Fraser Lake is substantial compared with the size of Fishers Brook watershed. There is currently no development in the section of Fishers Brook between Wetland #3 and Fraser Lake. There is no documented flooding in this section of Fishers Brook.

6.3.3 <u>Water Quality</u>

Water quality sampling was conducted during low flow conditions at three watercourses crossed by the proposed alignment, including the stream connecting Maple and Frasers Lake (WC2), Fishers Brook (WC3), and Black Duck Brook (WC6). These watercourses were selected for sampling because it is expected that the conditions encountered would be representative of those encountered along the length of the alignment. The locations of the water quality sampling locations is shown in Figure 6-8. Water samples were not taken during high flow conditions because high flow conditions were not encountered until late October and could not be accommodated during the study period. A summary of the analytical results is presented in Table 6-12.

The measured aluminum concentrations of Maple and Frasers Lake (WC2), and Fishers Brook (WC3) exceed the Canadian Water Quality Guideline of 5 µg/L for protection of Aquatic Life (CCME, 1999). There appears to be a problem with aluminum toxicity in Fishers Brook. Dissolved humic material is known to remove and bind dissolved aluminum (CCME, 1995), however, judging from the measured colour values, there is little dissolved humic material in these waterbodies. Peat-stained water has TCU values of approximately 100. Values of <10, such as those measured in WC2 and WC6, indicate clear water.

Figure 6-8
Water Sampling Locations

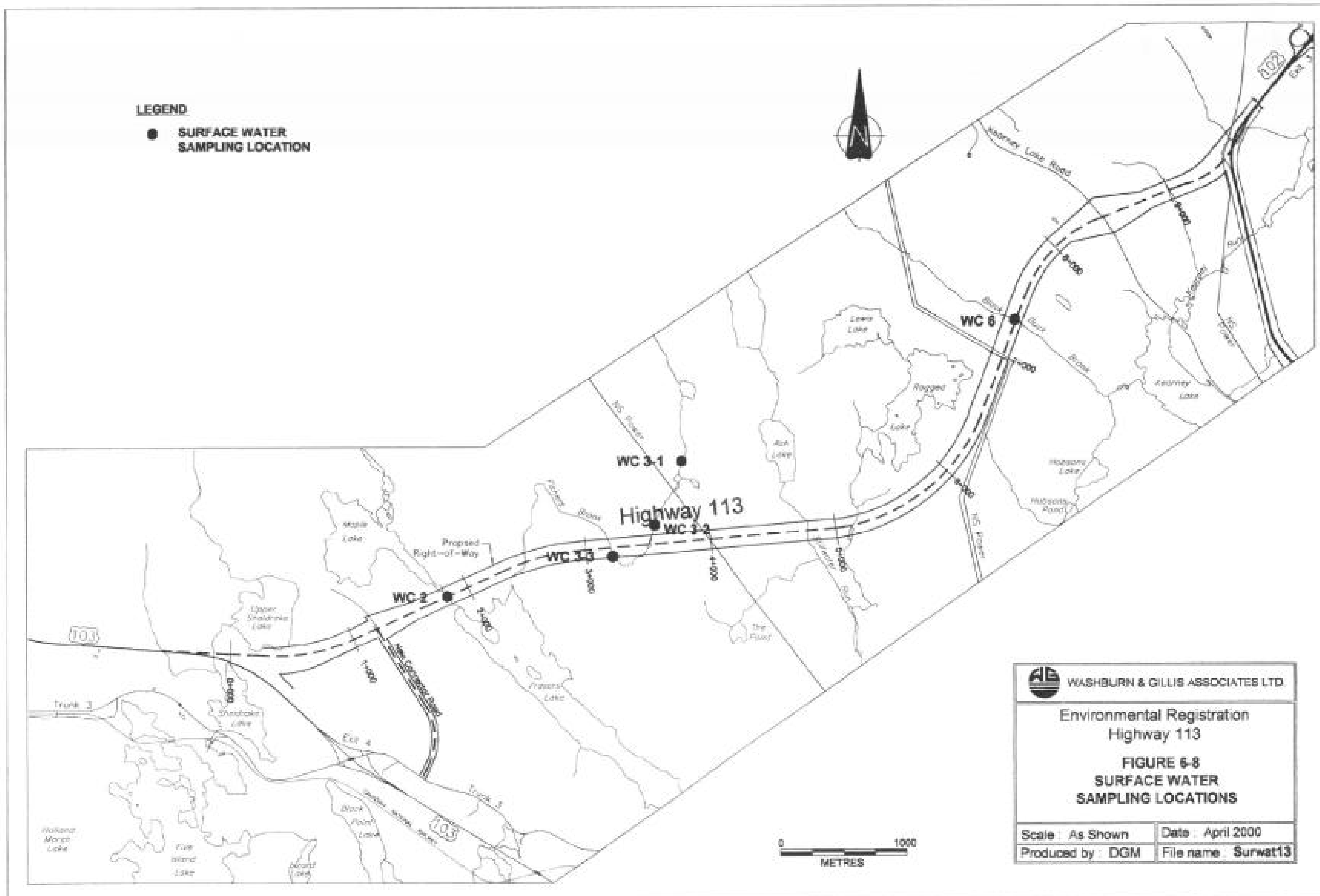


TABLE 6-12
Water Chemistry Data for Selected Streams

Parameter	Canadian Water Quality Guideline (Fresh Water Aquatic Life)	WC #2, Maple & Fraser Connector	WC #3, Fishers Brook (average)[1]	WC #6, Black Duck Brook
pH	6.5 - 9	5.7	4.8	6.8
Alkalinity (mg/L $CaCO_3$)	--	<1	na	9
Hardness (mg/L $CaCO_3$)	--	6.7	na	23.7
TDS (mg/L)	--	31	na	106
Conductivity (uS/cm)	--	63.6	na	215
Sodium (mg/L)	--	8.6	16.2	30.4
Calcium (mg/L)	--	1.7	na	6.7
Colour (TCU)	--	8	na	6
Aluminum (µg/L)	5 - 100	60	293	30
Iron (µg/L)	300	70	1100	30
Copper (µg/L)	2 - 4	<2	<2	<2
Lead (µg/L)	1 - 7	<2	<2	<2
Phosphorus (mg/L)	--	<0.1	na	<0.1
Nitrate (mg/L)	--	<0.1	na	0.08
Sulphate (mg/L)	--	5	na	4

Note: na non analyzed
1. Average of 3 samples taken along Fishers Brook

The nutrient (nitrate, phosphate and sulphate) are relatively inconsequential. In lower order streams, such as those in the study area, most of the production is generated on land, and transported into the aquatic environment (Vannote et. al., 1980). Additional water quality measurements, including pH and total dissolved solids (TDS) from the streams which are crossed by the proposed alignment were measured in the field and summarized in Table 6-13.

Generally, the streams along the proposed alignment are very susceptible to acidification. This is indicated by the low alkalinity values and the widely fluctuating pH readings.

A trend which is apparent is that the streams to the east of the study area, and those with upstream lakes, have higher pH levels, and probably higher buffering capacity. This may be the result of sea spray which has been demonstrated to influence the water chemistry of Nova Scotia lakes (Petersen et. al., 1986). The storage capacity of lakes would tend to meter the salt into the outlets. The salt would provide alkalinity, which would result in more stable pH regimes. Fishers Brook (WC3), which is relatively far from the ocean, and with no upstream storage, had the lowest alkalinity and pH readings. Black Duck Brook (WC6), which has McQuade Lake in its upstream basin, and which is relatively close to the coast, had a relatively high pH and TDS reading, along with measurable alkalinity.

TABLE 6-13
Additional Water Quality Data

Stream	pH	TDS (mg/L)
WC1	5.4	78
WC2, Maple & Fraser Connector	6.9	-
WC3, Station 1	4.6	123
WC3, Station 2	4.6	137
WC3, Station 3	5.2	137
WC4	6.7	134
WC5	7.2	32
WC6	7.2	196
WC7	6.9	140
WC8	6.4	907

The sodium measurement from the Black Duck Brook water sample was in the "moderately high" range (McNeeley et. al., 1979). The sodium concentration from the Maple to Fraser Lake Connector sample was in the "low" range (McNeeley, et. al., 1979). Sodium is a principal alkali metal, and is the major component of sea salt. The total dissolved solids concentration of Paper Mill Lake Inlet (WC8), which is situated immediately adjacent Bedford Basin, was the highest recorded.

Limited historical water quality data was available for the four lakes located in or near the study area (Table 6-14). The two lakes which are down-gradient of the proposed highway alignment, and are within the proposed study area, are Frasers and Sheldrake lakes. Two other lakes are outside of the study area, but may be influenced by the road development. They are Kearney and Papermill lakes. Table 6-14 provides relevant data on each of these lakes.

TABLE 6-14
Historical Water Quality Data: Lakes Within/Adjacent to Study Area

Lake	Surface Area (ha)	Drainage Area (ha)	Max. Depth (m)	Mean Depth (m)	pH	TDS	MEI	Thermal Strat.	Bottom DO
Sheldrake	12.9	458.7	7	2.75	5.8		-	Yes	deficient
Frasers	70.7	-	20	8.3	5.1	39	4.7	Yes	no
Kearney	61.5	2960	26	9.2	5.5 - 6.0	-	-	Yes	no
Papermill	22.3	-	6	-	6.5	-	-	No	no

Source: Lake Survey Information, NSDFA, 1999

Historical water quality data from the ENVIRODAT database was also recovered for Nine Mile River at Timberlea, Sandy Lake, Sheldrake Lake and two areas of Kearney Lake. The results are shown in Table 6-15.

TABLE 6-15
Historical Water Quality Data: Areas Adjacent to Study Area

Station	Colour Rel Units	Specific Cond	Turb JTU	DOC	NO_3/NO_2/dis mg/L	Ph
Nine Mile River	5 - 110	42 - 192	0.5 - 5.6	2.8 - 7.6	0.01 - 0.3	4.6 - 6.1
Sandy Lake	5 - 55	24 - 184	0.4 - 3.7	1.3 - 5.0	0.01	4.0 - 7.0
Sheldrake Lake	35 - 305	72 - 140	0.5 - 6.6	2.7 - 13.1	--	4.5 - 5.3
Kearney Lake	5 - 25	60 - 102	0.2 - 2.6	1.1 - 3.0	0.06 - 0.36	

Source: ENVIRODAT, 1999

6.3.3.1 <u>Fishers Brook Water Quality</u>

Potential contaminant source to Fishers Brook includes the Kingswood subdivision, which consists primarily of private residences. Sewage from the residences is typically disposed of through individual septic fields. Currently, there is no development immediately adjacent to Fishers Brook. There is no industrial establishment in Fishers Brook watershed that discharges waste effluent into Fishers Brook.

Contaminants that may potentially enter Fishers Brook from the Kingswood subdivision include road salt, pesticides, herbicides and fertilizers used for lawn care, other nutrients from sources such as sewage and pet feces, and remnants of household chemicals. Sediment from construction sites and road side ditches may also enter Fishers Brook with surface runoff.

Fishers Brook drains through a series of wetlands, including Wetlands #3 and #4, downstream of Kingswood subdivision. These wetlands serve as a natural filter and sink of contaminants. Any amount of contaminant loading into Fishers Brook will be further removed by these wetlands.

There are no known drinking or recreational users of Fishers Brook prior to its entering the Fraser Lake. Fish and wildlife are expected to be the primary users in this section of Fishers Brook. Aluminum toxicity may be a problem in Fishers Brook, as described in Section 6.3.3.

6.3.4 <u>Aquatic Resources</u>

The following sections describe the aquatic resources within the study area of the proposed highway alignment, including fish resources, benthic invertebrate communities, and recreational, commercial and Native fisheries (*i.e.*, fishery resource utilization).

6.3.4.1 <u>Fish Resources</u>

Spot-check electrofishing was performed on the 10 watercourse crossings along the proposed highway alignment. Results are summarized in Table 6-16.

TABLE 6-16
Spot-Check Electrofishing Results

Species	Watercourse									
	1	**2**	**3A**	**3B**	**3C**	**4**	**5**	**6**	**7**	**8**
Brook trout	0	4	2	0	0	14	3	0	0	2
American eel	3	14	0	0	0	3	5	0	0	0
White sucker	0	1	0	0	0	0	0	0	0	0
Gaspereau	0	1	0	0	0	0	0	0	0	0
Banded killifish	0	9	0	0	0	0	0	0	0	0
9-spine Stickleback	0	0	0	0	0	0	15	0	0	0

Brook trout and Atlantic salmon are considered the most important species potentially occurring in the study area, due to their importance as recreational angling catch and their sensitivity to habitat disturbance. As can be seen in Table 6-16, no salmon were collected from any of the 10 watercourse crossings of the alignment. Brook trout were found in five of the ten crossings, the Tributary between Maple and Frasers Lake, Fishers Brook, Stillwater Run, the outlet of Ragged lake, and the tributary to Papermill Lake. The water level in Black Duck Brook (WC6) was very low (almost dry) at the time of survey and no fish were recorded as a result of the electrofishing spot check.

6.3.4.2 Benthic Invertebrate Communities

Benthic invertebrate communities have the potential to change considerably before the start of highway construction. Therefore, it is proposed that field investigations to document baseline benthic invertebrate communities be conducted at a future time, closer to the start of highway construction, if still relevant.

6.3.4.3 Fishery Resource Utilization

Based on electrofishing results, the watercourses crossed by the proposed alignment do not represent high-quality opportunities for utilization of fish resources (*i.e.*, recreational, commercial or Native fisheries). However, consultation with DFO indicates that both WC2 (tributary between Maple and Frasers Lake) and WC4 (Stillwater Run) are potentially used by recreational fisheries (Jim Leadbetter, DFO, personal communication, 1999). No specific catch records are available for the watercourses traversed by the alignment.

6.3.5 Fish Habitat

This section presents a summary of habitat conditions found within the area surveyed along each watercourse crossed by the proposed alignment. The reach surveyed included 200 m upstream and downstream of the proposed alignment centreline (where possible) on each stream. Habitat summaries, from previous reports, are also provided for four lakes located in or adjacent to the study area.

3.3.5.1 Watercourse # 1 - Stream connecting Upper Sheldrake Lake and Sheldrake Lake

This watercourse connects Upper Sheldrake Lake with Sheldrake Lake and is crossed by the existing Highway 103. The proposed alignment crosses this watercourse north of the existing Highway 103. Habitat parameters measured are provided in Table 6-17.

TABLE 6-17
Watercourse Number 1 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	15	-	-
Rock	25	10	-
Rubble	20	10	5
Gravel	10	10	5
Sand	15	20	15
Fines	15	50	75
Channel Characteristic	Riffle/Run/Pool	Pool	Run/Pool
Depth Range (cm)	15 - 50	100	100
Wet Width Range (m)	1.5 - 4	30	5 - 20
Channel Width Range (m)	4 - 5.5	35	6 - 25
Vegetative Cover (%)	Grasses 30 Shrubs - Trees 70	Grasses 10 Shrubs 85 Trees 5	Grasses 10 Shrubs 80 Trees 10
Number of Pools	1	1	1

Spot-check electrofishing confirmed the presence of only three American eels. The proposed easement crosses at a pool section that is not considered to be critical habitat due to its high percentage of fines and embeddedness.

The overall substrate along the surveyed length of this watercourse consisted of fines, rock, rubble, boulder, sand and gravel. The upstream portion had coarser substrate materials present, while the downstream contained finer materials. The wet widths ranged between 1.5 and 30 m and the bank widths ranged between 4 and 35 m. There were a series of riffles, runs and pools along the surveyed length, with depths ranging from 15 cm at the riffles to approximately 1.0 m at the pools. Little or no erosion existed along the watercourse banks. The amount of undercut bank was 15% on average, and the overhanging vegetation was approximately 5% on average. Upstream, the potential spawning habitat is considered poor to moderate, and the quality of overwintering habitat is considered to be moderate.

Downstream, and at the crossing location, the potential spawning habitat and the quality of overwintering habitat is poor. The embeddedness of the substrate ranged from $\leq$20% at upstream sections to $\geq$50% at the downstream sections.

The surrounding vegetation consists of trees and grasses along the upstream sections with predominantly shrubs present along the downstream section and in the vicinity of the existing

Highway 103 and the proposed crossing. The slope of the terrain was considered to be low - moderate, and the flood plain widths ranged from 20 to >50 m.

6.3.5.2 Watercourse # 2 - Tributary between Maple and Frasers Lakes

This watercourse connects Maple Lake with Fraser Lake and is located to the east of Highway 103 and watercourse #1. Habitat parameters measured are provided in Table 6-18. Spot-check electrofishing confirmed the presence of brook trout, American eel, white sucker, banded killifish, and gaspereau.

TABLE 6-18
Watercourse Number 2 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	20	65	15
Rock	25	10	20
Rubble	5	5	35
Gravel	15	5	10
Sand	15	10	10
Fines	20	5	10
Channel Characteristic	Riffle/Pool	Run	Riffle/Lake
Depth Range (cm)	10 - 200	300	30 - 50
Wet Width Range (m)	1.5 - 30	15	2
Channel Width Range (m)	5 - 35	20	3 - 5
Vegetative Cover (%)	Grasses 30 Shrubs 30 Trees 40	Grasses 20 Shrubs 20 Trees 60	Grasses 75 Shrubs 5 Trees 20
Number of Pools	1		

The proposed easement crosses watercourse #2 at a run section that is not considered to be critical habitat due to the lack of undercut bank and minimal cover as well as the minimal amount of potential spawning habitat.

The overall substrate along the surveyed length consisted of boulder, rock, rubble, fines, sand and gravel. The wet widths ranged between 1.5 and 30 m and the bank widths ranged between 3 and 35 m. There were a series of riffles, a run and a pool along the surveyed length, with depths ranging from 10 cm at the riffles to 2 m at the pools, and 3 m at the run. No erosion existed along the watercourse banks. The amount of undercut bank was <5%, and the overhanging vegetation was approximately 5% on average. The survey ended at Frasers Lake.

Upstream the potential spawning habitat is considered poor to moderate, and the quality of overwintering habitat is considered to be moderate to good. Downstream and at the crossing location, the potential spawning habitat is considered poor and the quality of overwintering habitat is good. The embeddedness of the substrate ranged from $\leq$20 to 35%.

The surrounding vegetation consists primarily of trees, grasses, and shrubs. The slope of the terrain was considered to be low, and the flood plain widths ranged from 20 to 80 m.

6.3.5.3 Watercourse # 3A - Fishers Brook

Fishers Brook is located to the northeast of Frasers Lake and this crossing is the first of three crossings of this watercourse by the proposed easement (*i.e.*, 3A, B, and C).
Frasers Lake receives the water from Fishers Brook. Habitat parameters measured are provided in Table 6-19.

TABLE 6-19
Watercourse Number 3A - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	50	80	50
Rock	5	5	-
Rubble	5	-	-
Gravel	5	5	-
Sand	5	5	-
Fines	30	5	50
Channel Characteristic	Riffle/Run/Pool	Riffle	Run
Depth Range (cm)	12 - >100	5	>150
Wet Width Range (m)	2 - 17	3	8
Channel Width Range (m)	7 - 22	4.5	8
Vegetative Cover (%)	Grasses 50 Shrubs 20 Trees 30	Grasses 50 Shrubs 5 Trees 45	Grasses 30 Shrubs 40 Trees 30
Number of Pools	2		

Spot-check electrofishing confirmed the presence of brook trout. The proposed easement crosses at a riffle section that is not considered to be critical habitat due to the lack of undercut bank and minimal cover as well as the lack of potential spawning habitat.

The overall substrate along the surveyed length consisted of boulder, fines, rock, sand and gravel. The wet width ranged between 2 and 17 m and the bank width ranged between 4.5 and 22 m. There were a series of riffles, runs, and pools along the surveyed length, with depths ranging from 5 cm at the riffles, >1.5 m at the run sections, to >1.0 m at the pools. No erosion existed along the watercourse banks. The amount of undercut bank was 30% on average, and the overhanging vegetation was approximately 35% on average.

Upstream the potential spawning habitat is considered poor, and the quality of overwintering habitat is considered to be moderate. Downstream and at the crossing location, the potential spawning habitat is considered poor, and the quality of overwintering habitat is good. The embeddedness of the substrate ranged from ≤20 to 35%, with <20% in the riffles and runs and >50% in the pools.

The surrounding vegetation consists primarily of grasses, trees, and shrubs. The slope of the terrain was considered to be low to moderate, and the flood plain width ranged from 10 to 50 m.

6.3.5.4 Watercourse # 3B - Fishers Brook

Fishers Brook is located to the northeast of Frasers Lake and this crossing is the second of three crossings of this watercourse by the proposed easement. Frasers Lake receives the water from Fishers Brook. Habitat parameters measured are provided in Table 6-20.

TABLE 6-20
Watercourse Number 3B - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	40	40	30
Rock	-	-	20
Rubble	-	-	10
Gravel	10	10	-
Sand	20	10	5
Fines	20	10	35
Channel Characteristic	Run	Run	Riffle/Pool
Depth Range (cm)	>150	>150	5 - 80
Wet Width Range (m)	8	8	1.5 - 5
Channel Width Range (m)	8	8	2 - 7
Vegetative Cover (%)	Grasses 20 Shrubs 70 Trees 10 Bare ground -	Grasses 50 Shrubs 5 Trees 45 Bare ground -	Grasses 55 Shrubs Trees 40 Bare ground 5
Number of Pools			2

The proposed easement crosses at a run section that is not considered to be critical habitat due to the lack of undercut bank and the lack of potential spawning habitat. This section is classified as a shrub wetland and has had past influence from beaver dams, as there are remnants present at the proposed crossing.

The substrate along the surveyed length consisted of boulder, fines, rock, rubble, sand and gravel. The wet width ranged between 1.5 and 8 m and the bank width ranged between 2 and 8 m. There were a series of riffles, and pools plus one run section along the surveyed length, with depths ranging from 5 cm at the riffles, 20 to 80 cm at the pools, to >1.5 m at the run section, which is associated to an old beaver pond. No erosion existed along the watercourse banks. The amount of undercut bank was minimal at 5% on average, and the overhanging vegetation was approximately 20% on average.

Upstream, and at the crossing location the potential spawning habitat is considered poor, and the quality of overwintering habitat is considered to be moderate. Downstream, the potential spawning habitat and the quality of overwintering habitat is poor to moderate. The embeddedness of the substrate ranged from $\leq$20% to 50%

The surrounding vegetation consists primarily of grasses, and trees, with some shrubs (located around the old beaver pond area). The slope of the terrain was considered to be low to moderate, and the flood plain width ranged from 30 to 150 m.

6.3.5.5 Watercourse # 3C - Fishers Brook

Fishers Brook is located to the northeast of Frasers Lake and this crossing is the third of three crossings of this watercourse by the proposed easement. Frasers Lake receives the water from Fishers Brook. Habitat parameters measured are provided in Table 6-21.

TABLE 6-21
Watercourse Number 3C - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	40	40	10
Rock	-	-	25
Rubble	-	-	5
Gravel	-	-	5
Sand	-	-	5
Fines	60	60	50
Channel Characteristic	Run	Run	Riffle/Run
Depth Range (cm)	<150	<150	5.5 - 100
Wet Width Range (m)	15	15	0.25 - 1.5
Channel Width Range (m)	15	15	0.5 - 1.5
Vegetative Cover (%)	Grasses 45 Shrubs 50 Trees 5 Bare ground -	Grasses 45 Shrubs 50 Trees 5 Bare ground -	Grasses 80 Shrubs Trees 20 Bare ground
Number of Pools			

The proposed easement crosses at a run section that is not considered to be critical habitat due to the lack of undercut bank and the lack of potential spawning habitat. This section is classified as a shrub wetland.

The substrate along the surveyed length consisted of fines, rock, boulder, gravel, rubble, sand. The wet width ranged between 25 cm and 15 m and the bank width ranged between 50 cm and 15 m. The stream type was predominantly a run with one riffle section along the surveyed length. The depths ranged from 5.5 cm at the riffle, to >1.5 m at the run sections. A minimal amount of erosion existed along the watercourse banks, approximately 10%. The amount of undercut bank was 44% on average, and the overhanging vegetation was approximately 40% on average.

Upstream, and at the crossing location, the potential spawning habitat, and the quality of overwintering habitat is considered to be poor. Downstream, the potential spawning habitat and the quality of overwintering habitat is considered poor. The embeddedness of the substrate ranged from $\leq$20% to 50%, with the embeddedness leaning towards >50%.

The surrounding vegetation consists primarily of grasses, with some trees and with some shrubs, located within a wetland type area. The slope of the terrain was considered to be low, and the flood plain width ranged from 10 to 100 m.

6.3.5.6 Watercourse # 4 - Stillwater Run

This watercourse is located to the east of Fishers Brook and drains Ash Lake which is located to the north of the proposed easement. Habitat parameters measured are provided in Table 6-22. Spot-check electrofishing confirmed the presence of brook trout and American eel.

TABLE 6-22
Watercourse Number 4 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	5	5	5
Rock	10	-	65
Rubble	20	-	5
Gravel	15	-	25
Sand	10	-	-
Fines	40	95	-
Channel Characteristic	Riffle/Run/Pool	Run	Riffle/Run
Depth Range (cm)	4.1 - 100	100	6 - 12
Wet Width Range (m)	1.0 - 10	5	2
Channel Width Range (m)	1.1 - 10	5	2
Vegetative Cover (%)	Grasses 70 Shrubs Trees 30 Bare ground	Grasses 70 Shrubs Trees 30 Bare ground	Grasses 40 Shrubs 5 Trees 55 Bare ground
Number of Pools	2		

The proposed easement crosses at a run section that is not considered to be critical habitat due to the lack of undercut bank and minimal cover as well as the lack of potential spawning habitat. The area has been influenced by the presence of beaver dams which tend to degrade the potential spawning and overwintering habitat.

The substrate along the surveyed length consisted of fines, rock, rubble, gravel, sand, boulder. The wet width ranged between 1 and 10 m and the bank width ranged between 1.1 and 10 m. There were a series of riffles, runs and pools along the surveyed length. The depths ranged from 4 to 10 cm at the riffles, to 10 to 30 cm at the run sections, to an estimated 1 m at a pool section (remnant of a beaver pond). No erosion existed along the watercourse banks. The amount of undercut bank and overhanging vegetation was minimal.

Upstream the potential spawning habitat is considered poor to moderate, and the quality of overwintering habitat is considered to be moderate. Downstream, the potential spawning habitat and the quality of overwintering habitat is poor. At the crossing location, both the potential spawning and overwintering habitat is considered poor. The embeddedness of the substrate ranged from ≤20% to >50%, with the >50% being located at the pool/run sections which are associated with beaver ponds.

The surrounding vegetation consists primarily of grasses and trees and with a very minimal amount of shrubs. The slope of the terrain was considered to be low, and the flood plain width ranged from 50 to 100 m.

6.3.5.7 Watercourse # 5 - Outlet of Ragged Lake

This watercourse is located to the southeast of Stillwater run and drains Ragged Lake, which is located to the north of the proposed easement into Stillwater run south of the proposed alignment. Habitat parameters measured are provided in Table 6-23. Spot-check electrofishing confirmed the presence of brook trout, 9-spine stickleback and American eel.

TABLE 6-23
Watercourse Number 5 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	-	-	5
Rock	-	-	5
Rubble	5	-	10
Gravel	-	-	10
Sand	-	-	5
Fines	95	100	65
Channel Characteristic	Run/Pool	Run	Run/Pool
Depth Range (cm)	15 - 35	100	10 - 100
Wet Width Range (m)	1.5 - 6	9	1.5 - 13
Channel Width Range (m)	1.5 - 6	9.5	1.7 - 18
Vegetative Cover (%)	Grasses 50 Shrubs 45 Trees 5 Bare ground	Grasses 50 Shrubs 50 Trees Bare ground	Grasses 55 Shrubs 40 Trees 5 Bare ground
Number of Pools	1		2

The proposed easement crosses at a run section that is not considered to be critical habitat due to the minimal undercut bank and the lack of potential spawning habitat. This area has been influenced by the presence of beaver dams which tends to degrade the potential spawning and overwintering habitat.

The substrate along the surveyed length consisted of fines, gravel, rock, rubble, rock, sand, boulder. The wet width ranged between 1.5 and 13 m and the bank width ranged between 1.5 and 18 m. The watercourse is made up of predominantly run sections and three pool sections, along the surveyed length.

The depths ranged from 10 cm to 1 m at the run sections, to an estimated 1 m at a pool section, at an old beaver pond. Some erosion existed along the watercourse banks, approximately 20% on average. The amount of undercut bank was 40% on average and the overhanging vegetation was also 40% on average.

Upstream, and at the crossing location, the potential spawning habitat, and the quality of overwintering habitat is considered to be poor. Downstream, the potential spawning habitat and the quality of overwintering habitat is considered poor. The embeddedness of the substrate ranged from 35% to >50%.

The surrounding vegetation consists primarily of grasses and shrubs with a very minimal amount of trees present. The slope of the terrain was considered to be low, and the flood plain width ranged from 75 to 100 m.

6.3.5.8 Watercourse # 6 - Black Duck Brook

This watercourse is located to the east of Ragged Lake and drains into Kearney Lake, which is located south of the proposed easement. Habitat parameters measured are provided in Table 6-24. Due to the lack of water in this watercourse, no electrofishing data could be collected, therefore all measurements provided in Table 6-24 are estimates (excluding substrate and vegetation information). Water of minimal depth was observed within the downstream section.

TABLE 6-24
Watercourse Number 6 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	40	20	10
Rock	20	20	10
Rubble	20	20	10
Gravel	5	20	-
Sand	-	-	-
Fines	15	20	70
Channel Characteristic	Dry	Dry	Run
Depth Range (cm)	-	-	7.5
Wet Width Range (m)	1.5 - 5	3	7
Channel Width Range (m)	1.5 - 5	3	9
Vegetative Cover (%)	Grasses 50 Shrubs 45 Trees 5 Bare ground	Grasses 50 Shrubs 50 Trees Bare ground	Grasses 55 Shrubs 40 Trees 5 Bare ground
Number of Pools			

The proposed easement crosses at a dry section (at time of survey) that is not considered to be critical habitat due to the lack of undercut bank and the lack of potential spawning habitat, as well as the absence of water. This watercourse appears to have only seasonal flow.

The substrate along the surveyed length consisted of boulder, fines, rubble, rock, gravel. The wet width ranged between 1.5 and 7 m and the bank width ranged between 1.5 and 9 m. During the survey there was little or no water present, therefore only one section of still water was specified as a run section. The depth of this one section was 7.5 cm.. Little or no erosion existed along the watercourse banks. The amount of undercut bank was 5% on average with no overhanging vegetation.

Upstream the potential spawning habitat, and the quality of overwintering habitat is considered to be poor, due to the absence of water. Downstream and at the crossing location, the potential spawning habitat and the quality of overwintering habitat is also considered poor mainly due to the lack of water at time of survey. The embeddedness of the substrate was <20%.

The surrounding vegetation consists primarily of grasses, bare ground and trees. The slope of the terrain was considered to be low - moderate, with some steeper sections, and the flood plain width ranged from 60 to 100 m.

6.3.5.9 Watercourse # 7 - Tributary to Kearney Run

This watercourse is located to the east of Black Duck Brook and is a tributary to Kearney Run, which drains into the northeast corner of Kearney Lake, to the south of the proposed easement. Habitat parameters measured are provided in Table 6-25. No fish were caught during the electrofishing spot checks.

TABLE 6-25
Watercourse Number 7 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	-	-	5
Rock	-	-	5
Rubble	10	5	5
Gravel	5	5	5
Sand	5	-	5
Fines	80	90	75
Channel Characteristic	Run	Pool	Run/Falls
Depth Range (cm)	35	75	10 - 50
Wet Width Range (m)	1.5	12	1 - 2
Channel Width Range (m)	1.7	12.5	1 - 2
Vegetative Cover (%)	Grasses 10 Shrubs 10 Trees 60 Bare ground 20	Grasses 20 Shrubs 20 Trees 50 Bare ground 10	Grasses 15 Shrubs 40 Trees 15 Bare ground 30
Number of Pools		1	

The proposed easement crosses at a pool section that is not considered to be critical habitat due to the minimal amount of undercut bank and the lack of potential spawning and overwintering habitat.

The substrate along the surveyed length consisted of fines, rubble, gravel, rock, sand, boulder. The wet width ranged between 1 and 12 m and the bank width ranged between 1 and 12.5 m. The watercourse consisted predominantly of run sections with one pool section and a falls. The depth of the run section ranged between 35 and 50 cm, the pool section was 75 cm and the falls section was 10 cm. Erosion existed along the watercourse banks at approximately 10% on average. The amount of undercut bank and overhanging vegetation was 10% on average.

Upstream the potential spawning habitat, and the quality of overwintering habitat is considered to be poor. Downstream and at the crossing location, the potential spawning habitat and the quality of overwintering habitat is poor. The embeddedness of the substrate was < 20 to >50%.

The surrounding vegetation consists of trees, shrubs, bare ground and grasses. The slope of the terrain was considered to be low to moderate, and the flood plain width was >75 m.

6.3.5.10 Watercourse #8 - Tributary to Paper Mill Lake

This watercourse is located to the east of the tributary to Kearney Run and is a tributary to Paper Mill Lake. This watercourse is also presently crossed by Highway 102. Habitat parameters measured are provided in Table 6-26.

TABLE 6-26
Watercourse Number 8 - Habitat Parameters Measured

Parameter	Upstream of CL	At CL	Downstream of CL
Substrate (%)			
Bedrock	-	-	-
Boulder	-	-	-
Rock	-	-	-
Rubble	-	5	-
Gravel	-	-	-
Sand	-	-	-
Fines	100	95	-
Channel Characteristic	Run	Pool	Run
Depth Range (cm)	54	50	no water
Wet Width Range (m)	2	10(estimated)	5
Channel Width Range (m)	2	10(estimated)	5
Vegetative Cover (%)	Grasses 50 Shrubs 50 Trees Bare ground	Grasses 30 Shrubs 70 Trees Bare ground	Highway 102 crossing
Number of Pools		1	

During the electrofishing spot checks two (2) brook trout were caught. The proposed easement crosses at a pool section that is not considered to be critical habitat due to the lack of potential spawning and overwintering habitat.

The substrate along the surveyed length consisted of fines. The wet width ranged between 2 and 10 m and the bank width ranged between 2 and 10 m. The watercourse consisted of run and pool sections. The depth of the run/pool sections ranged between 50 and 54 cm. No erosion existed along the watercourse banks. The amount of undercut bank and overhanging vegetation was 45% on average.

Upstream the potential spawning habitat, and the quality of overwintering habitat is considered to be poor. Downstream and at the crossing location, the potential spawning habitat and the quality of overwintering habitat is poor. The embeddedness of the substrate was >50%.

The surrounding vegetation consists of grasses and shrubs. The slope of the terrain was considered to be low, and the flood plain width was >100 m.

6.3.5.11 Sheldrake Lake

This is a small (12.9 ha) lake in the headwaters of the Woodens River system which flows to St. Margarets Bay. Highway 113 will cross the connector stream between Sheldrake Lake and Upper Sheldrake Lake which is the upper-most of the 14 lakes on the main stem of the system.

Sheldrake Lake has a mean depth of 7 m. Nova Scotia Department of Lands and Forest (NSDLF) data from 1979 indicate that the lake was stratified in the early summer (July 5) with a surface water temperature of 19^{o}C, and a bottom temperature of 10^{o}C. It is not known whether this thermal stratification persists later in the summer. Dissolved oxygen in the bottom water during the 1979 survey was virtually non-existent. The pH of the lake water was low (5.6).

No salmonids were captured in an overnight gill net set in 1979. The only fish captured were golden shiners, although there were undoubtably eels present in the fish community as well. The sport fishing opportunities presented by Sheldrake Lake are extremely limited.

6.3.5.12 Frasers Lake

This is a long, narrow, deep lake with a surface area of 70.7 ha. It is a middle lake in the Nine Mile River system which drains to Shad Bay. Highway 113 will cross the stream connecting upstream Maple Lake and Frasers Lake.

Frasers Lake has a maximum depth of 20 m. In surveys done by NSDLF in the late summer of 1983, and in the early summer of 1974, the water column was strongly stratified, and contained acceptable levels of dissolved oxygen (>5 mg/L) from top to bottom. The pH of the lake was low (5.1 to 5.5), but acceptable.

The fish captured in association with NSDLF were white suckers, brook trout, American eels, and juvenile gaspereau. The lake was stocked from 2,000 to 8,200 fall fingerling brook trout annually for eight of the last twelve years. This is an effort to provide a sport fishery in a near-urban setting. The long, narrow shape of the lake provides sufficient shoreline length, and therefore, an acceptable amount of littoral area for brook trout. However, the presence of white suckers in the fish community would make it impossible to produce a fishery of acceptable quality based on wild trout.

6.3.5.13 Kearney Lake

Similar to Frasers Lake, Kearney Lake is long, narrow and deep. It has a surface area of 61.5 ha, and is the second lake upstream in a small system that drains to Bedford Basin. The highway will cross Black Duck Brook which is the northwest tributary of the lake.

Kearney Lake has a maximum depth of 26 m, and in surveys done in the summer of 1971 by the NSDLF the water column was strongly stratified. There were acceptable levels of dissolved oxygen (>5 mg/L) at all depths.

There were brown bullhead, golden shiners, white suckers, and brook trout taken in gill net sets in June of 1971. American eels are also undoubtedly present. There were no sport fish management initiatives described in the files which were reviewed for this project. Due to the presence of bullhead and white suckers in the fish community, a successful wild brook trout program would be impossible.

6.3.5.14 Papermill Lake

This is a small (22.3 ha) lake and is the lowest lake in the system that drains Jack Lake (pond) and Kearney Lake as well as other lakes and ponds. The outlet of this lake is regulated by a dam, and flows into the waters of Bedford basin. The dam provides an effective barrier to upstream and downstream fish migration. This lake was previously used as a headpond for the supply of water to the Moirs' candy factory. The lake is no longer used as a headpond, but is now used primarily for swimming and some fishing. Highway 113 crosses the tributary to Papermill Lake (Watercourse # 8) north of the existing Highway 102.

Papermill Lake is shallow and the majority of lake bottom is covered with dense submergent vegetation. The lake has a mean depth of 6 m. NSDLF data from 1971 indicate that the lake was unstratified in the late summer (August 30) with a surface water temperature of 18^oC, and a bottom temperature of 18^oC. Dissolved oxygen in the bottom water during the 1971 survey was 8.8 mg/L. The pH of the lake water was (6.5).

Brook trout, along with common suckers and brown bullheads were captured in an overnight gill net set on September 23 - 24, 1971. American eels were observed in the lake but not caught. Stocking data for the lake is available for 1991 to 1998, with 500 to 2400 fish being stocked to the lake throughout this period. The sport fishing opportunities presented by Papermill Lake are limited to the success of the stocking efforts and the amount of recreational activity.

6.4 Wetland Environment

Wetlands have been defined as "lands transitional between terrestrial and aquatic systems where the water table is at, or near, the surface of the land or the land is covered by shallow water at some time during the growing season. Wetlands are characterized by poorly drained soils, and predominantly hydrophytic, or water tolerant, vegetation" (NBDNRE, 1993). Thus maintenance of wetland habitat is dependant on maintenance of existing soil, vegetation and hydrologic conditions at a site.

6.4.1 Wetland Assessment Methodology

Wetland vegetation is the primary biological indicator of major ecological processes, their vitality and their ability to support wildlife. Wetland vegetation abundance and diversity depend upon a variety of factors, including soil type, topography and the hydrologic regime (Glooschenko and Grondin, 1988). The type of wetland habitat present is a major determinant of function and values within a wetland. For instance, major changes in vegetative communities, and thus habitat types, may result in a redistribution of wildlife species within a wetland (Kobriger *et al.*, 1983). Thereby, it can be seen that maintenance of wetland function is dependant on maintenance of habitat types within a given wetland, as defined by vegetation, soils and hydrologic conditions.

Pre-field and field investigations were focussed on defining wetland features, specifically vegetation, soils and hydrologic conditions, potentially affected by the proposed development.

The methodology employed for the wetland assessment was developed previously in consultation with regional regulatory authorities in relation to other linear corridor projects in NS (*i.e.*, Environment Canada, NSDNR, Washburn & Gillis Associates Ltd., 1998). Regional regulatory personnel were consulted to confirm the approach proposed prior to conduct of field investigations (Doug Archibald, personal communication, 1999).

The study methodology has three main components:
- identification of potentially affected wetlands;
- biophysical field investigations; and
- functional analysis.

Each component is discussed separately below.

6.4.1.1 Identification of Potentially Affected Wetlands

Wetland vegetation is the primary biological indicator of major ecological processes, their vitality, and its ability to support wildlife. Wetland vegetative abundance and diversity depend upon a range of factors including soil types and topography, but are most closely linked to the nature of the hydrologic regime (Glooschenko and Grondin, 1988). Plants most clearly illustrate the biological capability of the wetland. The nature and dynamics of the vegetative community ultimately define wetland habitat type and subsequent functional values of the site. Previous studies have shown that aerial photographs can be used successfully to delineate wetland vegetation communities (Shima, Anderson and Carter, 1976; carter, 1976; Weller, 1981; Lyon and Drobney, 1984).

Regional wetland atlases have been compiled through air photo interpretation. Pre-field activity including assessment of existing wetland mapping including the federal (Environment Canada, 1988) and provincial (NSDNR, 1992) Wetlands Atlas, as well as unpublished wetland atlas data being complied by NSDNR (Randy Milton, NSDNR, personal communication, 1999). All wetlands identified on these map sources which will be traversed by or within approximately 50 m of the proposed mapped alignment were identified and subsequently surveyed in the field. Wetland aerial extents were confirmed by independent review of aerial photography. A total of nine wetlands were identified from the Federal Wetland Atlas and seven from the newer provincial database. No wetlands were indicated on the NSDNR (1992) atlas map. All of the identified wetlands are shown in Figure 6-9.

Six of the wetlands in the study area are crossed by the proposed alignment. Table 6-27 summarizes the location of the highway in relation to the wetlands.

TABLE 6-27
Wetland Location in Relation to Proposed Highway

Wetland Number	Wetland Intersected by Alignment (Yes/No)	Location of Alignment Relative to the Wetland[1]
1	No	Proposed highway crosses 600 metres south.
2	No	Proposed highway crosses 200 metres south.
3	Yes	Proposed highway crosses the northern area of the wetland.
4	Yes	Proposed highway crosses the southern area of the wetland.
5	No	Proposed highway crosses 250 metres north.
6	Yes	Proposed highway crosses the southern area of the wetland.
7	No	Proposed highway crosses 70 metres north.
8	No	Proposed highway crosses 200 metres north.
9	No	Proposed highway crosses 150 metres south.
10A	No	Proposed highway crosses 400 metres south.
10B	Yes	Proposed highway crosses 15 metres north.
10C	Yes	Proposed highway crosses the southern area of the wetland.
10D	No	Proposed highway crosses 350 metres north.
11	No	Proposed highway crosses 7 5 metres south.
12	No	Proposed highway crosses 180 metres south.
13	No	Proposed highway crosses 190 metres south.
14	No	Proposed highway crosses 100 metres north.
15	No	Proposed highway crosses 350 metres south.
16	Yes	Proposed highway crosses the middle/southern area of the wetland.

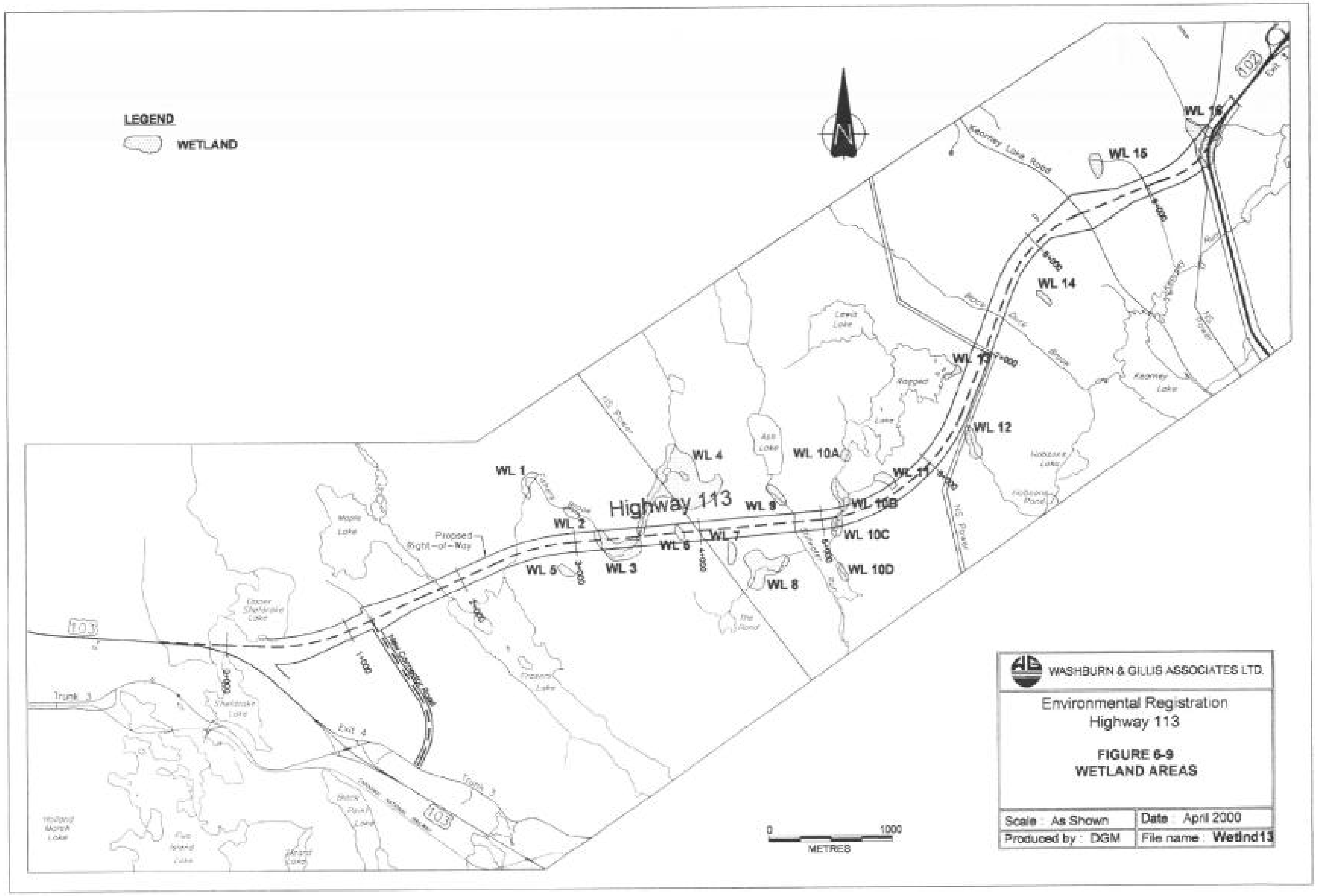
Note: 1. Approximate values based on current highway alignment.

Additionally, Duck Unlimited (DU) was contacted to identify any managed wetlands in the study area. It was reported by John Wile of DU (personal communication ,1999) that there are no DU managed wetlands in the study area.

6.4.1.2 Biophysical Field Investigations

Each identified wetland was investigated in the field and a detailed biophysical survey form was completed. The biophysical surveys detail information on the wetlands such as wetland type, class and subclass, characteristics of the water regime, vegetation types and adjacent land use. Sketches and photographs were also completed as part of the biophysical field investigation.

Figure 6-9
Wetlands



6.4.1.3 Functional Analysis

The Wetland Evaluation Guide formed the basis for wetland functional analysis (Bond *et al*., 1992). The guide describes three formal stages of wetland evaluation:

- Stage 1 General analysis of wetland functions and project description;
- Stage 2 Detailed analysis involving application of a multiple value evaluation matrix; and
- Stage 3 Specialized analysis, involving intensive wetland evaluation.

Stage 1 and 2 analyses were conducted for each wetland surveyed in the field. Stage 3 analysis is only required in instances where stage 1 and 2 results are insufficient to determine wetland functions and potential effects. Stage 3 analysis was not required for the wetlands within or adjacent to the proposed easement as a result of the detailed field assessments conducted. All functional analysis forms were prepared with reference to the biophysical field assessment and input from regional biologists.

Wetland Assessment Results

Table 6-28 lists all of the wetlands identified for field investigation. Additional details on the wetlands are presented in the biophysical data sheets in Appendix B.

Table 6-28 also summarizes the wetland classifications based on the field investigations and the classifications according to existing data from Environment Canada and NSDNR.

The majority, 17 out of 19, of the wetlands assessed are Bog-type wetlands. The remaining two wetlands are shrub and emergent wetlands. The following describes the three types of wetlands found, according to Dickinson *et al.* (undated):

- Bog Type Wetlands: peatland with water table at or near surface. Sphagnum moss dominant and area acidic and low in nutrients. May have trees or shrubs.
- Shrub Type Wetlands: wetlands dominated by shrubs with up to 30 cm of water.
- Emergent Type Wetlands: marsh with fluctuating standing or moving water. Rich in nutrients with emergent sedges, grasses and reeds.

Wetland sketches prepared in the field represent the relation of wetland components (*i.e.,* hydrologic conditions, vegetation communities, etc.). In most instances, habitat sketched closely resembles wetland delineations on project air photos. However, overall wetland shape may differ between habitat sketches and air photos delineations, since air photos delineation may indicate the historic high water level rather than the existing limits of wetland vegetation. The habitat sketches are included in Appendix B.

Stage 1 of the functional analyses provides a general analyses of the wetland in relation to the Project.

Stage 2 of the analyses assesses the functionality of the wetlands in relation to three broad categories:

- life-support values;
- social/cultural values; and
- wetland production values.

TABLE 6-28
Wetlands Within the Study Area

Wetland Number [1]	Wetland Type and Class Determined In Field		Wetland Atlas Number[2]	Wetland Type According To Existing Atlas Data
	Type	Class(es)		
1	Bog	Open water, Bog	9-1	Bog
2	Bog	Open water, Shallow Marsh, Shrub Swamp, Bog	9-2	Bog
3	Shrub Wetland	Open Water, Shrub Swamp, Bog	9-3	Bog, Shrub Swamp
4	Bog	Open water, Shallow Marsh, Shrub Swamp, Bog	9-4	Bog
5	Bog	Bog	--	Bog
6	Bog	Bog	--	Bog
7	Bog	Bog	--	Bog
8	Bog	Open water, Bog	8-12	Bog
9	Bog	Open water, Meadow, Bog	8-14	Bog
10A [3]	Bog	Open Water, Meadow, Bog	8-6	Bog
10B	Bog	Open Water, Shrub Swamp, Bog	8-7	Bog
10C	Bog	Meadow, Shrub Swamp, Bog	8-8 and 8-9[4]	Bog
10D	Emergent Wetland	Open Water, Shallow marsh, Bog	8-10	Bog
11	Bog	Bog	--	Bog
12	Bog	Bog	--	Bog
13	Bog	Shallow Marsh, Bog	--	Bog
14	Bog	Open Water , Bog	--	Bog
15	Bog	Bog	3-1	Open water, Shrub swamp
16	Bog	Open Water, Meadow Shrub Swamp, Bog	2-1	Bog, Shrub swamp

Notes
1. The wetland numbers designated for this project.
2. Wetland numbers derived from Environment Canada, 1988; unnumbered wetland data (--) obtained from unpublished NSDNR wetland database, 1999
3. Wetland 10A, 10B, 10C and 10D are so numbered because they are parts of a complex wetland as identified in the Wetland Atlas (Environment Canada, 1988).
4. The wetland is identified as two separate areas in the Wetland Atlas (E. C., 1988), however, no separation was apparent in the field, therefore the wetlands were surveyed as one.

Within each evaluation category, there are several subsections of the assessment as described below:

Life-support values "relate the capacity of the wetland to regulate and maintain essential ecological processes and life-support systems that have a value to society" (Bond *et al*., 1992).

Life-support values are evaluated using the following criteria (Bond *et al*., 1992);

- hydrological - value of the wetland in contributing to surface and groundwater resources (*e.g.*, contribution to usable surface water, flood protection benefits);
- biogeochemical - value of the wetland in contributing to surface water and groundwater quality (*e.g.*, sediment flow stabilization, pollutant sink);
- habitat - role of the wetland in contributing to the well-being of important plants and animal values (*e.g.*, rare, threatened or endangered animal or plant species, significant habitat for reptiles and amphibians); and
- ecological values - role of the wetland in stimulating relations of plant and animal communities (*e.g.*, wetland considered a classic example, display biological diversity that is of interest).

<u>Social/cultural values</u> relate the wetland to the importance that is placed on it related to human social and cultural issues. Social/cultural values are evaluated on the following criteria (Bond *et al*., 1992):

- aesthetic - role of the wetland in the quality of the scenic environment (*e.g.*, valuable aesthetic or open space function, sightseeing);
- recreational - role of the wetland in stimulating recreation activities (*e.g.*, opportunities for boating, high quality sport hunting and fishing);
- education/ public awareness - role of the wetland in stimulating public values and understanding (*e.g.*, used for scientific research, exist close to a large urban population);
- public status - role of the wetland in creating a sense of public ownership (*e.g.*, part of settlement and rural/urban lifestyle, easy public access); and
- cultural attribute values - role of the wetland in the identity of the people in the area (*e.g.*, forms part of a historical/cultural heritage of a regional population)

<u>Production values</u> relate the wetland to the value that is placed on agriculture natural resources and tourism issues. Production Values are evaluated on the following criteria:

- agricultural - role of the wetland in contributing to agricultural production (*e.g.*, provide water for livestock, provide a source of forage);
- renewable resources - role of the wetland in contributing to the viability of renewable resource harvest (*e.g.*, used for commercial or subsistence hunting, trapping and fishing, forest resources be harvested);
- non-renewable resources - role of the wetland in contributing non-renewable resources for consumption (*e.g.*, commercial source of peat for horticulture or energy, occur over known mineral or gas and oil deposits); and
- tourism and recreation - role of the wetland in stimulating tourism and recreational benefits (*e.g.*, important local, regional or provincial tourism or recreational attraction, national and international development).

A summary of the results of the Stage 2 functional analyses is provided in Table 6-29. The functional analyses wetland functions are indicated in the Table as present (P) or absent (--). The complete functional analyses forms are presented in Appendix B.

TABLE 6-29
Summary of Surveyed Wetland Functions

WETLAND	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.0 LIFE-SUPPORT FUNCTIONS																
Hydrological	P	P	P	P	--	--	--	--	--	P	--	--	P	--	P	P
Biogeochemical	P	P	P	P	--	--	--	--	--	P	P	--	--	P	--	P
Habitat	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Ecological	P	P	P	P	--	--	--	--	--	P	--	--	--	--	--	--
2.0 SOCIAL/CULTURAL FUNCTIONS																
Aesthetic	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	P
Recreational	P	P	P	P	--	--	--	--	P	P	--	--	--	P	--	--
Education and Public Awareness	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Public Status	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Cultural Attribute	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
3.0 WETLAND PRODUCTION FUNCTIONS																
Agricultural	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Renewable Resources	P	P	--	P	P	P	P	P	P	P	P	P	P	P	P	P
Non-renewable Resources	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tourism and Recreational	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--
Urban	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--
TOTALS	**9**	**9**	**8**	**12**	**5**	**5**	**5**	**5**	**6**	**9**	**6**	**5**	**6**	**7**	**6**	**8**

The total number of functions present for each wetland range from 5 to 12, with an average of approximately 7 functions represented by each wetland. Wetland 4, Fishers Brook Wetland presented the highest number of criteria present with 12 functions. The wetlands associated with the Fisher Brook system, Wetland 1, 2, 3 and also wetland 10 posses the second largest number of functions at 9.

In summary, all wetlands are important however, wetland 4 has been evaluated to provide the most function as defined in the functional analyses. Overall, the functions of this wetland are associated with hydrological, biogeochemical, habitat, ecological, aesthetic, recreational, education/ public awareness, public status, cultural attribute, renewable resources, tourism and recreation and urban functions.

6.5 Visual Resources

A majority of the land traversed by the proposed Highway 113 is considered to be a high quality resource area in terms of recreation and open space potential. Blue Mountain Hill (a block of Crown land located partially within the study area), shown in Figure 6-10, is promoted as a scenic vista.

NSDNR states that Blue Mountain Hill, a 152 m promontory just south of Ragged Lake, is a popular destination for hikers (Brian Kinsman, NSDNR, personal communication, 1999). From Blue Mountain Hill, the area's highest elevation, hikers can view Timberlea, Bedford and the Halifax region. The recreational values, including visual resources, of the Blue Mountain block of land have been promoted in Hiking Trails and Canoe Routes in Halifax County (Canadian Hostelling Association - Nova Scotia, 1977).

No other significant visual resources have been identified in the study area.

6.6 Social, Economic, and Cultural Conditions

This section provides a description of the existing environment, from a social and economic perspective, at a level of detail sufficient to assess project impacts. The study area for the socio-economic environment will include the local communities in the immediate project area (Hammonds Plains and Kearney Lake Road subdivisions and businesses, and the Kingswood and Sheldrake Heights subdivisions). In certain instances, socio-economic impacts may be realized outside the study area. It is expected that contractors from around the province, and especially from the HRM area, will be involved in the Project, although the related impacts are expected to be of a short-term duration.

6.6.1 Land Use and Activity Levels

The proposed highway RoW is, for the largest extent, undeveloped. Most of the land is presently forested and only at a few locations, close to existing roads, does development occur. The proposed route travels close to some permanent residences. The study area includes various residential and mixed resource uses. These land uses are described in the following subsections.

6.6.1.1 Planning and Development Control

Land use planning and development control in Nova Scotia are largely municipal functions, with the Department of Municipal Affairs acting in an advisory and approval capacity. Municipal planning objectives are generally achieved through a Municipal Planning Strategy (MPS). The ***Planning Act*** (1989) permits municipal councils to prepare MPSs for Districts within the municipality. The MPSs are implemented through zoning by-laws, land use by-laws, and other supporting legislation.

The study area falls within Municipal Planning Districts 15, 18, and 19 (Hammonds Plains, Upper Sackville and Beaverbank) and the Town of Bedford. The land use and zoning information was obtained from the ***Municipal Planning Strategy for Hammonds Plains, Upper Sackville and Beaverbank (15, 18, 19)*** (1987) and the ***Municipal Planning Strategy for Town of Bedford*** (1996). The Municipal Planning Strategy for Districts 15, 18 and 19 has been prepared according to the ***Planning Act*** and pursuant to municipal Council's adoption of Municipal Development Plan, Stage 2 Process, 1983. The Municipal Planning Strategy for the Town of Bedford has been prepared in accordance with the provisions of the ***Planning Act*** and is consistent with the Halifax-Dartmouth Regional Development Plan objectives.

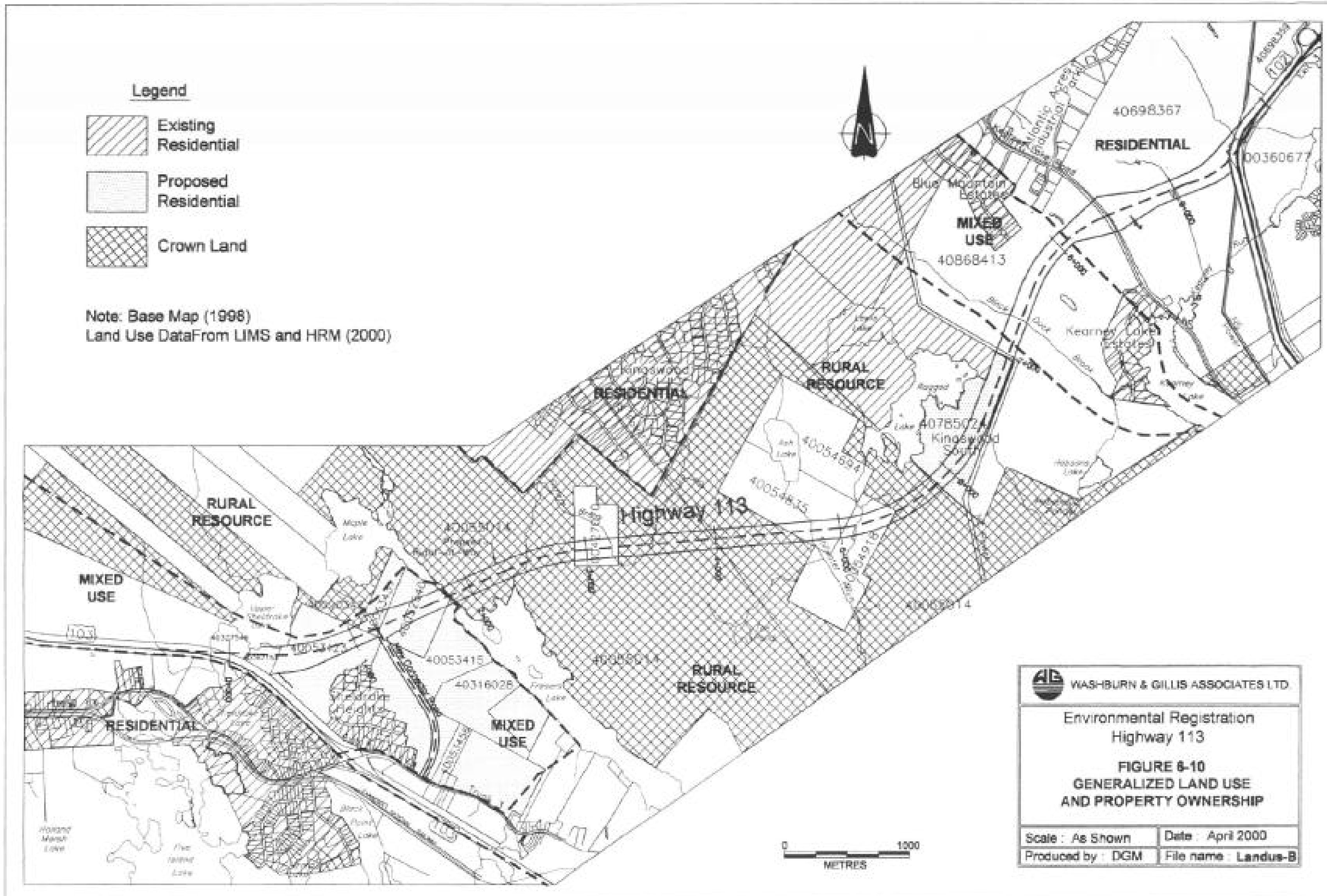
6.6.1.2 Existing Land Use and Property Ownership

A survey of existing land use in the study area and surrounding vicinity was conducted during September, 1999. Recent aerial photos, various scaled maps, and the MPS land use identification plans were used to assist in field observations to identify and record existing land use activities. In addition, the municipal planner for the various areas (Angus Schaffenburg, MCIP, HRM), was contacted to identify existing land use in the study area. The generalized land use of the area is shown in Figure 6-10. The majority of the required land is privately owned. Table 6-30 provides a summary of the properties crossed by or directly adjacent to the proposed highway alignment.

TABLE 6-30
Potentially Affected Landowners

PID #	Landowner	Relevance to Alignment
40519209	Annapolis Basin Group Inc.	adjacent
360677	same	crossed
417576	same	adjacent
40519191	same	adjacent
40698367	same	crossed
40698359	Canadian Red Cross Fractionation Corp.	crossed
40868143	Annapolis Basin Group Inc.	crossed
40785024	United Gulf Developments Ltd.	crossed
40055014	NS Department of Natural Resources	crossed
40054918	Barrett Lumber Company Ltd.	crossed
40054835	same	crossed
40054694	George and Janet Hue	adjacent
00427070	Roland Fraser	crossed
40053456	Piercey Investors Ltd.	adjacent
40316028	same	adjacent
40053415	same	crossed
40052540	same	crossed
40053431	same	crossed
40053423	same	crossed
40327546	same	adjacent
40767154	same	crossed
40090342	NS Department of Supply and Service	adjacent

Figure 6-10 Generalized Land Use and Property Ownership



Development in the area typically occurs along the Hammonds Plains Road, Kearney Lake Road and Trunk 3/Highway 103.

Several large residential subdivisions have developed and continue to develop from these roads and are located directly adjacent to the proposed Highway 113 corridor.

Much of the land which does not front on a public highway (backland) and is not part of the developed subdivisions is undeveloped. Land use in developed areas is primarily residential with commercial and institutional development scattered throughout.

TPW, Lands Surveys and Inventories Division, stated that no Federal Lands will be affected by the proposed alignment (David Alexander, TPW, personal communication, 1999).

The following sections provide more detail on existing and proposed land use in the study area.

Mixed Use

'Mixed Use' land use comprises a portion of the east and west ends of the study area. The 'Mixed Use' designation recognizes the semi-rural development characteristics, particularly, a traditional mix of low density residential, home business and resource uses, and provides for community uses and facilities. 'Mixed Use' also provides for a limited amount of commercial and industrial development.

Commercial

There are no commercial lands on the proposed alignment. Commercial lands near the study area are concentrated on the Hammonds Plains Road and in the Town of Bedford, east of the study area.

Two small Light Industrial Zones, with a combined developed area of approximately 93 ha, are located on the Kearney Lake Road adjacent to both sides of study area boundaries.

Generally, commercial outlets in the area serve only local markets, are sporadically located throughout the area, and include those typically associated with small town rural and suburban life in Nova Scotia.

Residential

The communities of the Hammonds Plains and Timberlea areas have experienced a considerable amount of residential growth since the early 1980s, which has resulted in a significant increase in population. Parts of the area continue to experience development pressure in the form of new residential subdivision development. The traditional land use development pattern was along the main roads, focussing Hammonds Plains Road, Kearney Lake Road and Trunk 3. Most traditional lots were large by today's standards and some infilling has occurred.

Areas of new residential growth have been developed over the past several years, as indicated on Figure 6-10. These include:

- Kingswood (north of the proposed Highway), located off of Hammonds Plains Road;
- Kearney Lake Estates (south of the proposed Highway), located off of Kearney Lake Road, adjacent to and north of Kearney Lake;
- Blue Mountain Estates (north of the proposed Highway), located off of Kearney Lake Road;
- Sheldrake Heights (south of the proposed Highway), near Highway 1032, located off of Trunk 3;
- Kingswood South (north of the proposed Highway), located off of Hammonds Plains Road; and
- Haliburton Heights and Haliburton Hills subdivisions (west of the alignment) located off of Hammonds Plains Road.

It is possible that land currently zoned as “Rural Resource” could be rezoned as residential in the future, leading to additional residential development in the area.

The distance between the proposed alignment and various existing residential areas is shown in Table 6-31.

TABLE 6-31
Approximate Distance Between Proposed ROW and Selected Areas

Road/Site	Distance to Residence (m)	Notes
Distance from main alignment ROW to residential areas at:		
Town of Bedford	500 +	E side
Blue Mountain Estates)	400	E side
Kearney Lake Estates	500 +	E side
Kearney Lake Road	-	E side
Kingswood	500 +	centre
Kingswood South	40	centre
Sheldrake Heights	200	W side
Haliburton Hills/Heights	400 +	W side
Highway 103	-	W side

There are no existing residential properties or urban/rural development on the proposed alignment, although existing development occupies adjacent land in some areas. In addition to the information received from the HRM planning department, the HRM development services department was contacted for information on development proposals near the proposed alignment. Two developments are proposed for lands adjacent to the RoW. These include an extension of Sheldrake Heights (south of the RoW) and an extension of Kingswood South (north of the RoW and south of Ragged Lake (Shawn Audus, HRM Development Officer, personal communication, 2000).

Agriculture

There is no agricultural land use along the proposed alignment, including fur farms, based on site surveys. The Canada Lands Inventory Map Series for the Atlantic Provinces states that due to the stoniness and shallowness of the bedrock, soils in the study area have no capability for crop use or permanent pasture. However, some small scale gardening for limited domestic use is undertaken in residential areas adjacent to the study area.

DFO (Jim Leadbetter, personal communication, 1999) stated that there are no aquaculture sites within the study area.

Rural Resource

Rural Resource land use comprises a majority of the proposed corridor. The Rural Resource designation applies to backland areas. These areas are primarily forested, interspersed with numerous lakes and streams. These largely undeveloped lands, which for the most part have no access to public roads, strongly contribute to the rural nature of the area.

The first priority of the Rural Resource designation is to encourage and support resource development and resource-based economic growth. Industrial development related to the natural resources will be permitted within the designation. Resource-related uses include operations such as: sawmills and related forest industries; gravel pits; quarries and crushers; kennels; greenhouses; and intensive agriculture operations.

The proposed route does not conflict with any known mineral or energy resource interest and the area is not under any mineral exploration license or mining permit. NSDNR stated that there are no strip mines, surface facilities of active underground mines, underground mines, pits and quarries and advanced mineral exploration (David Hopper, personal communication, 1999). However, one mineral claim is located south of the proposed alignment study area between Highway 102 and Kearney Lake.

Current and potential resources in the study area include:
- forestry; and
- aggregate production.

Forestry: The forested land contributes a valuable resource to local a lumber company (Barrett Lumber Company Ltd.). A section of the forested land at the approximate midpoint of the proposed alignment, south of Ash Lake, has been and is actively harvested by Barrett Lumber Company Ltd. A logging road leads from the Kearney Lake road at Harmony Park to the backlands in the vicinity of the proposed alignment (between Ash Lake and Blue Mountain). The road is presently used for access of machinery and hauling wood from the area. Contacts from NSDNR stated that they did not have any intensive forestry management, managed woodlots or sugar bush in the area (Doug Archibald, Jorg Belyeler, Don Cameron, Tim O'Brian, personal communications, 1999).

Aggregate Production: There is no aggregate production within the study area however limited aggregate production activity occurs in the region. Several small gravel pits have been developed outside the of proposed alignment, off of the Kearney Lake and Hammonds Plains Roads. The development of rock crushing operations is a possibility, given the area's geology, particularly the widespread occurrence of quartzite within the Goldenville Formation, which underlies the eastern end of the proposed alignment, and the fine-medium grained granite which forms Blue Mountain. The characteristics of the above mentioned bedrock are particularly suitable for aggregate extraction.

Wildlife Management

Based on correspondence with NSDNR (Doug Archibald and Brian Kinsman, personal communications, 1999) and Duck Unlimited (John Wile, personal communication, 1999) and site surveys, there is no wildlife management areas, ecological reserves or managed wetlands with the proposed alignment study area.

Institutional

There is no institutional land use along the proposed alignment. Five schools, and several churches are located more than 500 metres from the proposed RoW.

Recreational

Rural Resource land use is considered to be a high-quality resource area in terms of recreation and open space potential. In addition, the study area includes Crown land with a priority 1 classification designated by the Parks Division of NSDNR (Gary Westoll, personal communication, 1998) according to its potential for recreation and heritage development. Due to the close proximity of this Crown land to the metro area and with the associated rapid commercial and residential growth, the NSDNR highly values this block of land for backcountry recreation purposes.

The proposed highway alignment is located along the northern edge of the Blue Mountain Crown land block between Kearney Lake and Ash Lake. The Blue Mountain Crown land block is identified as a potential provincial park candidate on the Superior Outdoor Recreational and Heritage Resources on Crown Land map (NSDLF, 1989). This designation is based on the area's high capability recreation lands, quality natural heritage environments and significant background/wildland resources. These qualities are important given that surrounding lands are predominantly privately owned and have been experiencing rapid urban development in recent years. The recreational and natural values of the Blue Mountain Crown lands have been recognized in the NSDNR's ongoing IRM planning exercise for Crown lands. A proposed Strategic IRM Land Use Plan will be released for public review in 2000 and will contain proposals for future management and use of this area (Angus Schaffenburg, HRM, personal communication, 1999).

Based on 1:50,000 mapping and discussions with NSDNR staff there are no Provincial Parks, National Parks, or Park Reserves within the proposed alignment study area. However, as discussed above the Blue Mountain Crown land block is identified as a potential Provincial Park candidate.

Transmission Corridor and Telecommunication Utilities

Nova Scotia Power Inc. (NSPI) maintains four power line RoWs through the study area and two distribution line along Kearney Lake Road and Trunk 3. A description of the NSPI RoWs are as follows:

- 1 line (#8002), 345 KV, 285 ft wide RoW, located between Fraser Lake and Ash Lake;
- 2 lines (#6008 & 6016), 2 - 138 KV, 325 ft wide RoW, located east of Ragged Lake;
- 1 line (#5004), 69 KV, 66 ft wide RoW, located adjacent to the west of Highway 102; and
- Transmission Lines Removed, 60 ft RoW retained, located adjacent the east of Trunk 3.

Maritime Telegraph and Telephone Company Limited (MTT) maintains one telephone line on the Trunk 3 distribution line which belongs to NSPI. This telephone line can be raised to accommodate the construction of the proposed connector road.

East Link Cable maintains above ground cable lines along Kearney Lake Road and the Sheldrake Lake subdivision near Exit 4. These lines can be moved to accommodate the construction of the proposed highway.

Two radiocommunication stations (transmitter or receiver antennae) are located close to the proposed alignment study area boundary. A Halifax Regional Water Commission (HRWC) tower is located at the west edge of the study area and a Bedford Ready Mix Ltd. tower is located west of Kearney Lake Road.

Municipal Service Utilities

HRWC owns and operates the existing water infrastructure in the vicinity of the proposed highway. The existing water transmission main from the J.D. Kline Water Supply Plant (Pockwock) follows the alignment of Kearney Lake Road between Hammonds Plains Road and Dunbrack Street. Through the alignment study area boundary, at the point of the proposed alignment, the existing transmission main is 1200 mm inches in diameter and is located along the west shoulder of the roadway with a minimum of 1200 mm of cover. The transmission main is the single supply line for water service for the former City of Halifax. In addition, HRWC is planning for a future twinning of the transmission main from Hammonds Plains Road to Kearney Lake. The route will generally follow the northeast shoulder of the existing roadway.

With respect to planned infrastructure, HRWC has recently completed master plans of several areas in the vicinity of the proposed highway corridor. Details of this proposed infrastructure is as follows:

- Proposed 400 and 350 mm water mains from Hammonds Plains Road to the former City of Halifax constructed within future subdivision development just east of Highway 102.
- A future water main (400 mm diameter for local service) in Kearney Lake Road between Kearney Lake and Blue Water Road.
- A proposed reservoir site on a high point of land approximately 700 metres northwest of the proposed highway alignment.

The HRM and HRWC commissioned an Integrated Servicing Study which looked at long term servicing (25 years plus) on a regional basis. This study identified potential transmission main crossings of the proposed highway alignment and a proposed reservoir site near the highway alignment in the area south of Ash Lake. There is no present concern, however, future development plans of TPW and HRWC will have to consider these services relative to the proposed highway.

Miscellaneous

NSDOE stated that there are no landfill/waste disposal sites along the proposed alignment (Norma Bennett, personal communication, 1999).

Based on site surveys, several of the watercourses along the proposed alignment could be classified as navigable waters. Classification as a navigable water will be performed by the Coast Guard after a site inspection.

Based on correspondence from Halifax International Airport and Nav Canada (Maurice Dupuis, Transport Canada and Janet Shrieves, Halifax International Airport, personal communication, 1999) and site surveys, the proposed alignment is outside of the airports registered zoning and will have no impact on airport navigational aids.

6.6.2 Profile of Existing Conditions

The following profile of existing conditions is from the Profile Census Tracts in Halifax. The profile is based on 1996 Canada Census and 1991 unincorporated municipal statistics, both of which are the most recent statistical information available. The statistical information from the 1996 Canada Census for Halifax Subdivision C #132.02 was used to represent the study area which include Hammonds Plains, Lucasville, Spring Lake and Sheldrake Lake.

6.6.2.1 Population of the Study Area

The population of the study area (Subdivision C, #132.02), three local communities, Halifax County, and Nova Scotia is shown in Table 6-32.

TABLE 6-32
Population of the Study Area

Area	1991	1996	% Change
Study Area	4,705	6,833	+ 45.2
Hammonds Plains	281	-	-
Sheldrake Lake	339	-	-
Spring Lake	1,019	-	-
Halifax County	330,846	342,966	+ 3.7
Nova Scotia	899,942	909,282	+ 1.0

Source: Statistics Canada, Census of Canada and Halifax County Municipal Statistical Profile.

As shown in Table 6-32, the population of the study area (Subd. C #132.02) exhibited a strong growth increase of 2,128 people (45.2%) between 1991 to 1996, while Halifax County increased by 3.7%, and Nova Scotia population increased by 1.0%. 1996 population counts for Hammonds Plains, Sheldrake Lake and Spring Lake are not available. As a comparison, the next rural census subdivisions to the east and west, had a 14.9% and 9.4% increase of population over the same period.

These figures appear to substantiate the rapid growth of subdivisions in the area such as: Kingswood, Blue Mountain Estates, Kearney Lake Estates, and Sheldrake Heights over the last 10 years.

6.6.2.2 Age Structure of the Study Area Population

Table 6-33 provides the age characteristics of the population of the study area for 1996.

TABLE 6-33
Age Structure (1996)

	Study Area	Percentage of Total
Total Population	6,830	100
0- 4 Years	655	9.6
5 - 9 Years	575	8.4
10 - 14 Years	475	7.0
15 - 19 Years	375	5.5
20 - 24 Years	265	3.9
25 - 29 Years	515	7.5
30 - 34 Years	865	12.7
35 - 39 Years	805	11.8
40 - 44 Years	585	8.6
45 - 49 Years	505	7.4
50 - 54 Years	365	5.3
55 - 59 Years	245	3.6
60 - 64 Years	195	2.9
64 - 69 Years	145	2.1
70 - 74 Years	115	1.7
75+Years	145	2.1

Of particular interest is the 0 to 4, 30 to 34 and 35 to 39 year population groups which represent 9.6%, 12.7% and 11.8%, of the population respectively. The high percentage in the three age categories can be attributed to a rise in the amount of young professionals starting families in the study area. This also coincides with the large increase in population, the high education levels, the employment profiles and the relatively high income level for the study area, as shown in Table 6-33 to 6-40.

6.6.2.3 Commercial and Residential Properties

The number of commercial properties and business in the area has grown over the last few years. This trend has increased the value of commercial properties in the Area at the same rate as residential properties.

Dwellings within the study area are predominately single family. Of particular interest is the growth in housing construction compared to adjacent rural areas over the 1991-96 period. Tables 6-34 and 6-35 provides a summary of new housing construction in the area and in adjacent areas in recent years and the total number and average value of dwellings in the study area, respectively.

TABLE 6-34
New Housing Construction (1996)

Period of Construction	Study Area	Avg. For Adjacent Rural Areas
1971 - 1980	360	498
1981 - 1990	640	802
1991 - 1996	850	463

TABLE 6-35
Total Number and Average Value of Dwellings (1996)

	Study Area
Total Number of Dwellings	2,275
Average Value of Dwellings ($)	123,332

Of particular note is the steady and large increase in new housing construction in recent years.

Typical lot property within subdivisions in the study area are characterized as having a value of between $35,000 to $55,000, while lots having water frontage have a wider range of values of between $50,000 to $120,000 (Larry Thomas, Greater Homes Realty Inc., personal communication, 1999).

Table 6-36 provides a summary comparison of the study area versus neighbouring rural areas socio-economic (families and households) characteristics for 1996.

TABLE 6-36
Number and Size of Families and Households (1996)

	Study Area	Avg. For Adjacent Areas
Total Families in Private Households	2,065	2,308
Average Number of Persons per Family	3.2	3.2
Number of One-Parent Families	155	230
Number of Husband-Wife Families	1,905	2,075

6.6.2.4 Education Levels

Education levels as reported in the 1996 Census for the study area are shown in Table 6-37. This summary shows that a majority of the population in the study area (60.4%) received non-university education with and without a diploma or a university education with and without a degree. The education level, as noted above, of the of people in study area, is above that of the Nova Scotia population which was found to be 23.8%.

TABLE 6-37
Education Profile Study Area (1996)

	Study Area	% of Total Population
Total Population 15+ Years	5,100	100.0
Less than Grade 9	335	6.6
Grades 9 to 12 without secondary graduation certificate	985	19.3
Grades 9 to 12 with secondary graduation certificate	515	10.1
Trades certificate or diploma	185	3.6
Other non-university education only (with or without a diploma)	1,390	27.3
University without degree	690	13.5
University with degree	1,000	19.6

6.6.2.5 Labour Force Activity

Labour participation (1996) by industry, from the 1996 Census Tract, for the study area is presented in Table 6-38. The employment profiles indicates that 40.1% of the labour force in the study area are employed in the wholesale and retail trade, government services and health and social services.

As shown in Table 6-39, labour force status (1996) for the study area shows an overall participation and unemployment rate of 72.6% and 6.7%, respectively. The participation and unemployment rate in the study area was higher and lower than that of Nova Scotia (61.0% and 13.3%) respectively.

6.6.2.6 Income Levels

As shown in Table 6-40, income levels for the study area are higher than those of the adjacent rural areas to the east and west. Only the adjacent rural areas were compared due to the similarities to the study area, adjacent urban areas were ignored.

Table 6-40 shows study area average male incomes at $35,831 (above the adjacent area average) and average female employment income at $20,259 (above that for the adjacent areas). The average household income for the study area of $58,161 is also above that of the adjacent area.

TABLE 6-38
Employment by Industry (1996)

	Study Area	% of Total Population
All Industries	3635	100
Primary Industries	30	0.8
Manufacturing	280	7.7
Construction	310	8.5
Transportation and Storage	185	5.1
Communication and Other Utilities	225	6.2
Wholesale and Retail Trade	550	15.1
Finance, Real Estate and Insurance	260	7.2
Business Services	255	7.0
Government Services	520	14.3
Educational Services	280	7.7
Health and Social Services	390	10.7
Accommodation, Food and Beverages	125	3.4
Other Services	225	6.2

TABLE 6-39
Labour Force Status (%) (1996)

	Study Area
Male Participation Rate	80.6
Male Unemployment Rate	7
Female Participation Rate	64.6
Female Unemployment Rate	6.7
Overall Participation Rate	72.6
Overall Unemployment Rate	6.7

TABLE 6-40
Average Income (1996)

	Study Area	Adjacent Rural Area
Average Male Employment Income ($)	35,831	32,985
Average Female Employment Income ($)	20,259	18,975
Average Household Income ($)	58,161	54,040

6.6.3 Existing Industrial Structure and Economic Base

6.6.3.1 Industrial

A Light Industrial Park and an industrial property, with a developed area of approximately 93 ha combined, are located on the Kearney Lake Road adjacent to both sides of study area boundaries.

Atlantic Acres Industrial Park, the industrial park to the north of the proposed alignment, is a mixed-use industrial site with emphasis on light manufacturing and commercial industries.

6.6.3.2 Tourism

The economy of the area is not dependent on the tourist trade due to the mixed use designation, the large residential composition, and the type of commercial and industrial industries in the area. However, the area is in close proximity to the Halifax metro area which provides n chance for the community to take advantage of the economic benefits provided by the seasonal tourist population that visits the area.

As a result, a service industry has emerged to cater to the needs of tourists and residents alike. Services listed in the Nova Scotia Tourism Guide, 1999, include two campgrounds, one activity park, one provincial park and one golf course. In addition, other services such as restaurants/takeouts and gas/service stations are available.

6.6.3.3 Recreation

Recreational activities occur within the study area, including in the immediate area of the proposed alignment. Outdoor activities which are participated in by residents and tourists alike include: recreational fishing; hunting and trapping; canoeing and kayaking; hiking; walking; and field sports. Indoor activities focus on the schools.

Some recreational and potential recreational areas within the immediate area of the proposed alignment include Blue Mountain Hill, the Maple Lake to Fraser Lake canoe route, and various walking and ski trails.

The proposed highway alignment is located along the northern edge of the Blue Mountain Crown land block between Kearney Lake and Ash Lake. The Blue Mountain block is characterized by a rounded landscape of shapeless ridges and depressions in which there are scattered hills and knolls. Numerous lakes, ponds and stillwaters occur within the area. The varied landscape provides opportunities for canoeing, hiking, fishing and viewing.

During recent public meetings sponsored by Natural Resources to consider IRM issues on Crown lands, strong support was voiced by some members of the public for legislative protection of the Blue Mountain Crown lands. The recreational value of the Blue Mountain block have been promoted in Hiking Trails and Canoe Routes in Halifax County (Canadian Hostelling Association - Nova Scotia, 1977) and Canoe Routes of Nova Scotia (Canoe Nova Scotia Association and Camping Association of Nova Scotia, 1983). The former describes a number of hiking trails in the area, while both describe up to 11 kilometres of canoe routes.

NSDNR and Canoe Nova Scotia both identified Maple Lake and Frasers Lake as a popular canoe route. The canoe route between Maple and Frasers Lake, which will be crossed by the proposed highway, makes up a section of the canoe route from Cox Lake off the Hammonds Plains Road to St. Andrews Anglican Church in Timberlea.

There is also access to Maple Lake from Maple Lake Road which is used by Sheldrake Heights subdivision residents via a walking trail. The new highway will sever access from the end of Maple Lake Road to Maple Lake, however, new access will be provided by the proposed connector.

There is no designated recreational land use along the proposed alignment. In addition there are no federal or provincial parks or park reserves in the immediate vicinity of the study area. However, there is one provincial park outside of the proposed alignment study area (Lewis Lake Provincial Park) which is approximately 3 kilometres from the proposed alignment.

The economic activity generated by recreational activities is expected to contribute moderately to the local economy.

6.6.3.4 <u>Attractions</u>

In addition to the natural attractions, two man-made attractions are located in the general area. Located on the Hammonds Plains Road is a 9-hole golf course (Pin-Hi Golf Club), and on the Lucasville Road is Atlantic Playland which is a privately owned park attraction.

6.6.4 <u>Community and Cultural Base</u>

Community and cultural based recreation in the study area reflects that of a suburban area, including ball fields and outdoor playing fields, school libraries and gymnasiums , day cares, subdivision parks and playgrounds, churches, a nearby golf course, several hiking trails, and numerous rivers, lakes, and streams. These recreation facilities are located within the subdivisions and communities surrounding the proposed highway alignment study area.

The study area is located within the HRM District School Board area. There are no schools within the immediate proposed alignment study area, however there are several schools located in the surrounding subdivisions and communities.

Health care facilities for the study area and surrounding communities are provided, for the most part, in the adjacent urban core of HRM. Hospitals, medical and dental clinics, and various provincial departmental health services are located within the City of Halifax and Dartmouth and the Town of Bedford.

Police protection services are provided through the HRM Police Department and the provincial policing administered by Royal Canadian Mounted Police (RCMP) in the Eastern and western sections of the study area, respectfully.

Fire protection services are provided by the HRM Fire Department and the District Volunteer Fire Department in the eastern and western sections of the study area, respectfully.

6.6.5 Regulatory Environment

Approvals required for construction of the Highway, as of the date of this report, include:

- Ministerial approval of the Project from NSDOE, under Part IV of the ***Environment Act***, and compliance with any conditions of approval;
- Water Approval from NSDOE, under Part V of the ***Environment Act***;
- Approval under the Wetland Directive from NSDOE, under Part V of the ***Environment Act***;
- Navigable Waters Approval from Coast Guard/DFO;
- Approval to construct on the NSPI RoW;
- Approval from HRM to access municipally owned streets;

6.6.6 Use and Condition of Existing Roads

The existing local area network consists of two 100-series highways - Highway 102 and 103, and four other roads - the Hammonds Plains Road (Route 213), Kearney Lake Road, St. Margarets Bay Road (Trunk 3), and Lucasville Road, as shown in Figure 6-11.

Highway 102 forms part of the eastern boundary of the study area and extends from Halifax to Truro through central Nova Scotia and makes up part of the Trans-Canada Highway. Highway 103 forms part of the western boundary of the study area and channels traffic to and from the metropolitan centre of Halifax-Dartmouth to the South Shore and intervening communities. Both Highways connect to each other in the central core of the HRM.

The four local roads in the study area connect the local subdivisions and communities to each other and to the City of Halifax and the Town of Bedford and Sackville. The proposed Highway 113 will intersect Kearney Lake Road north of Kearney Lake.

6.6.6.1 Travel Characteristics

Highway 102 is a four-lane 100-series highway with controlled access and a speed limit of 110 km/hr. Highway 103 is a two-lane 100-series highway with controlled access and a speed limit of 100 km/hr in the area of the Highway 113 connection. Various types of highway traffic utilize Highway 102 and 103 for a variety of reasons, including commercial and home-work trips. Commercial vehicles utilize the highways sporadically in both directions. A majority of the home-work traffic on the highways travel to and from Halifax in the morning and afternoon respectively. Highway 103 will be four lanes, in the area of Exit 4, prior to Highway 113 being constructed.

Hammonds Plains Road (Route 213), Kearney Lake Road, St. Margarets Bay Road (Trunk 3) and Lucasville Road are two-lane paved collector roads with no access control (except Hammonds Plains Road between English Corner and Highway 103) and speed limits of 50 to 80 km/hr. Kearney Lake Road and St. Margarets Bay Road is used both by commuter and commercial traffic. Hammonds Plains Road, which serves communities between the Town of Bedford and the community of Upper Tantallon, is used mostly by local traffic and some commercial traffic. Through truck traffic is prohibited on the Hammonds Plains Road. The Hammonds Plains Road is also used as an alternate road to bypass the Halifax area when travelling between Highways 102 and 103.

Most routes have been subject to large traffic volume increases in the past six years as indicated in the Traffic Volume Book, 1999. This increase in traffic can be attributed to the large increase in population in the area. Communities have developed in a linear fashion, stretched out along the local roadways, and large subdivision developments have occurred in the recent past which have substantially increased the population in the area as shown in Table 6-32.

6.6.6.2 Condition of Highway

Table 6-41 presents a description of the existing conditions of the paved surface along Highways 102 and 103 and Hammonds Plains Road, based on site observations. TPW rates the road network system with a Rideability Comfort Index (RCI) value on a 0-10 scale as shown in Table 6-41.

TABLE 6-41
Existing Study Area Highway and Local Roadway Conditions

Highway/Road/Date	Posted Speed (km/hr)	Pavement Condition	Average RCI
Highway 102 (July 1998)	110	good	6
Highway 103 (July 1998)	100	good	5.5
Hammonds Plains Road February 1999)	50 - 80	fair to poor	3.8

Sources: TPW data files and site observations.

6.6.6.3 Traffic Accidents

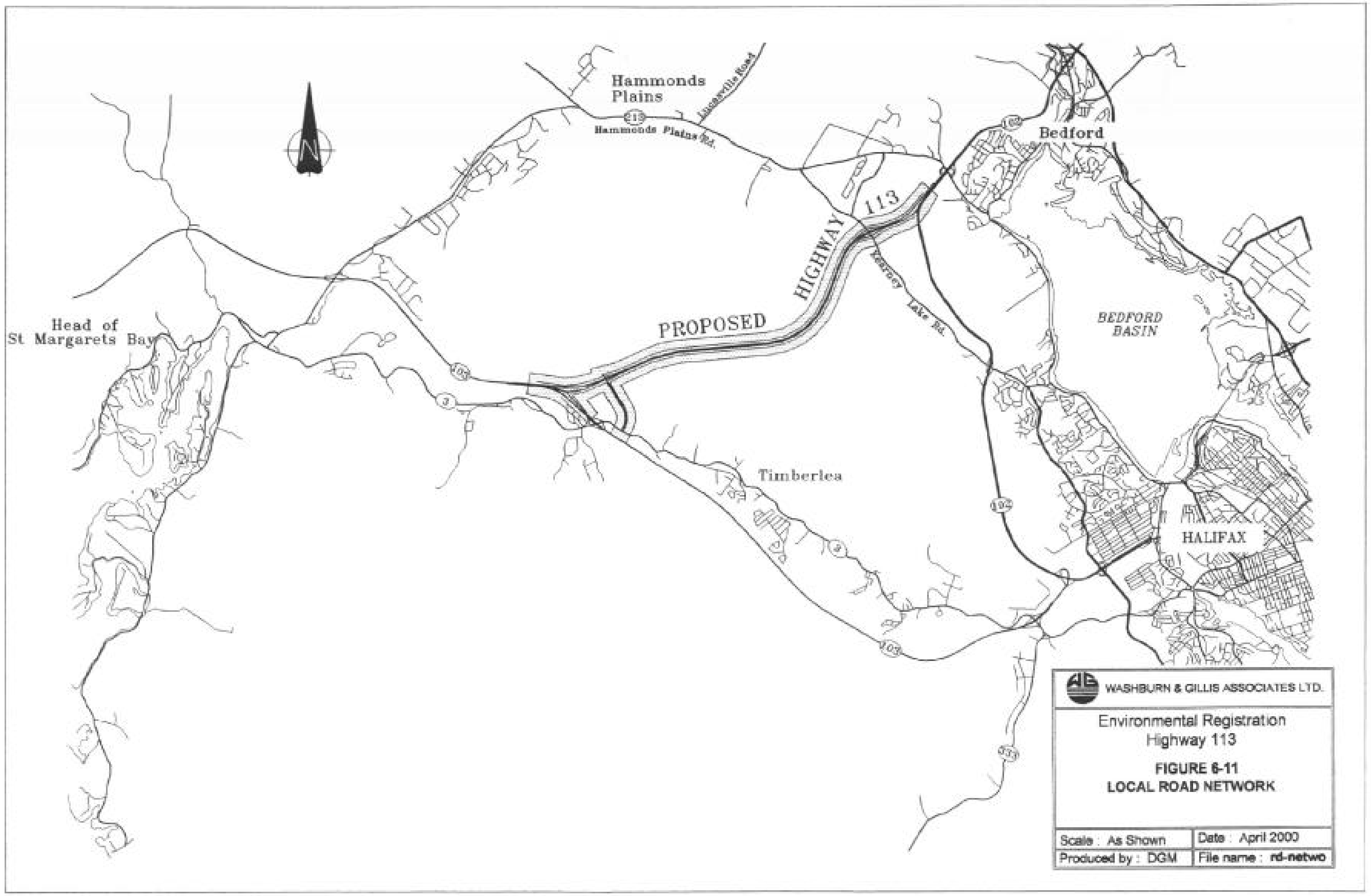
Average annual accident occurrence rates, measured in Accidents per 100 million vehicle - kilometres (HMVK), have been calculated from TPW accident records for Highway 102 and 103 and Hammonds Plains Road over a five year period from 1994 to 1998, as shown in Table 6-42.

TABLE 6-42
Summary of Vehicle Accidents (1994-1998)

Accident Class	Highway 102 (Section 30)	Highway 103 (Section 20)	Hammonds Plains Rd. (Section 30)
Property Damage Only	35.1	16.6	61.9
Injury	16.0	15.1	37.8
Fatal	0.3	1.4	1.3

The average annual accident rates (all classes of accidents) for Highway 102 and 103 and the Hammonds Plains Road, in the vicinity of the study area, were 51.5, 33.2 and 101.0 HMVK respectively. Average accident rates for all 100-series 4-lane highways (Highway 102), 100-series 2-lane highways (Highway 103) and 2-lane trunk highways (Hammonds Plains Road and Trunk 3) in Nova Scotia were 74.7, 53.7 and 107.6 HMVK, respectively.

Figure 6-11
Local Road Network



6.6.6.4 Traffic Surveys

Traffic survey information available from TPW provides traffic volumes in Average Annual Daily Traffic (AADT) for Highways 102 and 103 and the Hammonds Plains Road in the vicinity of the study area. AADT volumes are generated using the average number of vehicles passing a count location in a 24-hour period, averaged on the basis of one year. AADT volumes for Highways 102 and 103 and the Hammonds Plains Road are approximately 32,000 (1998), 12,000 (1998), and 12,000 (1995), respectively.

7.0 VALUED ENVIRONMENTAL COMPONENTS

The environmental assessment process requires, as referenced in the ***Canadian Environmental Assessment Act***, that the boundaries of an environmental study be established to focus the analysis on directly relevant issues and concerns.

This section describes the process used to identify Valued Environmental Components (VECs), which involves issues scoping and pathway analysis. As suggested by Beanlands and Duinker (1983), the VECs are determined on the basis of perceived public concerns related to social, cultural, economic, or aesthetic values. Generally, VECs are defined as those aspects of the ecosystem or associated socio-economic systems which are important to humans. The components could include the following:

- components which may be important socially;
- components which may be essential to the food web; and/or
- components which may be a reliable indicator of environmental change.

Specifically, VECs are species, habitats, environmental features, and resources which are particularly rare, unique, productive, indicative of environmental change, commercial, aesthetically valuable, or essential to ecosystem function and integrity. They include environmental components, including social and economic components, that are identified as having scientific, social, cultural, economic or aesthetic value.

7.1 Approach to Information Assemblage and Assessment

The initial step in this process involved identification of Environmental Components of Concern (ECCs) through public consultation, a review of applicable regulations, and discussions with resource managers and government regulatory agencies, including the following:

- Access Cable;
- Big Game Society of Nova Scotia;
- Bowhunters Instructors Association of Nova Scotia;
- Canada Department of Indian and Northern Affairs;
- Canada Department of Intergovernmental Affairs;
- Canadian Wildlife Service;
- Confederacy of Mainland Micmacs;
- Ducks Unlimited Canada;
- Eastlink Cable;
- Environment Canada;
- Fisheries and Oceans Canada;
- Forestry Canada;
- Greater Homes Realty Inc.;
- Halifax Regional Municipality;
- Halifax Water Commission;
- Halifax Wildlife Association;
- Industry Canada;
- Maritime Tel & Tel;
- Millbrook Band Council
- Nova Scotia Department of Education;
- Nova Scotia Department of the Environment;

- Nova Scotia Department of Fisheries & Aquaculture;
- Nova Scotia Department of Housing and Municipal Affairs;
- Nova Scotia Department of Natural Resources;
- Nova Scotia Department of Tourism and Culture;
- Nova Scotia Department of Transportation & Public Works;
- Nova Scotia Forestry Association;
- Nova Scotia Power Inc.;
- Nova Scotia Real Estate Association;
- Nova Scotia Trappers Association;
- Nova Scotia Wildlife Federation;
- Osprey Archery Association;
- Public Works & Government Services Canada;
- Shubenacadie Band Council
- Sport Nova Scotia; and
- Transport Canada.

In certain instances, field work was conducted to address data deficiencies where specific background information was not available at the required level of detail.

Within the study area, there are various environmental components that could be potentially affected by the Project. ECCs for the Project are summarized in Table 7-1.

7.2 Pathways and Linkages

Issues and concerns identified through issues scoping and potential environmental effects of the proposed Project are identified by examining the pathways through which Project activities may affect the environment. Where linkages between ECCs and the Project activities can be identified, and potential effects are a concern, these components become the VECs on which the impact assessment focuses. This process focuses attention on those VECs where significant adverse effects may occur (Canadian Environmental Assessment Agency, 1994). ECCs which will not be significantly impacted are no longer part of the analysis.

Pathways are considered for construction (including pre-construction) and operation. The possible pathways that provide linkages between the Project and the environment are summarized in Table 7-1. There is no pathway of concern for a number of the ECCs as these environmental components:
- were avoided as part of the alignment selection process;
- will be avoided based on recommendations provided in this report; or
- are not a concern, as no significant adverse effects are expected from the Project.

The impacts resulting from an pathway linkage between the Project and environmental components in the study area are discussed in Section 8.0. Standard practices that mitigate concerns related to identified pathways that are included as components of the proposed Project description are also discussed in the following section where applicable. Where standard practices address potential effects/concerns, the pathway is no longer considered a concern and no further analysis is required for the ECC. Where there are linkages between Project activities, and environmental components which may be significantly impacted, these components are considered as VECs and provide a focus for the impact assessment.

TABLE 7-1
Summary of Pathway Analysis for ECCs

Environment /Resources	ECCs	ECCs will be Avoided	Pathway of Concern Identified		Valued Environmental Components (VECs)	Possible Pathways
			Yes	No		
Atmospheric Environment	• Human health and safety		X		X	• Air emissions
	• Air quality		X		X	
	• Ozone depleting substances			X		
Terrestrial Environment	• Human health & safety		X		X	• Site runoff • Habitat alteration • Excavation • Blasting • Release of contaminants • Noise • Air emissions
	• Wildlife, including:					
	- large mammals including:					
	- deer		X		X	
	- moose		X		X	
	- herpetiles		X		X	
	- birds		X		X	
	• Plants and vegetative communities		X		X	
	• Environmentally sensitive areas		X		X	
	• Sensitive and critical habitat		X		X	
	• Wildlife management areas	X				
	• Ecological reserves	X				
	• Protected beaches	X				
	• Old growth hardwood stands	X				
	• Trees of distinction	X				
	• Groundwater & springs		X		X	
	• Geological Formations including					
	- mineral resources	X				
	- sand and gravel deposits	X				
	- mineralized slates	X				
	- shallow bedrock		X		X	
	- Karst terrain	X				
	- erodible soils		X		X	
Freshwater Aquatic Environment	• Fish, recreational					• Site runoff • Habitat alteration • Blasting • Noise • Release of contaminants • Watercourse obstruction
	- Brook trout		X		X	
	- Gaspereau		X		X	
	• Fish habitat		X		X	
	• On-going management initiatives, including stocking		X		X	
	• Surface water quality and quantity		X		X	
	• Sediment quality			X		
	• Hydrology/flood plains		X		X	
	• Hydrogeology		X		X	
Marine Environment	• Marine habitat	X				
	• Salt Marsh	X				

TABLE 7-1
Summary of Pathway Analysis for ECCs

Environment /Resources	ECCs	ECCs will be Avoided	Pathway of Concern Identified		Valued Environmental Components (VECs)	Possible Pathways
			Yes	No		
Wetland Environment	• Wildlife, including in particular:					• Habitat alteration • Blasting • Site runoff • Release of contaminants
	- large mammals (*e.g.*, moose)		X		X	
	- herpetiles		X		X	
	- birds		X		X	
	• Plants		X		X	
	• Environmentally sensitive areas		X		X	
	• Managed wetlands	X				
	• Important wetlands		X		X	
	• Hydrology/flood plains		X		X	
Socio-Economic Environment	• Provincial and regional economics					• Release of contaminants • Increased access • Decreased access • Noise • Change in land use
	• Proposed property development		X		X	
	• Public services					
	- transportation		X		X	
	- power transmission		X		X	
	- municipal services		X		X	
	- telecommunication towers	X				
	- telephone lines		X		X	
	- cable TV lines		X		X	
	- miscellaneous pipelines	X				
	- active railway lines	X				
	• Visual Resources		X		X	
	• Public safety		X		X	
	• Forestry resources		X		X	
	• Mining resources (active areas)	X				
	• Quarries	X				
	• Pits	X				
	• Mineral claims/exploration	X				
	• Petroleum claims	X				
	• Active agricultural land	X				
	• Fur farms	X				
	• Agricultural capability	X				
	• Intensive forestry management	X				
	• Woodlot management		X		X	
	• Sugar Bush	X				
	• Recreational hiking and canoeing		X		X	
	• Recreational fishing and hunting		X		X	

TABLE 7-1
Summary of Pathway Analysis for ECCs

Environment /Resources	ECCs	ECCs will be Avoided	Pathway of Concern Identified		Valued Environmental Components (VECs)	Possible Pathways
			Yes	No		
Socio-Economic Environment (continued)	• Archaeological/heritage and paleontological resources		X		X	• Release of contaminants • Increased access • Decreased access • Noise • Change in land use
	- designated historic sites	X				
	- other sites of historical significance (*e.g.*, heritage Structures)	X				
	- cultural landscapes		X		X	
	- paleontological sites		X		X	
	• National historic sites	X				
	• Heritage properties	X				
	• Burial grounds/cemeteries	X				
	• Heritage rivers	X				
	• Fish hatcheries	X				
	• U-fish ponds	X				
	• Aquaculture	X				
	• Landfill sites	X				
	• Navigable waters		X		X	
	• Airports	X				
	• Military bases	X				
	• Municipality/built-up area		X		X	
	• Reservoirs	X				
	• Schools	X				
	• Recreational Area		X		X	
	• Water supply areas	X				
	• Recognized views		X		X	
	• Indian Reserves	X			X	
	• Native Land Claims	X	X			
	• Federal land	X				
	• Park reserve	X				
	• National and Provincial parks	X				

8.0 PREDICTED IMPACTS UPON THE ENVIRONMENT

The approach to impact prediction used in this Project essentially follows those which have been outlined in a guide to the Canadian Environmental Assessment Act. The steps include deciding whether or not predicted environmental effects are adverse, whether the adverse effects are significant, and whether the significant adverse effects are likely. A general approach determined for the definition of adverse effects for those VECs for which regulations are in place was to use the regulations or guidelines where possible. Individual assessments of adversity were defined for those VECs for which no regulations were available.

The prediction of impacts has been separated into two main categories:

- impacts upon the biophysical environment; and
- impacts upon the socio-economic environment.

Further, these impacts have been predicted for both the construction and operation phases of the Project.

Bounding is an important aspect in the consideration of environmental impacts. Two types of bounds have been identified for this Project, first, bounds within which changes in the environment caused by the Project will be contained; and second, bounds within which the potential impacts on the receiving environment will be assessed. The spatial bounds for Project induced changes in the environment include a 150 to 400 m wide corridor, centred along the centreline of the proposed alignment. Bounds for the receiving environment vary according to the nature of the receptor. Bounds for watercourses include all watercourses which may be affected by drainage or other effects of the Project. These bounds generally include the watercourses downstream of crossing locations or in the case of impaired fish passage, the extent of movement of the migratory species. Bounds for terrestrial organisms (biota) are generally based on the extent of distribution of the biota or habitat type in question.

The potential significance of the identified adverse effects is considered for each VEC according to the magnitude or severity of the effect, geographical extent, duration and or frequency, degree to which the adverse effects are reversible, and the environmental context. The environmental context relates to the existing level of disturbance of the VEC and/or the fragility or degree of resilience to imposed stresses. Any activity which is predicted to lead to an exceedence in a regulated or guideline value of a parameter is judged significant.

Finally, the likelihood of occurrence of a significant adverse environmental effect is considered. The likelihood of occurrence includes the probability of occurrence or where insufficient data are available to permit the estimation of probability, the degree of uncertainty is considered.

In order to be considered a significant environmental impact, a deviation from background must be judged to cause changes in the process or state within the bounded area resulting in a sustained depression of fitness or density below naturally occurring levels. Where such changes are predicted, mitigation has been recommended.

8.1 Impacts Upon the Biophysical Environment during Preconstruction and Construction

Development/construction activities required by the proposed Project and the sensitive aspects of the biophysical setting for these activities are described in this section in order to identify potential environmental effects. Potential negative effects are described in the context of proposed mitigation.

The activities which will take place during the preconstruction and construction phases of the Project have been described in Section 2.0. To some extent, the construction activity descriptions have indicated efforts to be taken to minimize environmental impacts. These efforts are not repeated in this chapter, which expands on mitigative specifics.

Current standard construction practices generally include environmental protection measures which will mitigate potential environmental concerns. However, certain sensitive areas have been identified within the study bounds which may be at risk during the development/construction phase.

Construction of the proposed highway will involve the clearing of land, excavation, construction of embankments, and construction of roadway structures including culverts and bridges. Clearing, excavation, and earthworks will involve the use of bulldozers, power excavators and trucks. Erection of the structures will involve equipment including erection hoists, air compressors, welding machines, and pneumatic wrenches.

Potential concerns related to construction include:
- air quality including dust and gaseous emissions;
- noise;
- loss or alteration of terrestrial habitat;
- effects on aquatic resources including surface runoff and stream and wetland crossings;
- effects of general construction activities, including blasting, on aquatic biota and groundwater;
- effects on heritage resources; and
- effects of accidental events.

8.1.1 Air Quality

Construction-related activities which could adversely affect air quality include:
- dust emissions; and
- gaseous emissions from construction equipment.

8.1.1.1 Dust Emissions

Excavation and trucking activities during construction generate dust. In addition to the operation of construction equipment, the actual construction operations and materials used will result in airborne emissions. These will primarily be dust particulates which become airborne during earth-moving, drilling and blasting operations. The potential effect of dust is influenced by both site and weather conditions (rain and wind direction) and by preventative measures which may be taken. Uncontrolled emission of particulates may result in problems on the construction site itself and, under special circumstances, off-site. In extreme cases, health effects such as decreased lung function or other reactions can take place in sensitive individuals. Extremely high and continuous concentrations are needed for adverse effects to be seen on vegetation or agricultural crops. More usual effects include those of reduced visibility, soiling, and general nuisance. The generation of particulates which come from unpaved roads depends on the silt content of the soils being used, the proportion of dry days, driver habits, vehicle numbers and speeds, vehicle weight and the number of wheels on the vehicles.

Studies have found that dust from construction activities settles out very quickly and that a level of 150 micrograms per cubic metre will be exceeded at a distance of 50 metres, only two to three percent of the time (National Cooperative Highway Research Program), without mitigative measures. This level marginally exceeds the Nova Scotia 24-hour ambient air guideline of 120 micrograms per cubic metre for particulate matter. It is not expected that such levels would be generated on a continuous basis from construction activities.

Mitigative Measures to Control Dust Emissions

Surface dust emissions will be controlled by the use of water sprays and dust suppressants, as required.

Some airborne particulates are anticipated to result from normal construction activities. Most of the dust will settle on the ground and vegetation in the immediate construction area.

Dust emissions are not expected to have any deleterious effects on either the terrestrial or aquatic environment. However, special measures will be implemented to suppress surface dust emissions by use of water sprays and/or dust suppressants in the area of sensitive aquatic environments such as wetlands and streams.

Material processing plants such as gravel or rock crushers and asphalt plants will be located away from populated areas and sensitive aquatic and terrestrial sites and will be operated in accordance with NSDOE requirements. Populated areas to be avoided include: Highway 103 - Sheldrake Heights subdivision; Kearney Lake Road - Kearney Lake Estates; Blue Mountain estates and the Atlantic Acres Industrial Park; and nearby residences of the Kingswood subdivision.

Dust/particulate generation from storage piles depends on wind speeds, material moisture content, compaction and particle size. Dust from material storage piles in sensitive areas can be reduced by maintaining a slope of less than 10 degrees in the direction of the prevailing wind and orientation of the long dimension of the stockpile parallel to that direction.

Minor, short-term impacts such as intermittent soiling of buildings, vehicles, laundry, and other items, may be experienced when wind carries airborne particulates towards nearby developed areas.

Significance of Residual Effects

Because of the distance between the proposed construction and developed areas, the fact that most dust will settle on the ground and vegetation in the immediate construction area, and the dust suppression measures to be employed when necessary, significant residual adverse effects are unlikely to occur.

8.1.1.2 Gaseous Emissions From Construction Equipment

Construction equipment produces emissions which are typical of gas or diesel fuelled vehicle operation. These emissions comprise carbon monoxide, nitrogen oxides, hydrocarbons and ash. The emissions, depending upon microclimate, may cause occasional nuisance problems on construction sites, however, they do not present significant problems at adjacent sites due to their transitory nature.

The level of gaseous emissions during the construction phase and the potential impact of these emissions relates to the duration and intensity of the emissions. Generally, during the construction of a linear corridor the operations move along the length of the corridor over time and the emissions are relatively evenly distributed during the Project. An exception would be where particular Project components, such as large excavations or construction in and around watercourses, will require the residence time (in days) to be significantly greater.

Mitigative Measures to Reduce Gaseous Emissions From Construction Equipment

While a certain level of emissions will be unavoidable during the construction phase, certain operational changes can be employed to reduce or mitigate emissions to acceptable levels.

The most significant measure to avoid excessive releases of gaseous emissions to the atmosphere will be to ensure that equipment is kept in good repair and operates efficiently. These steps will prevent carry-through of elevated levels of hydrocarbons from engine operation and loss of lubricants through leakage. Refuelling will be carried out so as to minimize spillage and inlet caps maintained to reduce vaporization of fuel.

Significance of Residual Effects

Significant residual adverse effects due to gaseous emissions from construction equipment are unlikely with proper implementation of the mitigative measures described above.

8.1.2 Construction Noise

Due to the timing of the environmental registration (*i.e.*, 10 to 15 years in advance of highway construction) an ambient noise survey was considered impractical and would have little relevance to the Project, especially in view of the continuing area development. However, TPW intends to conduct a noise baseline study prior to construction.

To aid in the baseline study and provide information on potential problems and mitigative solutions the following section is provided which describes general construction noise impacts and mitigative measures for general construction noise problems.

Sound is defined as any pressure variation in any medium that the human ear can detect. Sound is commonly measured in decibels (dB), a dimensionless unit which expresses a logarithmic ratio of the square of the measured sound pressure level to the square of a reference level. The threshold of human hearing is defined as being 0 dB. Each time the average sound pressure is increased by a factor of ten, 20 dB is added to the sound pressure level.

The effect of noise on humans is not a simple relationship directly related to sound pressure levels. The frequency of a sound can have an important effect on how a sound is perceived. The loudness depends upon the acoustic energy at each distinct frequency present in the sound. The human ear can be very selective in its response to sounds at various frequencies. The sound of music playing on a radio may be pleasant to one person but to another person trying to concentrate or sleep, that same sound may be unappreciated or even unwanted. Noise can be defined in two ways; 1) an unwanted sound, and 2) a sound, generally of a random nature, the spectrum of which does not exhibit distinct frequency components. The A-weighted scale (dBA), devised by researchers and commonly used in sound measurement, approximates the response of the human ear to sound.

The equivalent sound level measurement, L_{eq} gives an average sound level over a period of time whereby over that time the stated average sound level contains the same amount of sound energy as the real-time varying sound. This is very useful when trying to measure noises that vary throughout the day, such as construction projects.

The way in which noise increases (propagates) or decreases (attenuates) between the origin and the receiver is directly dependant upon some or all of the following factors:

- topography;
- geometrical divergence from the source;
- absorption of acoustic energy by air;
- effect of different ground surfaces;
- foliage;
- reflection from buildings;
- wind; and
- temperature.

It is inevitable that during highway construction and operation noise will be produced as a result of site activities. At times levels may be reached that are considered to be a nuisance to people who are nearby. Localized impacts due to noise are anticipated during the construction phase. Activities such as blasting, excavating, and trucking, which are all very common during construction, are inevitable and by their nature produce varying levels of noise. These levels will be dependant upon many factors including frequency, weather conditions, topography, vegetation, and construction practices. Due to the nature of the proposed Project, these impacts are anticipated to be of short duration and very localised. These impacts are not expected to persist during the operation phase. Table 8-1 presents some common construction related noises measured using L_{eq}.

The Nova Scotia Department of the Environment noise guidelines identify L_{eq} criteria for different times of the day as shown below:

- An L_{eq} of 65 dBA between 0700 to 1900;
- An L_{eq} of 60 dBA between 1900 to 2300; and
- An L_{eq} of 55 dBA between 2300 to 0700.

TABLE 8-1
Typical Noise Levels for Construction Equipment (at 15 m)

Source	L_{eq} (dBA)
Generator	69 - 82
Compactor	72 - 88
Loader	72 - 96
Excavator	72 - 93
Grader	76 - 95
Bulldozer	73 - 95
Dump truck	70 - 96
Rock Breaker	110 - 140
Rock Drill	76 - 98
Jackhammer	76 - 98
Paving	82 - 93
Blasting *	128 *

* Regulated by Provincial Statute and HRM Bylaw
Source: Handbook of Noise Control, 2nd Edition, 1979

Although these noise levels are in the unacceptable range, the noise levels which may exist at various locations will depend upon several factors. These factors include the frequency and duration of equipment use, the combination of equipment used, the distance from the source, the absorptive capacity of ground materials, and the topography and vegetation in the Project area.

The volume and quality of noise determines the type of response elicited. Noise acceptable to humans for various land uses may, or may not, be acceptable to wildlife. Noise generated by construction activities may affect wildlife populations. Noise produced by such activities can either attract individual animals or induce panic and result in the withdrawal of a population from a previously used area. Studies have been conducted on various types of human disturbances with several wildlife species (Dorrance et al, 1985; Kuck et al, 1985; Eckstein et al, 1979; McCourt et al, 1974; Calef et al, 1973). The results indicate that disturbances elicit no response when the source of disturbance is located several hundred metres from the animals.

Some species, such as white-tailed deer, may be attracted to certain activities, the sound of which (*e.g.*, chainsaws) they presumably associate with the provision of forage. Deer have also shown habituation to various types of disturbances, such as traffic related noise.

Several studies have been conducted on the off-the-road effects of highway construction, but it is difficult to differentiate effects of highway construction and traffic from the effects of habitat conditions in the RoW and other human induced influences in the vicinity (United States Department of Transportation, 1982). For both birds and mammals, it seems that effects extend farther in open areas than in areas having denser cover.

There has been speculation that noise associated with construction activities and traffic may disrupt the breeding activities and territorial defence of some songbirds under some circumstances. However, little information is available to substantiate this (United States Highway Department of Transportation, 1982).

Michael (1975) reported on before and after construction studies of United States Highway 48 in West Virginia. No game animal seemed to exhibit a change in distribution as a result of the highway being constructed and no change in population density could be attributed to the presence of the highway. Indirect effects of United States Highway 48 extended no farther than 160 m from the highway. Shy animals such as the wild turkey avoided areas immediately adjacent to the highway but used areas 320 m from the highway. All other animals which were present in the study area frequented the area adjacent to the highway.

During construction, it can be expected that most wildlife species occupying the immediate vicinity of the construction site will initially be frightened away, but through habituation, these animals will return and reoccupy the surrounding areas, after a short time. Based on information in the literature and observations made during this study, it is indicated that most species of wildlife become habituated to the types of disturbances associated with highway construction and operation.

There is potential for secondary effects of highway construction on wildlife. Activities of construction workers and machinery can affect wildlife, depending on the location and timing of construction. Wildlife may be at risk during critical periods such as breeding season (Klein and Hemming, 1977; Klein, 1979).

Many species of wildlife inhabiting the area along the proposed alignment can be found utilizing breeding habitat in close proximity to existing highways. These include a variety of passerine birds (songbirds) and waterfowl. These species have become accustomed to the noise and physical presence of traffic, workers, and machinery conducting ongoing maintenance of existing highways. Construction of the new highway is not expected to have adverse effects on these species and habitat/function relationships. No significant impacts of construction are expected in relation to these species.

The common loon, which has been described as vulnerable to disturbance during breeding season (Clayden et al, 1984), may occur in open water areas along the proposed RoW. Disturbance of loons using areas in and immediately adjacent to the RoW during breeding season, could result in displacement of the nesting adults and abandonment of nests/juveniles. Due to their territorial behaviour, loons tend not to have concentrated nesting sites, being widely dispersed on suitable waterbodies. Disturbance during construction activities would be expected to have very localized effects. Depending upon the time of disturbance, loon pairs may relocate to another suitable site and establish a new nest in the same breeding season. Impacts resulting from construction of the proposed highway are expected to be very localized and significant impacts in the loon populations are unlikely.

Mitigative Measures to Reduce Construction Noise

If, during construction, noise related problems are identified, abatement strategies such as changes in equipment locations, location of haul roads and material stockpiles, restricted work hours, and use of alternative equipment or methods will be implemented, as appropriate.

Implementation of specific abatement and mitigation measures, as required, will negate most noise related impacts. Short-term residual impacts (noise marginally in excess of NSDOE guidelines) may be experienced by residents near the construction zone.

Construction noise perceived by stationary receptors will be at a maximum when construction activities are closest and decrease as construction proceeds further along the alignment.

Significance of Residual Effects

Significant residual adverse effects related to construction noise are not likely.

8.1.3 Loss/Alteration/Displacement of Terrestrial Habitat

The habitat along most of the proposed alignment can be characterized as primarily softwood stands. Wildlife described for the area are those characteristic of the identified forest cover and habitat types.

Highway construction activities can indirectly effect plant and wildlife habitat in a number of ways, including:

- fragmentation of the landscape, and, at a smaller scale, ecosystems; and
- alteration of water drainage patterns.

8.1.3.1 Potential Effects on Wildlife

The most obvious effect from highway construction is the clearing, grading, and surfacing of land that previously supported forests and other wildlife habitat, resulting in habitat loss and a reduction in the overall carrying capacity for some species. The incremental loss of habitat leads to an increase in the concentration of species in suitable remaining habitat. Increasing the concentration of animals (*e.g.*, deer) in an area may result in a number of negative impacts such as depletion of food sources (Doman and Rasmusen, 1944; Carhart, 1945; Erickson et al., 1961); an increase in vulnerability to predators such as coyotes, dogs, and black bears (Coté and Laliberté, 1989, BCME, 1991); an increase in the potential for propagation of diseases and parasites (Ellingwood and Caturano, 1988; Voigt et al., 1989; OMNR, 1990; BCME, 1991), an increase in intra- and inter-specific competition (*e.g.*, Hesselton, 1964), and an increase in the potential for poaching (Morasse and Beauchemin, 1976; Coté and Laliberté, 1989).

Increased edge creation is the key positive factor in the overall impact of linear corridors on wildlife, including birds. Such corridors break up the more or less uniform forest providing a more diversified habitat (Leedy, 1975). This edge habitat is particularly valuable for some species and may provide improved hunting success for some raptors (Ibid.).

The study area is primarily covered by forests interspersed with small wetlands. The area supports a good variety of wildlife species. The potential impacts of construction on wildlife habitat focuses on critical habitat identified, and the presence of species of special status.

Large Mammals: An abundance of suitable habitat exists in the area which will continue to be used by large mammals. There are no deer or moose wintering yards near the proposed highway alignment.

The proposed alignment passes through a reported mammal corridor between Maple Lake and Hammonds Plains Road. A new road may also affect bears if it bisects their home ranges. Bears are apprehensive about crossing frequently used roads. Increased traffic flows may tend to fragment home ranges or contribute to increased road kills.

Mitigative Measures to Reduce Impacts to Large Mammals

A mammal corridor will be maintained across the highway RoW in the Maple Lake area. The stream crossing structure between Maple and Frasers Lakes will be set back a minimum of two metres from the stream edges, on both sides, to facilitate wildlife passage.

Significance of Residual Effects

Significant adverse residual effects are unlikely with proper implementation of mitigative measure (to be developed in consultation with NSDNR) described above.

Furbearers: Several species of furbearers are found in the area along the proposed alignment. It is expected that any effects of the road will be minimal as the presence of man has already been established in the area. There are several small wetlands but the area to be directly affected by the highway is minimal. None of the wetlands have been identified as currently supporting large populations of furbearers in the area, and no significant impacts are expected for the aquatic mammal population or supporting habitat.

The study area hosts an abundance of small woodland mammals including voles, shrews and deer mice, all of which support larger mammals, and birds. No significant adverse impacts are likely due to construction.

Birds: Raptors are thought to be present in the area of the proposed alignment. Most raptors range far and wide in their foraging, but their breeding requirements are habitat specific, though flexible. It is not anticipated that any established nesting sites will be disturbed by the proposed alignment. Clearing of the easement will be completed during the winter to avoid the sensitive Spring nesting period. Therefore, significant impacts are unlikely.

The lakes and wetlands along the alignment do support waterfowl, but no critical habitat is expected to be lost to the alignment. Therefore, no significant adverse impacts are likely due to construction.

A variety of forest birds can be expected to exist in the study area. Much of the area's woodlands contain the varying habitat (*i.e.* low shrub, understorey vegetation, various tree canopy levels) used by this large array of songbirds and is likely that the birds will relocate to nearby suitable habitat. Significant adverse impacts of the proposed route on forest birds are not likely.

Reptiles and Amphibians: Both reptiles and amphibians are expected to exist in the area. There is a potential for habitat of the four-toed salamander in the study area, especially at Wetlands 3, 4, 10 and 16. Construction of the highway through such habitat would likely result in a significant adverse impact. No other significant adverse impacts on reptiles or amphibians are likely due to construction.

Mitigative Measures to Reduce Impacts to Reptiles and Amphibians

A field survey for four-toed salamanders will be conducted prior to design and construction of the highway to determine the presence or absence of nesting sites, if such a survey is determined to be reasonable/practical at the time. Appropriate mitigative measures will be determined based on the results of that work and in consultation with NSDNR. Examples of such mitigation include preservation of habitat by monitoring and strictly controlling construction activities near identified nest sites, and timing of construction to avoid nesting periods.

Significance of Residual Effects

Significant adverse residual effects are unlikely with proper implementation of mitigative measures (to be developed in consultation with NSDNR), should four-toed salamander nesting sites be identified along the alignment.

8.1.3.2 Potential Effects on Rare/Endangered Plants

There were no plants known to be rare or endangered found along the proposed alignment, therefore, significant residual adverse effects to rare or endangered plants are not likely.

8.1.3.3 Potential Effects on Environmentally Significant Areas (ESAs)

Wetlands were noted as being ESA's and the potential effects are described in section 8.1.5. There were no other ESA's identified and therefore, no significant impacts are predicted on ESA habitat, other than wetlands, along the proposed alignment.

8.1.4 Loss/Alteration of Aquatic Habitat

The proposed highway alignment crosses a number of watercourses (Fishers Brook is crossed three times) and is directly upgradient of two lakes. Details on these resources are provided in Section 6.0 of this report. The alignment crosses most streams at a point high in their respective drainage basins, and therefore these streams are typically small/narrow at the crossing locations.

Construction activities in and around streams and lakes can impact water quality and fish habitat in a variety of ways. Potential concerns associated with highway construction activities, include:

- erosion and sedimentation;
- fish passage;
- blasting;
- structural habitat effects; and
- accidental releases of hazardous materials.

Potential concerns and recommended mitigative measures are discussed in the following sections.

8.1.4.1 Erosion and Sedimentation

Potential impacts on the aquatic environment are associated with increased erosion and sedimentation in a watercourse, with attendant alterations to habitat quality. Sedimentation of surface waters can potentially result from site erosion and overland runoff, activities conducted on stream banks, and disturbance of substrate in the watercourse. Similar concerns with erosion and sedimentation exist with other aspects of the Project aside from the roadway proper, including potential effluent/runoff from borrow pits, crushing/screening activity, and aggregate washing areas.

The location receiving runoff, or the site of a watercourse crossing, and that area immediately downstream, may be significantly impacted. The natural characteristics of the watercourse may be temporarily altered by any of the above activities. The potential alterations may have an impact on the aquatic resources in terms of the biological communities which live in or near the waters and utilization of the aquatic resources.

The potential for soil erosion is a function of soil characteristics, exposure to precipitation, runoff, topographic features and when applicable, ice scouring and wave action along the banks of a watercourse. These factors may influence the extent of erosion when acting independently or in a combined manner, if suitable protection is not available.

Erosion is defined (Brady, 1990) as:

- the wearing away of the land surface by running water, wind, ice, or other geological agents including gravitational creep; and
- detachment and movement of soil or rock by water, wind, ice, or gravity.

The major areas of erosion concern are on slopes (either constructed or natural), and along the roadways near streams. Highway corridor slopes will be constructed of either on-site materials (soil or rock) or borrow. Rock slopes will have little potential for erosion.

Effects of preparatory activities for culvert/bridge construction or vehicle approaches depend upon the stream size, gradient, and time since the last disturbance (if any). Sediment introduced by clearing may be transported from high gradient sections of streams and accumulate in low gradient sections.

Soil disturbances associated with road and bridge construction near watercourses may result in direct or indirect sedimentation problems in streams. These activities have potential to affect water quality and quantity by exposing soil to erosion and increasing the rate of erosion by removal of vegetation (general areas and riparian zone) and by increasing the rate of surface runoff. As well, the use of certain construction practices may also create erosion problems.

Watercourse crossings, where machinery and equipment are across moved streams, have the potential to produce significant short- or long-term impacts if the stream bank or crossing erodes. The degree of risk to aquatic resources is related to site conditions and may be modified by the type of procedures employed during in-stream activities.

Increased sediment loading may potentially affect aquatic resources primarily through direct mortality and destruction of habitat. The discussion of potential effects focuses on salmonid species (*e.g.*, brook trout) which are known to be sensitive to the effects of erosion because of their life-cycle characteristics.

Direct effects on individual fish from mobilized sediment are theoretically possible, but extremely unlikely in the case of highway construction. Of potentially greater concern are the effects on aquatic habitat outside the immediate construction zone associated with release of sediments into the watercourses. The severity of effects is related to both the concentration of the sediments and the duration of the release event (Anderson, et. al., 1996; Newcombe and Jensen, 1996). The sources of these sediments include instream construction activity and activity on the approaches to the watercourse crossing location. The concern is that sediments will be released into the watercourse and move downstream. Depending on the size of the sediment particles and the energy in the watercourse, these sediments will be deposited at some point in downstream areas. Sedimentation may cause mortality of various fish life stages, and habitat degradation and loss.

The potential sources of sediment with the highest risk of long term effects are the highway approaches to the watercourse crossing locations. The Black Duck Brook Crossing with its long, steep approach is an example in the case of Highway 113. There is extensive evidence of unstablized slopes providing a continuing source of sediment to watercourses. There is also evidence that slopes can be stabilized to eliminate the approaches as a source of sediment (TERA Environmental Consultants, 1993).

The most serious potential for adverse effects on fish populations relates primarily to the timing of construction relative to sensitive life stages of fish populations. Seasonal windows are often used which disallow construction during periods when the most sensitive life stages of resident fish are present. This prevents the most serious potential for significant population level effects. The most commonly implemented closed window encompasses the period from the start of brook trout spawning in streams (~ Sept. 30) to the date of emergence of Atlantic salmon fry from the substrate (June 1). Effects will, however, result from the construction of watercourse crossings, and will depend on the sensitivity of the receiving environment and the concentration and duration of sediment release. The following mechanisms can lead to habitat damage:

- Mortality of free-swimming fish could result from exposure to high concentrations of suspended sediment or from smothering of eggs or juveniles within the stream substrate. The concentration of suspended sediment that is directly damaging to fish is dependent on the concentration as well as duration of exposure. While levels of 100 mg/L are frequently cited as harmful, lethal levels (LC_{10}) of suspended sediment for a number of fish species range from 580 mg/L to 97,200 mg/L in static bioassays (Sherk et al., 1974). Bioassay results indicate that early life stages are more sensitive than adults to suspended solids. Sublethal effects have been reported for a variety of fish species in waters containing suspended sediment concentrations of approximately 650 mg/L or greater, when continually exposed for a period of several days (Appleby and Scarratt, 1989). Anderson et. al., 1996 and Newcombe and Jensen, 1996 have developed formulas which predict the level of fish mortality and habitat damage from single suspended sediment events of known concentrations and duration.
- Sedimentation may cause a shift in the benthic macroinvertebrate communities, including travelling and drifting species, such as the *Ephemeroptera* (mayflies),

Plecoptera (stoneflies), and *Tricoptera* (caddisflies), and unavailable burrowers such as *Chironomids* (Waters, 1995).

- Sedimentation may limit the potential for the habitat to accommodate overwintering salmonid fish. Salmonids move into holes in the substrate in the autumn, and enter a torpid state to escape the effects of ice scour and to conserve energy. Salmonids need clean unembedded substrate for this (Hunter, 1991).
- Sedimentation may limit spawning potential by decreasing interstitial flow and suffocating incubating eggs, or it may trap alevins (sac fry) in the substrate and cause them to starve (Waters, 1995). Egg mortality is directly related to the geometric mean particle size of the substrate (Waters, 1995), and fry emergence is inversely proportional to the amount of material 1 to 3 mm in diameter. Sedimentation may result from direct erosion and sedimentation, or from re-distribution of previously-deposited sediment.
- Inundation of free stone substrate by sediment may cause all of the watercourse flow to occur within the water column. Intra-substrate flow moderates the temperature of the watercourse by cooling the water in the summer, and warming it in the winter. Disruption of intra-substrate flow due to sedimentation may alter instream temperatures and displace fish. Where sedimentation prevents intra-substrate flow, thick ice may form in the winter which could scour watercourse bottoms, or freeze to the substrate and kill salmonids (Rutherford, 1994).
- Pools filled with fine material from sedimentation do not provide the water depth or cover required for large salmonids. Brook trout and early run Atlantic salmon habitat may be lost as a result (Rutherford, 1994).
- Inundation of pools by sediment results in the development of streams characterized by runs instead of riffles and pools. This high energy system causes fallen leaves, which are the basis of the food chain, to be swept from the system. Watercourse banks may become eroded, and their channels excessively wide. Again, this may result in a loss of deep water habitat on which larger salmonids depend (Waters, 1995).

It is important to realize that one time erosion and sedimentation events seldom cause long-term damage to fish habitat in streams. The major problem is with chronic erosion which maintains habitat in a state of constant recovery and lower than optimal quality (Waters, 1985).

Proposed Measures to Mitigate Erosion and Sedimentation Concerns

The potential impacts related to erosion and sedimentation may be minimized by carefully observing standard operating procedures and construction practices. Contract specifications are prepared during the design of the Project and, along with the construction drawings, provide information on how to build the Project. The drawings and specifications provide methods to protect the environment.

Standard mitigative procedures to address erosion and sedimentation concerns include specifications on sediment control fences, erosion control structures, removal of erosion control structures, hydroseeding and mulching.

Additional environmental requirements are often included in the specifications as a result of conditions of approval by NSDOE during the environmental review process and Water Approvals process. The specifications state that the contractor is to carry out all work in such a manner so as to be in compliance with the various Federal and Provincial Acts and

Regulations concerned with the protection of the environment and any approvals or permits issued to TPW and/or the contractor.

The following discussion contains recommendations for generic mitigative measures for activities conducted near watercourses.

One major concern regarding watercourse alterations is the clearing of streamside vegetation. Clearing of vegetation to the waters edge may potentially destabilize stream banks and increase bank erosion, resulting in increased sedimentation. For these reasons, vegetation clearing will allow for a buffer strip along each stream bank, the width of which will depend on the bank slope and habitat type. Generally speaking, a minimum buffer strip width of 30 m will be left adjacent to stream crossings. TPW usually requires a 100 m wide buffer, depending on topography, until culverts are installed.

Construction activities will be conducted in accordance with the stipulations of the permit pertaining to each watercourse. It is anticipated that this will include such terms as restrictions on use of machinery on watercourse banks, limited crossing of watercourses, and stabilization of watercourse crossing areas.

To limit bank degradation, heavy equipment will not be used close to stream banks where possible. Bank stabilization techniques, such as rip-rap, will be used where required to limit bank erosion.

To prevent bed scouring and damage to adjacent land, stream crossing design will account for potential high water flows and spring ice passage, where applicable. Consideration will be given to providing a structure sufficient to pass a one-in-one hundred year predicted storm event. Encroachments into incised channels will be kept to a minimum. No more than one-third of a watercourse will be blocked at one time, during construction, to allow the continued flow of water and passage of fish, as required by the ***Federal Fisheries Act***.

As mentioned previously, sedimentation of downstream habitat may degrade the quality of the habitat, smother incubating eggs and decrease food availability from benthic fauna. While habitat in intermittent streams may not be significantly degraded by any watercourse crossing activities, downstream transport of sediment may degrade better quality receiving habitat.

Thus, sedimentation prevention techniques will be employed for both intermittent and permanent watercourses.

Potential impacts on aquatic resources may be further reduced by restricting bridge construction requiring in-stream work to the time period when spawning habitat is least vulnerable to effects of erosion and sedimentation (*i.e.*, early June through September). Therefore, activities requiring in-stream work will be conducted during the period from early-June through September where possible.

The measures outlined in the above text pertaining to watercourse crossings are generic in nature. Additional mitigative measures, including specific measures to protect the aquatic environment during construction and operation will be developed during the detailed design stages of the Project.

Where applicable, mitigative methods described above will also be applied to other source areas of sediment laden runoff. At the sites of other sources such as borrow pits, crushing/screening activity, and aggregate washing areas, runoff diversion ditches and sedimentation ponds will be constructed prior to commencement of the activities associated with the respective operations. This will minimize the amount of surface runoff across exposed soils, and will allow solids in site runoff to settle out in the ponds prior to leaving the site. All erosion/sedimentation control measures will be routinely inspected and maintained (*e.g.*, if ≥ 50% full, sediment control measures must be cleaned out to remain effective). Details of these measures will be prepared at the design stage when sufficient information is available to allow site specific design. Such details will be incorporated into the environmental protection plan to be developed prior to the start of construction activities. In addition, effluents associated with the Project will be characterized and associated pathways of concern identified.

Significance of Residual Effects

Provided that the mitigative measures identified above are successfully implemented, no significant residual adverse effects resulting from erosion and sedimentation are likely.

8.1.4.2 Fish Passage

Construction of bridges and culverts can affect fish populations. Improperly placed bridge abutments can create high velocity barriers to fish and cause downstream erosion. Improper culvert design can also result in high velocities or vertical drops at the discharge end of the culvert that are barriers to fish passage.

Studies of fish behaviour in fishways have indicated that if fish are highly motivated to move upstream, (*i.e.*, Atlantic salmon moving upstream to spawn) they will readily move through relatively narrow, shallow passages. Partial blockage of a river channel with the flow concentrated in the opening would not obstruct upstream passage of adult salmon providing velocities did not exceed approximately 4.0 m/sec (Slatick, 1970). Minimum water depths of 0.3 m are commonly used in fishways and water depths in many Maritime salmon rivers are of a similar depth. Where a sudden drop in water surface elevation cannot be avoided, a drop of 0.3 m is generally accepted as passable by most fish (Dane, 1978). A drop of 0.6 m does not present an obstacle to adult Atlantic salmon (Conrad and Jansen, 1983).

A specific fish passage concern associated with Highway 113 exists on the tributary between Maple Lake and Frasers Lake (*i.e.*, Watercourse #2). Historic fish population sampling in Frasers Lake revealed the presence of juvenile gaspereau. The anadromous species most likely utilizes the many upstream lakes in this system as spawning and nursery habitat. Therefore a priority will be placed on optimizing fish passage at the crossing of Watercourse #2.

Upstream fish passage can also be obstructed by chemical stimuli and increased suspended sediment concentrations. Studies of the reactions of fish to various chemical substances have indicated that several substances will cause an avoidance reaction (Brett and MacKinnon, 1954). The physical influences of suspended sediment on aquatic organisms has received considerable attention (Sherk et al., 1974; Appleby and Scarratt, 1989).

Wildish and Power (1985) reported that migrating smelt may avoid areas of elevated suspended sediment concentrations. Increased suspended sediment concentration has also been reported to delay or stop the migration of adult Atlantic salmon and to interfere with vision of bottom feeding fish (Bottom et al., 1985).

Proposed Measures to Mitigate Fish Passage Concerns

Watercourse crossings and culvert installation require a permit under both provincial and federal legislation. Permits will be acquired prior to construction, and stipulations contained therein will be followed. All culvert installations will meet the specifications outlined in the Guidelines for the Protection of Fish and Habitat: the Placement and Design of Large Culverts (DFO, Maritimes Region, 1998). Fish passage will be designed during the design stage of the Project, in consultation with DFO.

Mitigative measures applicable to the construction of crossings include: provision of fish passage around construction areas; separation of the construction area from the flowing watercourse through the use of cofferdams; not more than 1/3 of the stream channel blocked at one time; measures employed to minimize downstream siltation; and embankments stabilized as required. These measures will ensure that potential impacts, other than the temporary loss of habitat during culvert installation, will be minimized.

It is recognized that standard pipe culverts can eliminate habitat where they are installed. Several alternatives are available to minimize the amount of habitat lost. At stream crossings having good fish habitat, it may be desirable to install open-bottom arch culverts or baffled culverts. These and other options will be considered at the design stage when site specific details will be available.

Resident fish in most of the streams are not large (*i.e.*, brook trout). Therefore, the choice of culvert structure for stream crossings will include consideration of critical velocities for these fish, to avoid creating velocity barriers and allow unimpeded fish passage.

Suspended sediment concentrations anticipated to result from construction activities are not expected to result in significant negative impacts on migrating fish.

In general terms, stream crossings will be constructed in summer under low flow conditions; construction equipment will not be allowed in the watercourse; and the design of the crossing will provide appropriate conditions in terms of velocity and water depth to allow for fish passage. In addition, culverts will be constructed such that vertical drops are absent at the discharge end and stabilized to prevent erosion from creating a vertical drop. In-stream work associated with the construction of stream crossings will not occur after mid-October when spawning of salmonids is likely to occur.

Detailed construction plans will be prepared for all major crossings and submitted to DFO and other regulatory agencies for review. Fish passage at all water crossings, except those of intermittent streams, will be maintained at all times during construction.

Significance of Residual Effects

Provided that the mitigative measures identified above are appropriately implemented, no significant residual adverse effects to fish passage are likely.

8.1.4.3 Blasting

The use of explosives will be required to construct Highway 113. Blasting can potentially impact groundwater resources. Blasting in or near streams can harm fish if not properly administered.

Blasting in or adjacent to fish habitat has the potential to cause disturbance, injury, and/or death to fish, and disturbance, destruction or alteration of their habitats, sometimes at considerable distance from the point of detonation (DFO, 1993).

When detonated, explosives release large quantities of energy over a brief interval of time. Pressure generated from an explosion produces a shock wave in the surrounding medium (air, water, and soil) which attenuates over distance. Explosives detonated underground or underwater produce pressure waves within the particular medium which are propagated as body waves or surface waves. Two types of body waves are recognized: compressional waves and shear waves. Compressional waves have higher velocities and will arrive at any given point, prior to shear waves. The concern is that compressional waves will be propagated from the earth into waterbodies. Surface waves are usually produced when a body wave travels to the surface and is reflected back. Surface waves contribute to production of ground vibrations that are of concern to incubating fish eggs. The degree of damage is related to type of explosive, size and pattern of the charge(s), method of detonation, distance from the point of detonation, water depth, and species, size, and life stage of fish.

Underwater shock waves resulting in sudden changes of hydrostatic pressure may result in trauma and death of fish. This would be expected of strong shock waves resulting from a blast in close proximity to fish. Injuries may range from ruptured internal organs to scale loss. Potentially lethal injuries include the rupture of the swim bladder and rupture and hemorrhage of the kidney, liver, spleen, gonads, and sinus venous (Wright, 1995). Other injuries resulting from shock waves include ribs torn loose from the body wall, torn adipose tissue, and ruptured blood vessels in the body wall (Wright, 1995). Fatalities are caused either directly by trauma or indirectly through loss of equilibrium resulting in increased predation by other organisms or the inability to feed.

The susceptibility of fish to pressure change is dependent upon orientation with respect to the wavefront, body shape, body size, and presence or absence of a swim bladder (Wright, 1995; Yelverton et al., 1975). The impulse required to cause mortality increases considerably with body weight and thus smaller fish are more likely to be injured than larger fish.

Larval stages of fish do not develop a swim bladder until they have absorbed the yolk sac and have emerged. Therefore, they are fairly resistant to rapid pressure changes (Bishai, 1961). However, the eggs and embryos of salmonids and other fish are particularly sensitive to shock or agitation. The sensitivity varies with the stage of development (Smirnov, 1954; 1955). There is a high degree of sensitivity to shock and vibration until the eggs reach the eyed stage. Damage to the eggs and developing embryos consists of deformation and compression of the membrane, spinal curling of the embryo, displacement of the embryo and disruption of the vitelline membrane (Wright, 1995). Sub-lethal effects such as a change in behaviour in fish have also been observed on several occasions as a result of noises in the environment (DFO, 1993). The effects may also be intensified in the presence of ice and in hard substrate.

The use of explosives in and near fish habitat also may result in the physical and/or chemical alteration of that habitat (DFO, 1993). Sedimentation resulting from the use of explosives may cover spawning areas or may reduce, or eliminate, benthic invertebrates which are an important source of food for many fish. By-products of explosions can be toxic to fish and other aquatic biota as they may contain ammonia or similar compounds which have the potential to enter the water.

Proposed Measures to Mitigate Blasting Effects on Fish

Two types of explosive impact models have been developed by DFO in order to estimate setback distances and lethal impact zones for charges buried on land and charges used under water. Furthermore, DFO has developed guidelines for the use of explosives in or near water (DFO, 1993). The intent of these guidelines is to protect fish and fish habitat from the destructive forces of explosives. The guidelines stipulate that "no explosive may be used that produces, or is likely to produce, an instantaneous pressure change greater than 100 kPa (14.5 psi) at a distance greater than 10 m from the point of detonation." In the same context, it is also stipulated in the guidelines that "no explosive may be used that produces, or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during egg incubation." Setback distances for the above two requirements have been calculated by DFO using the on-land explosive impact model. The results are shown in Table 8-2.

TABLE 8-2
Setback Distance (m) From Point of Detonation to General Fish Habitat for Various Substrates and Spawning Habitat for all Types of Substrates

Type of Substrate	Weight of Explosive Charge (kg)						
	0.5	**1.0**	**5.0**	**10.0**	**25.0**	**50.0**	**100.0**
Rock	5.0	7.0	15.0	20.0	35.0	50.0	70.0
Frozen Soil	5.0	6.0	14.0	20.0	31.0	45.0	62.0
Ice	5.0	6.0	13.0	18.0	30.0	40.0	55.0
Saturated Soil	4.0	4.0	12.0	18.0	28.0	40.0	55.0
Unsaturated Soil	3.0	4.0	10.0	12.0	20.0	28.0	40.0
Spawning Habitat (for all types of substrates)	15.0	20.0	45.0	65.0	100.0	143.0	200.0

Source: DFO, 1993; as modified in Wright, 1995.

It is also required by the guidelines that in the case where the two above requirements cannot be met, the potential impacts of the blast on fish and fish habitat are to be assessed and a mitigation plan developed. The necessity to develop a mitigation plan will depend mainly on the biological and physical characteristics of the stream. The assessment and the mitigation plan, if required, will be subject to approval by DFO.

Several measures may be employed to minimize the effects of explosives on fish and fish habitat. Based on the available literature, (Munday et al, 1986; DFO, 1993), the following mitigative measures may be employed, as appropriate:

- Blasting should be undertaken, as much as possible, at the time of least biological activity or biological sensitivity;
- If multiple charges are to be used, time-delay detonation initiators (blasting caps) should be used to reduce the overall detonation to a series of discrete explosions;
- Detonation of small underwater charges, consisting of detonator caps, could be set off one minute prior to the main charge to scare fish away from the site;
- Physical removal or exclusion of fish from the detonation area prior to the blast;
- Decking the charge which subdivides the charge in one drill hole into a series of smaller charges to reduce the overall detonation to a series of smaller discrete detonations or explosions;
- Use of non-propagating explosives;
- Use of two caps to detonate each charge to ensure detonation as planned without cap failure;
- Over-drilling the holes to ensure proper fracturing of the substrate;
- Use of gravel or similar substrate to stem holes (*i.e.*, filling the holes to the substrate surface level after the charge is in place); and
- Replacement or enhancement of any disrupted habitat upon completion of the blasting.

Respecting the appropriate set back distance from watercourses will minimize potential impacts on resident aquatic biota (Table 8-2). The effectiveness of these measures is dependent on several site-specific characteristics. Discrepancies between effects predicted and those observed under actual field conditions may be expected when blasting adjacent to waterbodies where soil conditions, the geometry between the blast source and the waterbody, and the soil-water interface act to attenuate, reflect, and refract shock waves. Therefore, monitoring of fish habitat in proximity to blasting areas is recommended to assess the effectiveness of mitigative measures employed.

Significance of Residual Effects

Provided that the mitigative measures identified above are appropriately implemented, no significant residual adverse effects to aquatic habitat resulting from blasting are likely.

8.1.4.4 Structural Habitat Effects Resulting From Construction Activities in or Near Watercourses

Overhanging vegetation provides protection to aquatic habitat through cover, shade, and regulation of microclimate temperatures. Failure to promote regrowth of vegetation along watercourse banks following disturbance may lead to potentially detrimental effects on aquatic habitat, including loss of shade and cover for aquatic species. Elimination of undercut resulting from flattening or compression of watercourse banks by construction equipment, may also adversely affect aquatic habitat through reduction in shade and cover.

The cross-section of watercourse channels is typically characterized by a thalweg, an naturally occurring channel in the watercourse which follows the deepest line of the watercourse bed.

This structural characteristic can be destroyed if a trapezoidal channel is constructed, thereby altering the natural meander of the watercourse.

Proposed Measures to Mitigate Structural Habitat Effects

The following mitigative measures can be employed to minimize potential adverse effects on aquatic habitat resulting from structural habitat changes:
- limit removal of riparian zone vegetation;
- promote regrowth of vegetation in areas adjacent to watercourses following disturbance;
- minimize the use of heavy equipment in and adjacent to watercourses;
- keep ground disturbance to a minimum in and adjacent to watercourses; and
- maintain natural thalweg of the watercourse channel.

Significance of Residual Effects

Provided that the mitigative measures identified above are appropriately implemented, no significant residual adverse effects to structural aquatic habitat are likely.

8.1.4.5 Accidental Release of Hazardous Materials

Degradation of watercourses may occur through accidental release of hazardous materials, including POL (petroleum, oil, lubricants).

Accidental release of hazardous materials may occur from storage, handling, and refuelling sites. Loss of POL may also occur from parked vehicles, and equipment operation.

Potential effects on aquatic resources resulting from an accidental release of hazardous materials may include mortality of aquatic biota and degradation of aquatic habitat. Any spills that occur will be remediated to meet Federal and Provincial regulatory requirements.

Proposed Measures to Mitigate Effects Due to Accidental Release of Hazardous Materials

The principal means for minimizing the potential for effects related to accidental release of hazardous materials is by ensuring that an adequate level of awareness of the environmental sensitivity of environmental components is maintained by contractors and workers, and through incorporation of appropriate preventative and response measures in construction practices. Additional mitigative measures include:
- Personnel will be trained in WHMIS for the proper handling of hazardous materials to be present on site during construction.
- All construction equipment and machinery will be maintained in good working condition and monitored to prevent leakage of fuels, lubricants, and other fluids.
- All fuels, lubricants, and other hazardous materials will be stored outside of established buffer zones in designated areas with an impervious liner and berms to provide spill containment for 120 percent of the stored volume. Additional sorbent material will be made available on-site to assist in spill clean-up.
- Hazardous materials will not be stockpiled in close proximity to watercourses and wetlands. No fuelling will be conducted within 30 m of a wetland or watercourse.

- Storage tanks/areas will be checked regularly to identify leaks, and contingency plans prepared in anticipation of accidental events that may result in releases of hazardous materials.

Significance of Residual Effects

Provided that the mitigative measures identified above are implemented, no significant residual adverse effects due to accidental releases of hazardous material are likely.

8.1.5 Loss/Alteration of Wetland Habitat

The following sections address to potential adverse effects to wetland habitat from soil erosion, water quality, and Fishers Brook Wetland.

8.1.5.1 Soil Erosion

Soil erosion is of particular concern at watercourse crossings due to potential effects of suspended solids and sedimentation on fish and other resources. Concerns related to watercourse crossings are specifically addressed previous sections. In this section, soil erosion is considered for non-crossing locations in the context of physical changes to the wetland habitat and the potential for effects to extend well beyond the construction zone.

Due to their very nature, the wetland areas along the alignment are a low risk of erosion losses. However, there is potential for gully erosion to occur if the fine, erodible soil underlying vegetated cover is exposed. This may result from a process whereby water flow is concentrated in narrow channels for short periods of time, eroding the soil from this narrow area to considerable depth. However, it is not possible to mathematically predict such an occurrence.

Excavated materials and construction fills are also subject to erosion. Therefore, erosion within the wetland and erosion of soils in areas adjacent to and upgradient of the wetland, may result in adverse effects on surrounding wetland habitat. Areas along the proposed alignment which are adjacent to wetlands and have been identified as areas of concern with respect to potential erosion losses include:

- Wetland 3 and Wetland 4; Fishers Brook Wetland
- Wetland 10; Trib. of Ragged Lake; and
- Wetland 16; Trib. to Paper Mill Lake.

Mitigative Measures to Reduce the Effects of Erosion on Wetlands

To minimize the potential for gully erosion in the wetland areas, the following points must be considered in planning any work to be conducted in wetland areas:

- Ground disturbance will be kept to a minimum; all activities and infrastructure will be maintained within the RoW at all times, and within the footprint area where practical.
- Stabilization and revegetation of disturbed areas will be done concurrently with construction.
- Existing local drainage patterns will be retained where possible.

- Drainage structures will be designed to dissipate hydraulic energy and maintain flows at velocities sufficiently low enough to prevent transport of native soil material.

The potential for erosion of excavated materials and construction fills may be minimized with consideration of the following:

- Excavated materials will be removed from the construction zone as soon as possible. If stockpiling is required, the area will be isolated from adjacent habitat to prevent off-site sediment transport.
- Excavated materials used for construction purposes will be stabilized and immediately vegetated.
- Clean, coarse fill materials will be used to minimize sediment loadings in runoff.

Significance of Residual Effects

If construction practices are employed that include measures to reflect the above considerations, no significant residual adverse effects to wetlands are likely.

8.1.5.2 Water Quality

Highway construction activities may have detrimental effects on water quality to varying degrees. The quality of wetland waters may be subject to adverse local and/or short-term effects; widespread or long-term effects on water quality are less common (Shulinder et al, 1979b). Due to the predominance of aquatic-based food chains in wetlands, water quality changes have potential for impact on wetland productivity and diversity. There is potential concern for the proposed Project to influence local wetland water quality. The water quality may be affected by suspended solids in runoff from construction and excavated materials, leachate from construction materials (*i.e.*, asphalt and concrete), and spillage of toxic materials (*i.e.*, petroleum products). Excess suspended solids stem from two aspects of highway construction:

- Disturbance of the existing submerged substrate can create heavy loads of suspended organic and inorganic matter in the surrounding water. Excavation, piling construction, and equipment operation are usually associated with this type of sediment problem.
- Sediment laden runoff from cleared land and constructed fills, or sediment loads from construction material processing sites, excavated material disposal, can place elevated levels of predominately inorganic matter into aquatic systems. This occurs during construction and may continue until stabilization follows completion.

Suspended solids from highway construction can cause the wetland to become inhospitable for some organisms. The ecology of most aquatic systems has been found to be adversely affected by accelerated erosion and sedimentation. The severity of problems caused by suspended solids generally decreases with distance from the roadway, and with time after construction is completed (Shulinder et al, 1979b). Turbidity is known to have adverse effects on aquatic primary productivity, feeding, and reproductive success of higher organisms. When prolonged turbidity is experienced, significant changes in wetland function and class structure can be expected (Shulinder et al, 1979b).

Chemical pollution of adjacent wetlands can occur through contamination from such sources as construction machinery, fuels and lubricants, and surfacing/construction materials. The severity of the impact of these substances on a wetland habitat is variable, and can be affected by water regime, precipitation patterns, topography, and the sensitivity of the particular organisms to the chemical concerned (Shulinder et al, 1979b).

Mitigative Measures to Reduce Effects to Water Quality in Wetlands

Problems related to maintaining water quality in wetlands adjacent to highways can be mitigated by both the design and construction practices employed. The design features listed below can be a cost-effective means of removing solids and associated pollutants from highway runoff:

- surface runoff directed as overland flow as much as possible to promote water percolation and contaminant removal;
- vegetated ditches;
- shallow water ditches; and
- detention/sedimentation basins equipped with debris traps and baffle arrangements.

Control of suspended solids and turbidity resulting from highway construction is achieved through the control of erosion and highway runoff. Erosion control practices must be used at the construction site. Both temporary and permanent control measures are necessary to prevent erosive materials from entering adjacent wetland sites. Erosion and sediment control measures may be implemented both during and after construction not only to protect affected wetlands from this type of pollution, but also to ensure the continuing integrity of the highway structure and the unimpeded operation of drainage appurtenances.

The principal means for minimizing the potential for impacts related to chemical pollutants, is by ensuring that an adequate level of awareness of the environmental sensitivity of wetland areas is maintained by contractors and workers, and through incorporation of appropriate measures in the construction practices. Prior to undertaking the construction of the highway, the contractors and construction site supervisors will be instructed in matters related to the specific issues of concern. Specific mitigative measures will be included in contract specifications and strict on-site control and inspection programs will be conducted to ensure that the special considerations are not neglected or overlooked. Several elements need to be included in these considerations:

- All construction equipment and machinery will be maintained in good working condition and monitored to prevent leakage of fuels, lubricants, and other fluids.
- When machinery is not in use, drip pans or drop sheets will be placed underneath to catch any leaking fluids.
- All fuels, lubricants, and fluids will be stored in designated areas with an impervious liner to contain any spillage.
- Refuelling and other servicing of machinery will be conducted in designated areas with an impervious liner to contain any spillage of fluids.
- Construction material processing facilities (*i.e.*, asphalt and concrete) will not be located in wetlands.
- Construction materials will not be stockpiled in wetlands.
- Contingency plans will be prepared in anticipation of accidental events that may result in releases of undesirable materials.

Significance of Residual Effects

Significant residual adverse effects are not likely with design and construction practices developed to address the above considerations.

8.1.5.3 Potential Impacts to Fishers Brook Wetland

A highway crossing may affect the wetland hydrology by changing the contributing factors of the water balance equation. Highway crossings may result in fragmentation of a wetland, causing part of the wetland to be isolated from its water sources. A highway crossing may also alter the discharge characteristics of a wetland, causing a temporary higher water level than under natural conditions. The impact of a highway crossing on the hydrology of a wetland is dependent on the location of the highway crossing, and the characteristics of the wetland.

All wetlands are important and provide functions, however, Wetland 4, Fishers Brook Wetland, has been evaluated to provide the most function of any encountered along the alignment, as defined in the functional analyses. Overall, the functions of this wetland are associated with hydrological, biogeochemical, habitat, ecological, aesthetic, recreational, education/ public awareness, public status, cultural attribute, renewable resources, tourism and recreation and urban functions. Construction of the highway has a potential to affect all of these functions, but not significantly if proper construction practices are implemented. The hydrological function is discussed in detail below. The other functions listed are not expected to be significantly affected mostly due the location of the highway.

The highway alignment crosses the narrow tail portion of Wetland #4 (see Figure 6-9), which has a typical width of 50 m. Assuming a highway alignment width of 60 m, the maximum area of Wetland #4 that may be filled as a result of the highway construction is estimated to be 0.3 ha., compared with the total wetland area of 6.5 ha. The highway crossing at this location will essentially not cause any fragmentation of this wetland.

Wetland #3 is located adjacent to Wetland #4, along Fishers Brook (see Figure 6-9). Assuming a highway alignment width of 60 m, the maximum area filled by the proposed highway alignment is estimated to be less than 1.8 ha., compared with the total wetland area of 3.9 ha.

The highway construction may result in physical fragmentation of Wetland #3. Based on the wetland configuration in relation to the highway alignment, it is unlikely that the highway alignment will cut off the hydrological connection of any portion of the wetland from Fishers Brook.

In summary, the impact of Highway 113 development on Wetlands #3 and #4 is limited to the fill area. Approximately twenty percent of the total area of Wetlands #3 and #4 will be filled by the proposed highway. The proposed alignment preserves most of Wetland #4 which has been evaluated to provide the most functions of any wetland along the alignment. The hydrological function of the remaining portion of the wetlands will not likely be significantly affected by the highway development.

Generally, the proposed alignment location is acceptable, relative to preserving the various functions of the Fishers Brook Wetland. A minor alignment adjustment of 30 m, or so, to the north would result in less total wetland area being filled and preserve more of Wetland #3. However, such an alignment adjustment would result in more infilling of Wetland #4. It is recommended that the current alignment be maintained to limit the potential impact to Wetland #4.

Mitigative Measures to Reduce Fishers Brook Wetland Hydrology Impacts

The following design recommendation is provided to ensure the hydrological function of the Fishers Brook Wetland. This recommendation should also be considered during the design of the highway through all other wetland areas along the alignment.

- The design of the highway crossing of the wetlands should preserve the discharge characteristics of the wetlands.

Significance of Residual Effects

No significant residual adverse effects are likely to the hydrology of wetlands along the alignment with implementation of the general design principles identified above.

8.1.6 Effects of Construction on Flooding

Excessive flooding can result in serious losses of both public and private property as well as environmental damage associated with habitat destruction and erosion and sedimentation. It is unlikely that the flooding of streams will be a problem if the proposed watercourse crossings are properly designed to allow relatively free passage of ice and water during spring thaw.

8.1.6.1 Fishers Brook

The construction of Highway 113 may require filling of some of the wetland areas along Fishers Brook, resulting in a reduction of storage capacity available for flood alleviation. Expected expansion of development in Fishers Brook watershed, particularly Kingswood subdivision, may result in higher runoff and peak flood levels than under the current conditions. There is no current development along Fishers Brook, downstream of the highway crossing of the wetlands, prior to its entering Fraser Lake. It is unknown if future development will occur in this area. Increased flood levels could result in stream bank erosion and affect stream stability.

Highway 113 crosses two wetlands along Fishers Brook: Wetland #3 and Wetland #4. The portion of Wetland #4 located within the corridor is long and narrow and typically 50 m in width. As discussed previously, the maximum area of Wetland #4 that will be filled as a result of Highway 113 construction is 0.3 ha., compared with 6.5 ha. of the total area of Wetland #4. Fishers Brook discharges into Wetland #3 approximately 50 m downstream of Wetland #4. Assuming the discharge characteristics of Wetland #4 will be preserved in the design of the highway crossing, the flood characteristics in the section of Fishers Brook between Wetland #3 and Wetland #4 will not likely be affected by the highway crossing, due to the relatively small proportion of the storage area affected.

The highway alignment intersects the main body of Wetland #3, reducing its storage capacity and affecting the flood characteristics downstream of this wetland. The maximum reduction of storage area for this wetland is estimated to be 1.8 ha., compared with the total storage area of 3.9 ha.

Hydrological modelling was conducted to assess the impact of highway crossing on the flood characteristics downstream of Wetland #3. As is typically the case for small watersheds, there is no measured stream flow data available for Fishers Brook. To facilitate the hydrological modelling, a flood flow hydrograph (stream flow variation with time) corresponding to 1:2 and 1:25 year precipitation events was simulated using the SCS method. The topographic features of Fishers Brook watershed were used in the development of the hydrograph. Consideration was also given to the existing and anticipated development in the watershed.

The developed hydrograph was routed through the storage areas upstream of the highway crossing of Wetland #3. The hydrological modelling was conducted for the total available storage areas with and without highway development. The maximum combined reduction of storage area from Wetland #3 and Wetland #4 was considered in the modelling to evaluate the impact of the highway development on flooding downstream.

Reduction in total storage area of a watershed will result in increase in peak flood flow and decrease in temporary storage in the watershed. A comparison of the peak flood flow and maximum temporary storage for with and without highway development, as obtained from the hydrological modelling, is provided in Table 8-3.

Table 8-3 shows that, for a 1:2 year flood event, the maximum increase in peak flood flow caused by the highway development is 0.02 m^3/s (28%), compared to the peak flood inflow of 0.54 m^3/s and peak flood outflow of 0.07 m^3/s under the current conditions. For a 1:25 year flood event, the maximum increase in peak flood flow is 0.08 m^3/s (13%), compared with the peak flood inflow of 2.4 m^3/s and peak flood outflow of 0.6 m^3/s under the current conditions.

TABLE 8-3
Summary Results of Hydrological Modelling - Fishers Brook Wetland

	Unit	1:2 Year Flood		1:25 Year Flood	
		Without Highway Development	With Highway Development	Without Highway Development	With Highway Development
Maximum instantaneous inflow	m^3/s	0.54	0.54	2.4	2.4
Maximum watershed storage	m^3	7600	7400	30000	29000
Peak flood outflow	m^3/s	0.07	0.09	0.60	0.68

As discussed previously, there is no development along Fishers Brook prior to its entering Frasers Lake that can be affected by flooding. Based on the results obtained from the hydrological modelling, it is likely that increases in peak flood flow caused by Highway 113 development will not affect the hydrological regime of Fishers Brook or cause stream channel erosion.

Proposed Measures to Mitigate Flooding Impacts

Crossings will be properly designed to alleviate the potential for increased flooding of watercourses along the proposed route. Plans for crossings will ensure that floodplain storage that presently exists, is maintained as much as possible to reduce the potential for increased water levels. In addition, the design of the highway crossing wetlands will preserve the discharge characteristics of the wetlands and structures at stream crossings will be designed to allow for relatively free passage of ice to reduce the likelihood of the creation of ices dams leading to increased flood levels.

Significance of Residual Effects

Assuming proper design of structures required for all stream crossings and wetlands, significant residual adverse effects related to flooding are not likely.

8.1.7 Effects of Construction on Groundwater Resources

Construction of the highway has the potential to impact on the quality and quantity of groundwater as a result of blasting operations, removal of overburden, excavation of rock and sand and gravel deposits, and release of construction related chemicals (*e.g.*, during vehicle maintenance and refuelling). Groundwater quality can be impaired through increases in suspended sediment and nitrate levels as well as chemical releases caused by construction activities.

Construction activities, including blasting, may have either a negative (*i.e.*, reduction or loss of supply), positive (increased supply) or nil effect depending on whether water-bearing bedrock fractures become smaller, larger, or remain unchanged as a result of induced seismic blast waves.

Blasting can also influence the flow into bedrock wells. In the vicinity of the proposed alignment, it is expected that any potential effects to existing local wells would be to those relying on fracture flows. All drilled wells in the area penetrate either igneous rocks of granitic nature or metasediments of the Goldenville Formation. In either case, water yielded to these wells is through various types of fractures. The effect of blasting in the Project area on groundwater resources might be a concern depending on site location/conditions and nature of blasting.

Construction could potentially affect both shallow and deeper aquifers, if the flow regimes are significantly disrupted as a result of blasting. Construction in the vicinity of wells could result in alterations to the hydraulic characteristics of the groundwater flow system. This may result in the dewatering of surficial sediments or altered subsurface flow conditions (*i.e.*, primary and secondary permeability) from blasting or if an area is left open or infilled with disturbed materials. The extent of such dewatering and subsurface alterations will depend on factors such as the size of the area to be disturbed and explosive charge.

In addition to the potential impacts related to groundwater supplies for human consumption, construction activities also have the potential to affect that portion of the groundwater flow regime that supplies the baseflow to local streams. Examples of such impacts could include a loss or reduction in streamflow and/or the introduction of contaminated groundwater to aquatic habitats. This could result in alteration or destruction of sensitive habitats and/or mortality of aquatic resources.

There are numerous bedrock wells in the area immediately adjacent to the proposed alignment - adverse impacts to those wells is a concern. The wells closest to the highway alignment are in the vicinity of the housing developments near Sheldrake Lake at the western end of the alignment. A survey of all potentially affected water wells will be conducted prior to construction, in accordance with the ***Guidelines for Sampling of Domestic Water Supplies in Conjunction with Construction of Highways*** and the ***Procedure for Conducting a Pre-Blast Survey***.

Proposed Measures to Mitigate Construction Effects on Groundwater Resources

Several measures may be employed to minimize the effects of blasting on groundwater resources. In many respects, the measures are similar to those used to minimize the effects on fish and fish habitat (see Section 8.1.4.3).

In those instances where water well problems are experienced, additional mitigative and/or remedial measures will be required to provide suitable potable water supplies for affected persons. Effective measures will be implemented to rectify water supply problems after a thorough analysis of the problem(s) is completed. Options for mitigation and remediation include:

- on-site treatment of existing water supply;
- modification of existing well construction;
- construction of new well;
- provision of a new long-term water supply (*e.g.*, rainwater cisterns);
- provision of a short-term bottled water supply; and
- construction of a central water supply.

If the instance occurs where streamflow quality is altered because of groundwater changes, little can be done except to remove any sources of contamination (*e.g.*, on-site remediation of chemical spills). Residual impacts could include temporary or permanent destruction of habitat and the resulting loss of aquatic resources.

Significance of Residual Effects

By ensuring construction is completed in a manner that respects the potential for damage to groundwater supplies and implementation of remedial and mitigative measures in instances where they are warranted, significant residual adverse effects to potable groundwater supplies are unlikely.

8.1.8 Human Heritage/Archaeological Resources

An heritage resource assessment was conducted, under Heritage Research Permit A1999NS43, for the proposed highway. The assessment included historical and background research and fieldwork. Three recorded sites were previously identified by others outside the study area. The three sites consist of a Susquehanna isolated find (4000 BP), historic petroglyphs, and a historic paper mill. These sites, being located outside the study area, will not be impacted by this Project.

The entire length of the proposed RoW was examined for heritage resources with the focus on the four high potential areas identified by the predictive model. Although a testing program was anticipated for the high potential areas, poor soil development and rocky terrain prevented any shovel testing. No heritage resources were identified within the study area during the field investigation. Nonetheless, heritage resources may be present, given the elevated potential of the Blue Mountain Hill and Maple Lake/Frasers Lake areas, and those resources could be adversely affected by construction. Loss and/or disturbance to archaeological/heritage resources is a potential impact that will require mitigation.

Proposed Measures to Mitigate Construction Effects on Human Heritage/Archaeological Resources

A field verification and reconnaissance program was completed and the information used in this assessment. Additional investigations will be conducted along the RoW to confirm the presence or absence of heritage resources. Specifically, the following will be undertaken to mitigate potential impacts to heritage resources that may be present in the Blue Mountain Hill and Maple Lake/Frasers Lake areas:

- A thorough surface survey of the Blue Mountain Hill area within the RoW will be completed to identify potential heritage sites and artifacts. Shovel testing is not practical due to the poor soil development and exposed bedrock in the area.
- Construction monitoring for heritage resources will be undertaken in the area between Maple Lake and Frasers Lake. Monitoring will be completed for a distance of 100 m on both sides of the stream.

Construction monitoring will be undertaken at the Maple Lake/Frasers Lake area which has a high potential for the presence of heritage resources, but cannot be spatially defined by additional research or fieldwork. Monitoring during construction provides an opportunity to collect artifacts and record data prior to disturbance. Monitoring to recognize, assess, record and take the appropriate actions necessary will be carried out under archaeological license during construction. Objectives and protocols for monitoring will be developed in consultation with the Nova Scotia Museum prior to implementation.

The results of the surface survey of Blue Mountain Hill will be used to determine if mitigation is required in that area. An absence of heritage resources will nullify any requirement for mitigation. If heritage sites or artifacts are identified in the area, appropriate mitigative measures will be determined in consultation with the Nova Scotia Museum.

Since construction of the highway is scheduled within 10 to 15 years, databases, current to that time, will be reviewed prior to construction, to verify that sites have not been identified within the study area.

Significance of Residual Effects

No significant residual adverse impacts to heritage resources are likely with proper implementation of mitigation measures noted above.

8.1.9 Accidental Events

The most common accidental event associated with the construction and operation of a highway is a toxic spill.

Accidents may be classified as non-transport or transport-related. These may result as a result of human error or mechanical failure, and may involve vehicle accidents, or leakage from equipment, trucks, or storage facilities.

Non-transport related accidents may occur during the operation of equipment at the construction site or as the result of a fire associated with the stored flammable material. Spills of fuel, oil, and asphaltic material are also possible. The storage of flammable material in a large volume and for an extended time, is not foreseen for the normal road construction practices. However, when an operation at the site indicates that leaks, spills, or fire are likely, the procedure will be followed as recommended in the ***Dangerous Goods Initial Emergency Response Guide*** (Transport Canada, 1992) and the ***Manual for Spills of Hazardous Materials*** (Environment Canada, 1984).

Concerns are related to accidental releases of petroleum, oil, and lubricant (POL) into the environment due to spills at POL storage and handling sites and refuelling points, loss of POL from parked vehicles, and from bulk transport of materials along the highway. Releases of POL may result in contamination of soil, groundwater, and surface waters.

Contamination of soil may result in a chronic source of contamination to both groundwater and surface waters. POL may taint groundwater resources and render them unsuitable for potable water sources. Groundwater may act as a secondary contaminant source, conveying the POL contaminants off-site to down-gradient aquifers and discharging to surface waters. POL entering surface waters may affect biota directly through toxic effects or indirectly through altered water quality.

The composition of petroleum products is complex and can contain tens of thousands of different compounds, principally hydrocarbons (Birchard, 1982). It is, therefore, essential that a characterization of the properties of the petroleum products be defined when attempting to predict its fate and effect on the environment (MacKay, 1982). Generally, petroleum products which result in the worst pollution problems are ordinarily the most stable compounds or mixtures (Wilber, 1969). Thus, the toxic effect of a petroleum product in the aquatic environment varies considerably because of the different chemical composition of each petroleum product. The toxicity of petroleum products is related largely to its solubility in water.

Long-term impacts of spilled petroleum compounds are associated with the fraction which sinks and becomes incorporated into bottom sediments and benthic organisms (Rashid, 1974; Vandermeulen and Gordon, 1976; MacKay, 1982). Petroleum compounds are rarely denser than water. Sinking occurs when particles of a compound are associated with denser particles of sediment or detritus. Presumably, in areas with a high sediment load, this sinking mechanism would be more prevalent. Degradation of sedimented petroleum compounds is very slow and it may persist for many years (Vandermeulen and Gordon, 1976; Vandermeulen, 1982).

Petroleum pollution from accidental spills may result in the loss of fish, and vegetation. Plants in marshes or in shallow parts of lakes and stream, may be temporarily eliminated as a result of oil pollution. However, plants may re-establish when the petroleum derivatives have decomposed (Wilber, 1969).

Petroleum compounds have the potential to adhere to the epithelial cells of the gills of fish and interfere with normal respiration. Under conditions of relatively mild pollution, the mucus which is produced by fish as a defensive mechanism may remove the oil. However, in heavy pollution, this mechanism is inefficient and the oil tends to accumulate on the gills and smother the fish (Wilber, 1969). Petroleum compounds sinking to the bottom may destroy benthic organisms. Petroleum products contain soluble materials which can be ingested by fish and, thus the flavour of the fish flesh may become tainted, or if ingested in enough quantity, depending on the toxicity of the water soluble fraction, death may occur (Wilber, 1969).

If sufficient oil is present as a pollutant, it acts like other organic substances and tends to deoxygenate the waters (Wilber, 1969).

Proposed Measures to Reduce Concerns Related to POL Storage and Handling

Care will be exercised in the handling of all POL products. To prevent a release of petroleum from POL sites temporary containment areas will be constructed to trap accidental spillage. New and waste POL will be stored in areas providing adequate spill containment. Field containment areas will be constructed using an impermeable liner with berms to provide spill contaminant for approximately 110% of stored volume. The liner will be covered with an absorbent pad and additional absorbent material maintained at the site to assist in spill clean-up.

Refuelling will be carried out over similar liner material with an absorbent pad to contain potential spills when possible. During periods when construction vehicles are not in use, drip pans will be placed under common leakage points, where practical.

Containment will also be provided for bulk refuelling areas. Personnel will be trained in the proper handling of petroleum to prevent common problems such as spillage from tank overfilling. All petroleum storage tanks will be checked for leakage regularly to identify potential problems before they can occur. All storage, containment, handling, and refuelling sites will be maintained at a minimum distance of 75 m from watercourses.

If a spill occurs, the emergency response process will involve two main forms of action: immediate; and post-emergency actions. The immediate action will be taken by properly equipped emergency response personnel at the site. Obviously contaminated soil will be cleaned up immediately. The contaminated soil will be removed and placed in appropriate storage containers for subsequent disposal. Emergency personnel will be informed of the incident if the volume spilled is over the required reporting threshold limit. Action plans will be guided by the ***Contingency Plan Criteria for Releases of Dangerous and Hazardous Wastes*** (NSDOE, 1990), the ***Dangerous Goods Initial Emergency Response Guide*** (Transport Canada, 1992), and the ***Manual for Spills of Hazardous Materials*** (Environment Canada, 1984).

Post-emergency action will involve sampling of soil and surface water in nearby watercourses for the contaminant(s). All contaminated soil will be removed and disposed of in an approved manner, depending on the type and concentration of the contaminant(s). In the event of a spill, the appropriate agencies will be notified as part of the initial emergency response.

Significance of Residual Effects

As indicated above there is potential for the release of petroleum compounds into the environment to result in significant adverse impacts. The likelihood of such releases will be reduced to acceptable levels through the incorporation of the identified mitigative measures.

8.1.10 Visual Resources

Blue Mountain Hill (a Crown block of land located within the study area) has been identified as a potential visual resource. No other visual resources have been identified along the route. The proposed highway traverses the lower northern side of Blue Mountain Hill and, therefore, it is not expected that the visual appeal of the resource will be significantly affected by the Project. Depending on the final design and vertical alignment of the highway, some opportunities may be presented for the enhancement and/or development of scenic look-offs, especially of the Blue Mountain Hill area.

8.2 Impacts Upon the Socioeconomic Environment during Preconstruction and Construction

Development/construction activities required by the proposed Project and the sensitive aspects of the socio-economic setting for these activities are described in this section in order to identify potential environmental effects. Potential negative effects are described in the context of proposed mitigation.

Potential concerns related to construction include:
- land use;
- property values;
- economic activity; and
- safety.

8.2.1 Land Use

As described in Section 6, the existing and future land use in the study area is designated as ‘Mixed Use’ and ‘Rural Resource’ with small areas at the east and west ends of the corridor designated as ‘Residential’. The ‘Mixed Use’ and ‘Rural Resource’ designation recognizes the semi-rural development characteristics, particularly a traditional mix of low density residential, home business and resource uses, and provides for community uses and facilities. ‘Mixed Use’ also provides for a limited amount of commercial and industrial development.

Impacts of the proposed highway on existing and future land use will include residential development, resource land use and recreational land use. The following sections describes impacts to existing and future land use, including the effects of fragmentation of landholdings.

Development: Severance of properties, resulting from highway construction, may where warranted result in the construction of parallel access roads as part of the Project to lands that presently have no or limited access. This increased access is a benefit to property owners. The consequence will be an opportunity for increased residential development, however, it is not expected that the Project will result in a substantial shift from expanding development from the existing subdivisions.

Severance of properties can also result in a negative impact to developers and communities that wish to expand existing subdivisions across and into properties which the proposed RoW will cross. The proposed highway will affect the future development of Piercey Investors Limited's subdivision, Sheldrake Heights, due to fragmentation of properties. In particular, it will affect the future expansion of Merganser Avenue and Maple Lake Road.

Without the proposed highway, Maple Lake Road and Merganser Avenue would likely have been extended towards Haliburton Heights and Haliburton Hills subdivisions, and connected to other roads during future phases of the Sheldrake Heights subdivision, making the existing Sheldrake Heights the initial phase of a larger subdivision. With the proposed Highway 113, Merganser Avenue and Maple Lake Road will remain cul-de-sacs, somewhat isolated from the larger developments.

Resource: Current and potential resources in the study area include forestry and aggregate production. As with the residential development, the improved access to lands that presently have no or limited access will result in a benefit to forestry operations in the area. However, fragmentation of land, due to the construction of the proposed highway, may adversely affect forestry operations wishing to expand across the proposed RoW. Currently Barrett Lumber Company Ltd. (BLC) is actively harvesting near the proposed alignment near Ash Lake/Ragged Lake. The proposed alignment runs across BLC land. A negative impact to BLCs wood harvesting operation will result due to the severance of the land.

There is no aggregate production within the study area however the development of rock crushing operations is a possibility given the area's geology. Due to the potential for aggregate production, on-site rock crushing operations may be used during the construction of the Highway 113. Asphalt and concrete plant operations may locate in conjunction with the aggregate facilities, due to the availability of the resources used in these manufacturing processes.

The development of gravel pit and quarry and crusher operations may be encouraged in areas of high aggregate potential due to the additional access the construction of the Highway 113 will provide.

Recreation: The use of hiking trails, ski trails, and canoe routes will be will be affected by construction of the proposed alignment. Construction activities will interrupt use of the trails and canoe routes unless mitigative measures are incorporated into the Project. In addition, recreational fishing and hunting success is expected to diminish in immediate proximity to the construction activities.

NSDNR states that Blue Mountain Hill is a popular destination for hikers. The recreational values, including visual resources, of the Blue Mountain block of land have been promoted in Hiking Trails and Canoe Routes in Halifax County (Canadian Hostelling Association - Nova

Scotia, 1977). The construction of the proposed alignment, which will run along the north of Blue Mountain, will cut off existing access to hiking trails in the area, although access can be gained from other directions.

NSDNR and Canoe Nova Scotia identified Maple Lake and Frasers Lake and the brook between the two lakes as a well used canoe route. The canoe route will be crossed by the proposed highway between Maple Lake and Frasers Lake.

A walking trail to Maple Lake from Maple Lake Road is used by Sheldrake Heights subdivision residents. The trail is located on a combination of both public and private lands. The new highway will cut off current access from the end of Maple Lake Road to Maple Lake. Replacement access to the Maple Lake area will be provided by the connector road from Trunk 3 to be built as part of the Project.

Sport Nova Scotia indicated that without proper mitigative measures many extensively used cross-country ski trails will no longer be accessible due to the construction of Highway 113. Additionally, access roads from construction may provide an increase in access to recreational areas. However, people who traditionally enjoyed the area may be affected by the potential increase in recreational use of the area.

Mitigative Measures to Reduce Impacts to Land Use

Development: Mitigative measures to reduce negative impacts due to land fragmentation may involve compensation to the land owners, as discussed in Section 10.

Resource: Mitigative measures to reduce negative impacts due to land fragmentation may involve compensation to the land owners, as discussed in Section 10. However, depending on the final design of the highway, access may be provided to all properties utilized by forestry harvesting operations.

Recreation: Depending upon the final design and vertical alignment of the highway, some opportunities may be presented to mitigate the impact the proposed highway may have on the visual resource of Blue Mountain. The final design of the proposed highway will follow the natural contours of the area as much as practical. Clear cutting of the RoW will be limited to the amount needed for construction and operation of the highway. These mitigation measure will help better blend the highway into the natural environment of the Blue Mountain area.

To mitigate the impact to the use of the canoe route between Maple and Frasers Lake, a bridge or culvert with adequate clearance for canoeists during the high water season, will be constructed across the brook connecting Maple and Frasers Lake. This crossing will be part of the final design of the proposed highway to allow canoe travel during operation of the proposed highway.

To mitigate the impact to the use of hiking and ski trails during construction, access (via culvert or similar crossing) will be provided, where feasible and/or practical, across the proposed alignment at select areas, for example Blue Mountain Hill and Maple Lake. The access will be constructed to ensure continued year round use of the trails after construction. All existing trails will be identified and their use evaluated during the detailed surveying to be completed prior to final design.

The use of hiking and ski trails, including the walking trail to Maple Lake, and the canoe route between Maple and Frasers Lake will likely be closed-off during some stages of construction activity due to safety reasons (*i.e.* during blasting). However, this will only be for short durations while construction activity is within the immediate vicinity of the trail or route.

Significance of Residual Effects

Significant residual adverse effects to land use are not likely with proper implementation of the mitigative measures or compensation to affected parties.

8.2.2 Economic Activity

The construction activities are anticipated to last for approximately 3 years. Construction will generate local employment (labourers, operators, road safety personnel, etc.) for the duration of activities. This employment will be a positive impact for the local community.

Traffic will continue to use regular travel routes during construction of the proposed alignment, and therefore, most businesses will not experience a decline in activity. A increase in traffic due to construction is predicted to occur. Construction activities will likely create an increase in commercial activities related to demand for local suppliers of goods and materials (trucks, aggregates, lumber, rentals, etc.) as well as meals. The overall impact of construction on commercial activities is predicted to be positive.

8.2.3 Safety

Construction of the highway, including the road and structures, will cause an increase in traffic through the various communities adjacent to the proposed highway. Much of this traffic will consist of employee cars and trucks, utility vehicles, heavy trucks, and machinery moving slowly and turning often. In addition, detours will be required on existing roads for the construction of structures and interchanges. These detours will require interruption of existing traffic flow patterns.

Mitigative Measures to Reduce Safety Concerns

Existing and well established traffic safety procedures including, warning signs, flagging, and speed reductions, will mitigate any potential increase in danger related to construction traffic. In addition, warning signs will be established along hiking and ski trails and canoe routes in the area during construction.

Significance of Residual Effects

No significant adverse residual effects to public safety are likely due to construction of the highway.

8.3 Impacts Upon the Biophysical Environment during Operations

Highway 113 will operate throughout the year. Traffic will move along the highway at relatively high speed (up to 110 km/hr). Stopping areas are not anticipated to be designed into the facility, however, there will be connections at Highways 102 and 103, Kearney Lake Road, and Trunk 3.

Before discussing the potential effects of the operation of the proposed Project on the environment, it is relevant to consider the null hypothesis for the Project. The null hypothesis suggests that the Project not take place and that the current ownership patterns remain. Currently, the route alignment is split between private and crown land. The lands now owned by the Crown are managed as undesignated lands. It is possible that in the future much of the Crown land along and near the alignment will be divested to private owners. Private land management practices ensure that the land, in many cases, is managed for the benefit of the owner.

8.3.1 Air Quality

The level of pollutants at any point in the environment at any particular time are determined by source emission rates, dispersion characteristics, and removal rates. Atmospheric emissions near highways are predominantly due to vehicle exhaust although suspended particulate matter may also be increased by passing traffic.

Typical sources of highway related pollutants are listed below, from Hamilton and Harrison (1991):

- Carbon Monoxide (CO) - vehicle exhaust;
- Sulphur Dioxide (SO_2) - vehicle exhaust;
- Nitrogen Oxides (NO_2 and NO_x) - vehicle exhaust;
- Lead Compounds (Pb) - vehicle exhaust;
- Volatile Organic Compounds (VOC) - vehicle exhaust, crankcase blow-by, fuel tank evaporation, carburettor;
- Heavy Metals (Zn, Cd, Ni, Cr, and Fe) - component wear, auto body deterioration, brake linings;
- Polycyclic Aromatic Hydrocarbons (PAH) - vehicle exhaust, roadside burning;
- Total Suspended Particulates (TSP) - smoke, dust;
- Other vehicle compounds (brake fluid, antifreeze, lubricating oil, engine oil, grease, etc.); and
- Compounds used for highway maintenance (salt spray, herbicides, etc.).

Deposition of the above-mentioned pollutants can result in impacts to surface water, dust, and soil. Re-suspension by the passing vehicle results in continuous redistribution on and near the highway.

In addition, wash-off resulting from rainfall and snowmelt tends to remove contaminants from the highway but at the same time furthers the distribution process and increases the affected area.

The process of emission - dispersion - deposition - removal is extremely dependant upon local conditions, including wind, weather, temperature, fuel consumption, etc. and can vary greatly over space and time. As a result pollution levels can vary as well. Table 8-4 presents typical values of pollutant levels in the highway environment.

Pollutants emitted directly from motor vehicles are termed "primary" pollutants. Primary pollutants include compounds previously mentioned such as CO, SO_2, NO_x, VOCs, dark smoke, lead, and particulate elemental carbon (PEC). Most of the primary pollutants are transformed in the atmosphere, through a series of physical and chemical reactions, to other different "secondary" pollutants. Secondary pollutants include substances such as photochemical air pollution (smog), ozone, and various nitrogen and sulphur compounds.

Certain pollutants are so pervasive that they are present even in the most remote areas such as the high Arctic. Six have been designated "criteria" pollutants: TSP, CO, SO_2, NO_2, Pb, and photochemical oxidants (O_3). Following is a brief explanation of the criteria pollutants which may pose concern along the proposed route:

8.3.1.1 Total Suspended Particulates (TSP)

Total suspended particulates (TSP) are solid or liquid particles which tend to suspend in air. In many cases these particles can be respired into the lungs. TSPs consist of a wide variety of compounds ranging from dust to PAHs.

During highway construction, operation, and maintenance, dust and smoke are suspected of being the largest contributors to total TSP levels. Particulate emissions from diesel and gasoline powered vehicles have been shown to be a cause of the soiling of buildings. Usually, this is manifested by visible streaking on the sides of buildings caused by the redistribution of soot by rainwater. Concrete walls tend to become unevenly, and hence more obviously, discoloured because of the high water absorption properties of concrete which inhibits washing of the entire surface. Subjective observations in Britain, France, and Sweden, have indicated that serious disfigurement of building facades can occur within ten years, depending on building type, material, and levels of pollution.

The acceptable annual mean concentration of 70 micrograms per cubic metre (µg/m^3) and the acceptable 24-hour mean limit of 120 µg/m^3 are set by regulatory agencies. TSP levels vary greatly between locations, dependent upon climatic and weather conditions, wind conditions, and activities in the surrounding areas. For example, in 1989, the annual geometric mean for Halifax was 35 µg/m^3 while in Charlottetown it was 22 µg/m^3. TSP levels in rural undeveloped areas, not influenced by commercial or farm activity, can be expected to range between 15 and 35 µg/m^3. In June, 1991, 24-hour sampling conducted at Alma and Greenhill, Nova Scotia, revealed TSP levels ranging between 13.2 and 95.6 µg/m^3 (JWEL., 1991). The 95.6 µg/m^3 reading was recorded at the Irving Station in Alma next to the existing 104, a two lane highway.

In all likelihood, TSP levels in the Highway 113 study area will fall in the range of typical values for rural/suburban area (15 µg/m^3) and those recorded at Highway 104 (95.6 µg/m^3).

TABLE 8-4
Typical* Pollutant Levels in the Highway Environment

Pollutant	Typical Level
Total Suspended Particulates (TSP) (airborne)	100 µg/m^3
Total Suspended Solids (runoff)	100 g/m^3
Particulate Elemental Carbon (PEC) (airborne)	3 µg/m^3
CO	2 mg/m^3
SO_2	60 µg/m^3
NO_2	50 µg/m^3
NO_x	150 µg/m^3
Total Hydrocarbons	1500 µg/m^3
VOC	500 µg/m^3
Zinc (Zn) in air	0.1 µg/m^3
Zn in dust	350 µg/g, 20 mg/m^2
Zn in stormwater	100 mg/m^3
Copper (Cu) in air	0.1 µg/m^3
Cu in dust	60 µg/g, 3 mg/m^2
Cu in stormwater	50 mg/m^3
benzo (a) pyrene (PAH (BaP)) in air	2 ng/m^3
benzo (a) pyrene in dust	0.5 µg/g
benzo (a) pyrene in stormwater	0.1 mg/m^3

* Specific site details related to the values that were measured are unavailable.
Source: Hamilton and Harrison, 1991.

8.3.1.2 Carbon Monoxide (CO)

It is estimated that the greatest single source of carbon monoxide in Nova Scotia is gasoline powered vehicles (NSDOE, 1995). A review of 1995 CO monitoring data from downtown Halifax (Barrington St.) indicate that levels were within desirable levels. One-hour and 8-hour maximum levels are below 5 ppm, compared to the 1-hour objective of 31 ppm and 8-hour limit of 13 ppm. An annual objective for CO has not been adopted by the Province. A lack of data regarding 8-hour and 1-hour mean concentrations makes it difficult to predict whether CO target values will be exceeded.

8.3.1.3 Sulphur Dioxide (SO_2)

Sulphur dioxide originates from a variety of sources including coal-burning and oil-fired thermal power plants as well as vehicle emissions. The acceptable annual mean and 24-hour mean concentrations of SO_2 have been set at 60 and 300 µg/m^3 respectively. SO_2 concentrations throughout the Maritimes generally range between 0.1 and 7 µg/m^3.

8.3.1.4 Nitrogen Dioxide (NO_2)

Gasoline combustion is the single largest source of nitrogen dioxide. Other sources include combustion processes such as wood burning and power plant operation. The annual mean and 1-hour mean acceptable concentrations for NO_2 are 100 and 400 µg/m^3, respectively. Previous reports have shown that NO_2 levels vary greatly throughout the region, averaging below 10 µg/m^3 at Shearwater and less than 30 µg/m^3 at Halifax.

A review of 1994 NO_2 monitoring data from downtown Halifax (Barrington St.) and CFB Shearwater indicate that ambient levels (4 to 8 pphm) were well within acceptable levels (21 pphm) on an hourly basis. The CFB Shearwater site represents a non-urban environment where vehicle emissions were not as significant a factor on local air quality. Annual levels at both sites are typically below 2 pphm, below the acceptable level of 5 pphm.

The long term trend for NO_2 levels in the Halifax-Dartmouth area is relatively constant and well within the desirable range (NSDOE, 1994).

8.3.1.5 Lead (Pb)

There is some indication that lead pollution in ambient air is fairly well under control. The phasing out of leaded gasoline has greatly reduced the amount of lead in the air. Lead from past pollution persists in many parts of the environment.

8.3.1.6 Ozone (O_3)

Ozone, a secondary pollutant, is created by a variety of pollutants when they interact with sunlight. NO_x and hydrocarbons from a variety of sources, including vehicle emissions, combine in air to form O_3 which can be transported by prevailing winds or lie relatively stagnant in a particular area. High concentrations can cause plant damage and deterioration of a variety of building materials. The acceptable 1-hour mean concentration is 160 µg/m^3.

8.3.1.7 Associated Concerns

Several issues are prevalent with respect to air quality issues and may arise as a result of the proposed highway operation and maintenance activities.

The first relates to airborne releases from vehicle traffic. One of the VECs identified was air quality in the immediate environs of the proposed alignment. Wanner (1990) measured air pollutants in the vicinity of a four lane highway with a traffic volume of 22 vehicles per minute. Measured concentrations decreased with distance from the highway. Reported concentrations of nitrogen dioxide, which is regulated by NSDOE, are presented here for comparison. Wanner reported concentrations of nitrogen dioxide ranging from 50 ppb at the centre line to 20 ppb at 80 metres. Another recent EIA of a proposed highway in Nova Scotia used a modelling approach to predict concentrations of airborne pollutants along a proposed highway corridor (P. Lane Associates Ltd, 1990). The proposed traffic volumes were lower than those reported by Wanner, as will be the proposed Highway 113 traffic, and the calculated concentrations were proportionally lower. In addition, reduced grades and higher speeds, when compared to Hammonds Plains Road and Trunk 3, will lead to an reduction in vehicle emissions.

In view of this information, significant adverse impacts on local air quality from the operation of the proposed facility are not likely.

8.3.2 Traffic Noise

Section 6.0 summarized general ambient noise levels from a variety of sources and CMHC, NSDOE and FHWA noise guidelines.

Identifying traffic related noise impacts involves predicting noise levels at noise sensitive sites. Due to the timing of the environmental registration (*i.e.*, 10 to 15 years in advance of highway construction) noise sensitive sites were impossible to predict, especially in view of the continuing area development.

Although it was impossible to predict noise sensitive areas within the proposed alignment study area, general traffic noise factors and levels are discussed. The following factors directly affect the amount of traffic noise a person hears:

- number of vehicles;
- percent of heavy vehicles;
- traffic speed;
- vehicle slow downs, stops and acceleration;
- road gradient; and
- road surface.

The following list summarizes the general noise levels generated by traffic at different distances from the source obtained from the ‘Road Traffic Noise Effects on Housing’ published by CMHC. This summary assumes a straight and level road on the same grade as the surrounding land with an average daily traffic volume of 20,000 veh./day, a traffic speed of 110 km/hr, uninterrupted traffic flow, 16 to 21 percent heavy vehicles and more than half the ground surface between the source and receiver as “soft” (*e.g.*, planted with grass, shrubbery or other dense vegetation). The values are A-weighted noise levels expressed in dB.

Distance	Noise Level
30 m	73 dB
50 m	66 dB
100 m	60 dB
200 m	54 dB
500 m	48 dB

Currently, the closest home to the proposed highway is 200 m from the centerline of the highway and separated by a forested area. As shown above the proposed highway would cause a typical noise level of 54 dB which is within CMHC, FHWA and NSDOE noise guidelines, although levels in excess of 54 dBA should be expected at some times.

Potential impacts from noise have been discussed previously, related to construction, which is also relevant to overall operational noise considerations. With respect to noise associated with the operation of the proposed highway, no significant impacts are expected on wildlife.

Waterfowl and other birds have been documented to use a highway RoW for many life cycle components (Leedy, 1975; United States Department of Transportation, 1982). These include potentially sensitive stages such as nesting. It is anticipated that utilization of the habitat available within and adjacent to the proposed RoW will occur, as it has along the other highways. However, with respect to highway operation activities such as roadside maintenance, there is potential to adversely affect species using low level RoW vegetation during sensitive periods (*i.e.*, nesting).

Proposed Mitigation of Effects related to Traffic Noise

If noise levels are predicted to approach or exceed guideline values for noise sensitive sites over the design life of the highway, consideration will be given to attempting to reduce the noise levels where possible. Reductions could be incorporated into the highway design by using earth berms where possible and/or depressing the highway in the noise sensitive areas. Even so, it is almost certain that there will be an increase in noise in areas near the proposed highway.

To accommodate the noise concerns of the public, TPW retains a buffer of existing vegetation, where possible, between new transportation projects and existing developments that occur prior to identification of a transportation corridor. TPW states that a minimum 25 m buffer will be preserved within the Highway 113 RoW.

Mitigative measures will be adopted to minimize potential impacts on waterfowl and other birds utilizing low vegetation cover within the RoW during sensitive periods. RoW maintenance procedures (*e.g.*, vegetation management activities and other maintenance requirements) will include:

- scheduling maintenance activities so that they are conducted during the summer and fall periods, after eggs have incubated and young birds can mobilize; and
- adherence to vegetation management practices that result in the least disturbance to the RoW vegetation.

With these measures in place, no significant impacts are expected on nesting waterfowl and other birds. As with construction activities, no significant adverse effects to wildlife are likely due to operations-related noise.

Significance of Residual Effects

It is unlikely that significant residual adverse effects due to noise will occur with proper implementation of the mitigative measures. TPW will conduct baseline noise monitoring along the proposed highway alignment and near adjacent developments prior to construction.

8.3.3 Impacts to Water Quality

In general, highway operations can impact water resources in terms of both quality and quantity. Following is a summary of the potential impacts.

Stormwater runoff, infiltrating surface water, and groundwater recharge subject to highway related activities may contain a variety of pollutants, many of which were described earlier. Activities such as construction (siltation), operation (accidents), and maintenance (de-icing chemicals, herbicide, and/or pesticide use) of highways can contribute significantly to the degradation and impairment of the quality of surface water and groundwater resources.

As a result of the activities mentioned above, many chemical substances, in addition to the ones listed earlier, can find their way to water supplies used for human consumption and other uses. One of the major problems with this type of pollution is that once a water resource is impacted it is extremely difficult and expensive if not impossible to remediate.

Proposed Measures to Mitigate Impacts to Water Quality

The Canadian Drinking Water Quality Guidelines (1996) were prepared by the Federal-Provincial Sub-committee on Drinking Water of the Advisory Committee on Environmental and Occupational Health under the authority of the Minister of National Health and Welfare. Other guidelines for Canadian water quality have been prepared and published by the Canadian Council of Ministers of the Environment (CCME) and Environment Canada. These guidelines cover added water uses including recreation, agriculture, and freshwater aquatic habitat. The guidelines limit the concentrations of several contaminants, above which water is unusable for particular purposes.

Mitigative measures designed to lessen the impacts to surface water and shallow groundwater supplies, centre around trying to control highway runoff in terms of amount and destination. This includes ensuring that runoff is properly controlled by the highway drainage system and that runoff is released to watercourses that are capable of assimilating the pollutant concentrations.

Nonetheless, shallow dug groundwater supplies may experience seasonal variations in parameters such as chlorides (caused by salt runoff), however these variations are usually short in duration and quality is restored quickly by natural flushing actions.

Deeper bedrock water supplies polluted by highway runoff may require modification, replacement, relocation, or treatment. Shallow fracture systems may flush relatively quickly similar to that experienced in shallow dug wells.

Additional mitigative measures to decrease the potential for significant adverse impacts to water quality, include:

- channelling highway runoff to appropriate discharge locations;
- limiting the use of chemicals (including de-icing chemicals, pesticides, and herbicides) to a minimum; and
- implementing those measures identified earlier to mitigate the potential effects of accidental releases of hazardous material, as appropriate.

Seasonal changes in surface water quality can be expected because of the use of highway de-icing chemicals. These changes typically peak during the spring thaw when runoff is greatest. Little can be done to remediate groundwater changes due to contaminated runoff except to remove any sources of contamination (*e.g.*, on-site remediation of chemical spills or use of alternate de-icing chemicals). Residual impacts could include temporary or permanent destruction of habitat and the resulting loss of aquatic resources.

Significance of Residual Effects

Provided the mitigative measures identified above and those identified for highway pre-construction/construction are implemented as appropriate, no significant adverse impacts to water quality are likely.

8.3.4 Habitat Loss

Consideration has been given to the potential impact of operation on both terrestrial, aquatic habitat and wetland habitat. Consideration with respect to these environments are discussed below.

8.3.4.1 Terrestrial Habitat

There is concern for the potential interference with periodic movements of wildlife currently using habitat along the proposed alignment. A variety of animals may migrate across considerable distances to reach required seasonal life cycle requisites of habitat. The location of the highway is the principal consideration determining whether certain populations of animals will be affected (American Association of State Highway and Transportation Officials, 1975; United States Department of Transportation, 1982). The potential impact of a highway on large mammal abundance and distribution and the relationship between their activity and automobile collisions, are functions of highway location relative to the species requisites, other than the RoW (Leedy, 1975). Placement of a highway such that it becomes an obstacle to free movement relative to critical areas of heavy wildlife use, such as forage, areas providing seasonal cover, and travel routes to and from these areas, can lead to animal mortalities (Shulinder et al., 1979a).

Areas of potential wildlife concentration identified along the proposed alignment are of concern. Although deer and moose may be found along the proposed alignment, critical habitat such as deer wintering areas are not found within the study area. It was reported by NSDNR that a major mammal travel corridor exists between Maple Lake and Hammonds Plains Road, outside the study area. NSDNR also reports a large number of deer road kills on Highway 103 near Exit 4 and on Kearney Lake Road.

Although construction of the proposed highway has the potential to create adverse impacts associated with interference with wildlife movement and wildlife/vehicle collisions, specific mitigative measures are not warranted at this time. Wildlife populations can fluctuate a great deal over a period of 10 to 15 years, the anticipated time before construction begins. TPW will consult with NSDNR prior to construction to assess wildlife populations in the area. Specific mitigative measures may be warranted at that time based on those consultations.

8.3.4.2 Aquatic Habitat

The stream crossings required for the Project and the general habitat for each crossing have been defined in earlier sections. Precise locations of the stream crossings will be defined during the final survey of the route. Irrespective of the specifics of each stream crossing, in those crossings where culverts are used rather than bridges, there will be a potential for loss of natural stream habitat which can only be considered adverse under the no net loss provisions of the ***Fisheries Act***. The significance of this loss can be determined from the relative magnitude of the habitat loss in the context of available stream habitat and whether or not the potentially lost habitat is critical for the support of stream populations.

Given that stream habitat surveys have been conducted on probable locations and that the final locations can only be defined during final design and survey, there is some uncertainty regarding the potential for identification of potentially critical habitat. The level of uncertainty has been reduced somewhat by the absence of critical habitat in any of the stream sections surveyed thus far, however some level of uncertainty remains.

Finally, it has been demonstrated clearly that stream crossings can be designed and constructed without significant damage to the environment if appropriate guidelines are followed (Graynoth, 1979). The potential for mitigation of any identified significant adverse impacts is large and would include route adjustment and/or specific construction practices.

Given the relative scale of the Project and the area of habitat to be removed, no significant adverse effects of habitat loss on the resident biota are likely. Nonetheless, there may be a requirement for remedial actions to be implemented in the case of damage to or loss of fish habitat. These actions could include stream modifications or improvements, including:

- installation of open bottom culverts and stream bottom creation;
- in-stream debris removal;
- installation of digger logs or gabion deflectors;
- installation of in-stream catchment basins;
- pool creation;
- installation of rip-rap; and
- planting of stream-side vegetation.

Remediation, including habitat restoration, must be designed for specific stream sections and associated habitats. When final route location is determined, detailed measures can be designed, with approval from DFO, for incorporation into the Project, if necessary.

8.3.4.3 Wetlands

It is TPW's practice to avoid wetlands, where possible and to apply compensatory mitigation for habitat loss, if necessary.

The goal of mitigation is to replace, as near as possible, the ecological functions which are provided by the wetland area and are unavoidably lost through Project activities.

Detailed field investigations will be undertaken again, following final alignment selection and prior to construction, to characterize the wetland habitat and function presented by each affected wetland and any changes from the information contained in this report. That information will be used in determining the necessary mitigation/compensation.

There are various measures appropriate for compensatory mitigation for habitat loss in the study area (Lowry, 1990; Kruczynski, 1990):

- restoration/re-establishment of a wetland in an area where it has historically existed, but which now performs no, or few, wetland functions;
- creation - construction of a wetland in an area which was not a wetland in the recent past; and
- enhancement - increasing one or more of the functions of an existing wetland.

The choice of which option to employ depends on site-specific characteristics of available locations. The choice will be based on consideration of factors that limit the ecological functioning of the system affected (Kruczynski, 1990).

Wetlands naturally change in size, community structure, and in locality in response to several natural influencing factors. It has been suggested that the design of mitigative measures include compensatory wetlands of a greater size than the area affected in expectation of these changes in created, restored, or enhanced wetlands (Willard and Hiller, 1990; Kruczynski, 1990):

- restoration ratio of 1.5:1;
- creation ratio of 2:1; and
- enhancement ratio of 3:1.

Under the ***Environment Act***, TPW will apply for and receive a Water Approval for each proposed wetland crossing prior to the start of construction. To minimize wetland disturbances, all construction activity will be conducted in accordance with the Watercourse Alterations Specifications and other stipulations which may be made by regulatory agencies in certain circumstances.

8.3.5 Rare Plants

There were no identified plants of special status adjacent to the proposed route and therefore no significant impacts associated with operations are not predicted.

8.3.6 Reduction in Species Diversity

There is no anticipated reduction in species diversity or food web disruption associated with the operation of the facility. Food supplies for all animals identified along the corridor will remain intact. Therefore, no significant adverse impacts are likely.

8.3.7 Habitat Effects

Habitat types considered here include critical wildlife habitat and environmentally significant areas. These are considered in terms of increased access to the area. With the lack of critical or unique habitat in the study area, significant adverse effects are unlikely.

8.3.8 Discharges to the Environment

In addition to air quality issues, as discussed, there are several other potential sources of discharges to the environment due to the operation of the highway. These include erosion and sedimentation associated with watercourse crossings and accidental spills.

Recommendations for design and installations for stream crossings have been described in the preceding sections. This information indicates that there will continue to be a risk of uncontrolled release of sediments from stream crossings until such time as the soils in the vicinity of the crossing are stabilized.

The likelihood of a continuing impact can be significantly reduced by proper construction practices and regular monitoring of the stream crossings throughout the life of the Project.

The operation of the highway will result in increased public access to the area, with an increased potential for associated pollution from accidental spills. It has been concluded that these potential problems will be adequately addressed by mitigative measures identified in preceeding sections of this report, effective communication and education of users, local residents, and emergency response crews.

Provided the mitigative measures identified above, and those identified for pre-construction/ construction are implemented as appropriate, no significant adverse impacts resulting from discharges to the environment are likely.

8.3.9 Obstruction of Fish Passage

Fish passage will be considered throughout the Project in the location and design of watercourse crossings. The recommended construction practices will limit the potential for obstruction of fish passage. The proposed location and construction practices for any required major bridges along the route will prevent obstruction of fish passage. As discussed above, all stream crossings along the route will be monitored regularly so as to ensure that adequate passage is maintained. Significant adverse impacts to fish passage are unlikely.

8.3.10 Effects on Human Heritage/Archaeological Resources

Two areas of elevated archaeological potential were identified, however the risk to archaeological resources has been determined to be low, if construction-related mitigation described earlier is enacted.

8.3.11 General Negative Effects on Environmental Quality

The most serious threat to environmental quality is associated with uncontrolled use or activities in the environment. For example, it is difficult to enforce regulations regarding fishing, hunting or forestry practices in areas where accessibility is restricted. The operation of the highway may in fact result in improved environmental quality due to increased opportunities for enforcement of regulations and practices in the vicinity of the highway, including the numerous lakes, streams, and trails on adjacent lands.

8.3.11.1 Increased Fishing Pressure

There is existing access to the area via a variety of roads and trails. The proposed Project will increase the access to the lakes and streams in the area with the attendant potential for increase in angling pressure. The potential increase in angling pressure will primarily be felt on the brook trout populations. The effect of angling pressure on brook trout populations has been reported by Varley (1984). Varley reported that brook trout are among the most susceptible of salmonids to angling pressure. For example, twenty hours of fishing per hectare per year resulted in removal of 50 per cent of catchable trout in a population. This indicates that relatively low fishing pressure has the potential to significantly reduce brook trout populations. The existing angling pressure in the area has not been determined, however given the access which is currently available, this pressure could be significant.

It is suspected that many of the trout sampled in electrofishing associated with this Project, and with historic netting operations were of hatchery origin. Wild trout production in waterbodies of the area would be severely limited by existing nutrient-poor and acidic water chemistry, poor physical habitat quality, and the presence of competitive fish species. Ongoing trout stocking in the lakes of this near-urban area will continue to provide the bulk of the trout angling opportunity.

Significant adverse effects are unlikely due to increased fishing pressure.

8.3.12 Atmospheric Condition

There is potential for micro-climate modifications in the vicinity of the Project due to the construction of large fills. Large fills can cause significant long-term blockage of sunlight in areas which can reduce the temperature of the ambient environment. This micro-climate modification can have impacts on light and temperature sensitive biota.

The most significant fill area within the proposed alignment is a 740 m section of highway surrounding Black Duck Brook with a maximum fill depth of 19 m. Due to the depth of fill and the horizontal positioning of the proposed highway in this location (northeast to southwest) this fill area is not expected to have a significant impact on the climate of the area.

8.4 Impacts Upon the Socioeconomic Environment during Operations

8.4.1 Land Use

Impacts of the proposed highway on existing and future land use will include development, resource and recreational. The following sections describes impacts to existing and future land use, including the effects of fragmentation of landholdings.

Development: Impacts to development as a result of operations and the associated mitigative measures are predicted to be similar to those as described for the construction phase. Significant effects are unlikely.

Resource: Impacts to development as a result of operations and the associated mitigative measures are predicted to be similar to those as described for the construction phase. Significant effects are unlikely.

Recreation: Impacts to recreation as a result of operations and the associated mitigative measures are predicted to be similar to those as described for the construction phase.

It was stated by TPW that access across Highway 113 to Maple Lake will be by way of the proposed Connector road overpass which will include a sidewalk for pedestrian movement.

If the proposed construction mitigative measures are implemented, no significant residual impacts are likely for recreational activities in the study area.

8.4.2 Property Values

8.4.2.1 Residential

There is one residential subdivision (Kingswood South) located immediately adjacent to the proposed alignment. Due to the residential growth in the area it is expected that with the probable construction of the highway, 10 to 15 years in the future, additional subdivisions will also expand to the boundaries of the proposed RoW.

Residential property values depend on a number of factors (including supply and demand), resulting in an inability to predict, with certainty, long-term impacts to specific properties. Compensation for affected properties is discussed in Section 10.0.

8.4.2.2 Commercial

Some commercial properties along Hammonds Plains Road may experience a decline in value resulting from a change in traffic patterns. Nonetheless, properties located at proposed intersections and interchanges may experience an increase in commercial value resulting from improved access and visibility. The increased access to Highway 102 and 103 for local commercial and industrial businesses is a benefit to property owners.

The overall long-term impact on commercial property values is predicted to be insignificant. Compensation for affected properties is discussed in Section 10.0.

8.4.3 Economic Activity

8.4.3.1 Employment

Operation and maintenance of the proposed Project will have a minor positive impact on the local economy by providing a slight increase in the number of jobs (required for highway maintenance) on an annual basis.

8.4.3.2 Commercial Activity

Existing businesses in the study area along Hammonds Plains Road, Kearney Lake Road, and Trunk 3 rely primarily on through traffic between the Highway 102 and 103 and local residents for sustained commercial activity. Local traffic is not expected to change however, the diversion of through traffic by the proposed highway, away from these businesses, may have a negative impact on commercial activity.

Location is critical to businesses that cater to through traffic (including tourists) and residents. The creation of interchanges and intersections with high visibility and improved access will provide the opportunity for relocation of existing or establishment of new service related businesses.

Construction of the Project will provide improved access to resource land that was previously, in some instances, too remote to develop. The result will be an opportunity for increased resource development. Nonetheless, it is not expected that the Project will result in a substantial change from existing resource development patterns.

Generally, it is predicted there will be a minor impact to the commercial activity reliant on through traffic. Compensation for affected properties is discussed in Section 10.0.

8.4.4 Transportation Linkages

Overall the impacts of the proposed Highway 113 upon the study area transportation system will be positive, due to the reduction of traffic and accident levels on Hammonds Plains Road and the increased safety and efficiency of travel to be provided by Highway 113.

8.4.4.1 Changes in Traffic Patterns

Local subdivision traffic patterns will remain largely unchanged in the study area. Local traffic will continue to use Hammonds Plains Road, but will experience improvement in traffic flow. This improvement will result because through traffic which presently uses Hammonds Plains Road to travel between Highways 102 and 103 will use Highway 113. Some commuter traffic generated from within the study area originating near the eastern and western access points of Highway 113 will travel on Highway 113 to benefit from the freer flow and higher speeds. Traffic which presently passes between Highway 103 along the South Shore and Highway 102 north of Bedford, will experience the most benefit from the shorter route, higher speeds, and freer flow along Highway 113. Commercial traffic travelling between Highways 103 and 102 will similarly benefit from the traffic improvements resulting from Highway 113.

Residents of the Sheldrake Heights subdivision were concerned about the amount of traffic, especially the potential for landfill bound truck traffic, on the proposed connector. Additional traffic modelling was undertaken by TPW in response to the concerns of Sheldrake Heights residents and to predict traffic volumes on the proposed highway and local roads. The traffic modelling indicated that the landfill, east of Otter Lake, appears to have very little effect on the Highway 113 traffic. The only area that would make beneficial use of the Highway 113 to travel to the landfill would be from around the Kearney Lake Road/Highway 113 interchange.

Vehicles that would use the new connector road would be many of the same vehicles that currently use the Sheldrake Lake Exit off Highway 103. These vehicle would be travelling to or from the Lewis Lake, Hubley and Timberlea areas. This confirms that the connector primarily serves area residents. Approximately 3,300 vehicles per day are expected to use the connector when the road opens. This volume is well within the capacity of the collector road.

Traffic modelling predicts that traffic on Trunk 3, on either side of the connector, will increase with the completion of Highway 113 in 2016 to approximately 2,000 to 2,300 vehicles per day, a volume well within the capacity of the Trunk highway. The modelling also predicts that traffic on Kearney Lake Road, from Highway 113 to the Atlantic Acres Industrial Park, in 2016, will increase from 6,560 vehicles per day without construction of Highway 113 to 8,500 vehicles per day with construction. A traffic volume of 7,700 vehicles per day is expected on Kearney Lake Road south of the Highway 113 interchange.

Approximately 12,000 vehicles per day currently travel on Hammonds Plains Road between the Highway 102 interchange and the Lucasville Road. Highway 113 will significantly reduce the through non-truck traffic on Hammonds Plains Road. Traffic modeling indicates that there would be up to a 6,500 vehicles per day reduction on portions of Hammonds Plains Road in the year 2016.

Access to Highway 113 is by way of the high speed “fly-overs” and the interchanges at Kearney Lake Road and the connector west of Frasers Lake. HRM has requested that provisions be made to incorporate a future interchange if the need arises (David McCusker, HRM, personal communication, 1999). Specifically, HRM feels that once construction of the proposed highway begins (10 to 15 years) there may be a need for an additional access interchange located in the vicinity of Kingswood. Such an interchange would require construction of a proper collector road to serve Kingswood and not a direct connection to subdivision streets. This interchange would introduce more local usage of Highway 113.

8.4.4.2 Traffic Speed, Level of Service and Safety

Improvements in travel efficiency will reduce the time required to travel the distance between Highways 103 and 102 by approximately 8 to 10 minutes per trip and through traffic will not have to travel into the central core of the HRM. In addition, there will be a reduction in traffic volume and an improvement in traffic flow along Hammonds Plains Road due to the change in the nature of the traffic (presumably, local with much less through traffic). Therefore, Highway 113 will not only provide a new facility with good safety performance but it will increase the safety performance of the existing facility, Hammonds Plains Road. It is not expected that travel speed will change along any of the local roads within the study area due to the construction of Highway 113. The traffic volumes will change on local roads as discussed above however, they are not expected to change within subdivisions in the study area.

8.5 Impacts of the Environment on the Project

In addition to the impacts of the Project on the environment (as described in Sections 8.1 to 8.4) there is an understanding that the environment also directly affects the Project. This is clearly demonstrated by the design considerations and mitigative measures employed to ensure that environmental impacts are eliminated or minimized throughout the construction and operation phases of the Project. Those measures are an example of how the environment directly modifies the Project. The other area where the environment may impact the Project concerns weather conditions along the proposed corridor and their impacts on driving conditions.

8.5.1 Impact of Weather on Driving Conditions

Weather has the potential to influence driving conditions by affecting safety through decreased visibility and traction leading to the increased possibility of accidents. The most common weather conditions that affects driving include snow, ice, rain, wind, and fog. The proposed route is located on the boundaries of the Eastern Nova Scotia climatic region. These regions are characterized by generally cool temperatures moderated by a strong coastal influence with high rainfall and frequent sea fog.

TPW adheres to a winter maintenance policy for 100-series highways that requires that the pavement is kept free of ice and snow (see Section 2.0). With the exception of occasions when maintenance equipment has yet to clear a road (*e.g.*, during a winter storm), the "bare pavement" policy minimizes most concerns related to ice and snow accumulation and its impact on driving safety.

Although in a coastal area, the proposed route is somewhat sheltered by the surrounding topography including numerous hills. In addition, the land adjacent to the proposed route is, for the most part, forested, and will likely remain so, thereby providing a windbreak in instances when it would be beneficial. Minor drifting of snow may occur within the RoW, but regular maintenance, as per policy, will ensure it does not impede traffic movement along the highway.

One of the greatest concerns to traffic safety along the highway may be fog. Nonetheless, the prevalence of fog in this area of the province is similar to conditions experienced in other parts of Nova Scotia. As with other weather conditions, such as rain, it is the responsibility of the vehicle operator to reduce speed in accordance with the driving conditions. With speed reduced as necessary, fog is not expected to impact driving safety.

Overall weather conditions are not expected to significantly impact driving conditions.

8.6 Cumulative Impacts

There is a potential for cumulative impacts associated with the Project. The approach taken to the consideration of cumulative impacts is presented below and is similar to that suggested in a guide to the ***Canadian Environmental Assessment Act***.

Cumulative environmental effects may be considered as those effects occurring when:

- the same type of perturbation occurs with such high frequency that the ecosystem cannot recover from separate perturbations (time crowding);
- the same type of perturbation occurs in locations close together so that effects overlap spatially (space crowding); and
- different types of perturbations, possibly from separate projects or activities, affect similar environmental components.

The potential for cumulative effects in the categories outlined above was considered for the VECs identified in Section 7.0. Cumulative effects were considered for activities which will be repeated during construction or operation of the facility and for activities which currently take place in the environmental setting of the Project and which will be increased by the construction or operation of the Project.

Many of the VECs are protected in some manner by existing federal or provincial legislation. Where specific legislation may not exist with respect to individual VECs, land use practices which pose the most significant threat to these VECs are controlled, as discussed below.

Air quality is monitored on a regular basis in various locations by the provincial government. There is no indication that ground level concentrations are of concern within the preferred corridor.

Groundwater is a concern in much of the Project area due to the reliance on domestic wells for water supplies. In certain locations, shallow springs may be used for water supplies. There have been local incidences of petroleum contamination in aquifers in NS; however, none have been identified during public meetings or discussions with regulatory agencies. Provincial laws, regulations, and guidelines exist for the protection of groundwater.

The majority of the highway alignment passes through forested areas. Forestry operations for pulp or saw logs are a common land use. A portion of the corridor also passes through suburban areas which have been identified for existing or future subdivision development. Forestry operations and residential development therefore place the greatest pressure on VECs within the area.

A portion of the alignment is located on crown land. The provincial government regulates cutting operations on crown lands. This regulation is enacted through requirements for annual cutting plans to be filed for harvesting on crown land. The province controls the level of cutting on designated areas such as deer wintering habitat and have established set back distances from watercourses. In addition, the province has exerted influence over cutting practices on much of the remaining privately owned forested land through agreements with landowners.

Forestry practices have also historically placed pressure on aquatic resources including anadromous fish populations. Particular concern has been expressed about the impact of stream crossings on populations, either from interfering with fish passage or from introduction of unacceptable levels of sediments into water courses. Fisheries and Oceans Canada has in place a "no net loss of fish habitat" policy which is effected through watercourse alteration permitting procedures of the provincial governments. In addition to these permitting procedures, the enforcement branches of both levels of government are vigilant in enforcing upon the regulations.

Other pressures on the natural populations of the Project area, including deer, bear, fish and other harvested resources, stem from the level of access to the resources which is currently in place. There currently is access to the area via a series of woods roads and trails. These routes are used by an unknown number of people for hunting, fishing and hiking. This level of access is accompanied by levels of hunting and fishing with attendant pressures on existing populations. Hunting and fishing pressure is controlled by bag limits in place for all game animals and fish. These limits are reviewed periodically based on information on the state of the resource, as well as any changes to the level of pressure from hunters and anglers.

The construction of the proposed Project will increase accessibility. This increased access has the potential to result in cumulative impacts to rare or endangered plants, fish populations and sensitive and critical habitats outside the study area. Increased access alone will not result in negative impacts, nor would such impacts necessarily be significant. The probability of such significant negative impacts is not possible to predict given the present state of information. Should the increased access result in increased fishing pressure, in addition to that already in place there will likely be a decrease in fish populations.

Accidental events have characteristically been identified as an area of concern with any Project assessed. The highest levels of concern have to do with uncontrolled release of petroleum compounds. While the potential for such releases relates to any operation (*e.g.*, refuelling of chainsaws), the magnitude of any effect relates to the sensitivity of the receiving environment and the quantity of materials released. There is increasing concern over such events in all facets of industry. Another area of concern regarding accidental events is related to fire prevention.

NSDNR, working in concert with the forest industry, has set aggressive fire prevention programs. Such programs and their adoption during construction will limit the potential for accidental fires.

8.6.1 Relationship Between Project-related Effects and Those of Other Activities

Due to practical limitations, no attempts have been made to quantify the extent of existing habitat alteration which has occurred within the study area from land use practices. Although the majority of habitat disturbance has been related to forestry operations and residential land development, other land uses are contributing to localized losses of habitat, both on a permanent and temporary basis. The majority of Project-related effects on wildlife habitat will be additive to those resulting from other existing land uses. This will result in a permanent, incremental effect on terrestrial VECs.

For short stretches of the easement, impacts from construction activities will overlap with those of other land uses, resulting in a combined impact zone which is larger than those of the individual projects (*e.g.*, where construction occurs next to forestry operations). Time crowding (*e.g.*, where impacts from one land use are not assimilated before the next occurs) is anticipated between the proposed highway and harvested forest areas. Regeneration of the harvested area will occur over time, therefore, it is not likely that significant adverse cumulative impacts will occur.

Most wildlife avoid open areas, preferring to move about under the concealment of forest cover providing protection against predation. Forestry operations involving clear cutting or selective cutting can result in large open areas which pose a significant barrier to wildlife movement. If forestry operations occur adjacent to the highway, typically the area harvested is much larger and more restrictive to wildlife movement. However, within two to three years of cutting, vegetative growth will reestablish sufficiently to provide suitable cover for wildlife movement in harvested areas. Therefore, it is not likely that significant adverse cumulative impacts will occur.

From a fisheries perspective, the degree to which land use activities have collectively impacted resident fish populations within the study area is less clear. It is likely that nutrient/contaminant contributions from runoff and wastewater have altered nutrient regimes within some of the watercourses. In addition, forestry operations are undoubtedly contributing to sediment runoff into watercourses, and the productive capacity of some streams may have been modified as a result.

Effects on water quality from highway construction primarily represent short-term additive effects to those impacts from runoff associated with forestry operations and residential wastewater. Adverse habitat modifications at watercourse crossings will be corrected by using specified restoration techniques to comply with the "no net loss" policy of DFO. Consequently in most cases, the Project-related impacts are likely to be assimilated quickly by the aquatic system, and will not represent long-term additive effects to the VECs.

There is potential for cumulative effects associated with runoff from existing land use practices and development in the Project area combined with runoff from the highway during operation. While there are no industrial discharges in the Project area, resource based operations (forestry, mining, etc.) and significant residential developments either exist or are a potential. Such operations have the potential to effect changes in water quality due to stream crossing construction in a manner similar to that described above for the proposed Project and through runoff containing herbicides, pesticides, nutrients, suspended sediments, and a variety of other contaminants. A variety of runoff management practices will be implemented to prevent the discharge of highway runoff into receiving waters. Many highway runoff constituents are correlated with sediment in the runoff, and can therefore, also be reduced with the sediment. Particulates will be removed by sedimentation, retention, and/or filtration. Dissolved fractions are removed by adsorption, chemical interaction, precipitation, and biological uptake. Management practices will promote maximum exposure of highway runoff to vegetation and soils through overland flow and infiltration. Wetland ecosystems are effective in assimilating large quantities of runoff constituents (Hvitved-Jacobson and Yousef, 1991). In summary, the runoff from the highway will be controlled to an extent whereby significant adverse cumulative effects are unlikely.

9.0 ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

The impacts analysis has shown that the Project will provide an increased level of relatively safe and free flowing two-way direct access, by 100-series Highway, from Highway 102 to Highway 103. In addition, local traffic in the Hammonds Plains area will experience less congestion resulting in greater commuter safety.

Other benefits of the project include a reduction in travel time, a corresponding reduction in vehicle emissions, and an increase in commercial property values near proposed intersections and interchanges.

Predicted negative impacts associated with the project include decreased land development opportunities, interruptions to forestry operations, and a loss of terrestrial and wetland habitat in the area occupied by the highway. None of the impacts are predicted to be significant when mitigation is accomplished through compensation.

Other impacts may be experienced by biophysical and socioeconomic components of the environment, however, those impacts have been determined to be insignificant in the context of causing a sustained depression or an impact in excess of legislation or guidelines.

A summary of the impacts is provided below:

Negative Predicted Impact	No Predicted Impact	Positive Predicted Impact
Loss of Terrestrial Habitat	Air Quality	Economic Activity
Loss of Wetland Habitat	Noise	Commercial Property Value
Land Development	Wildlife	Transportation
Forestry Operations	Rare & Endangered Species	Improved access to Backlands
	Environmentally Significant Areas	Reduced travel time
	Aquatic Resources	Reduced vehicle emissions
	Wetland Function	Increased Public Safety
	Groundwater Supplies	
	Surface Water Quality	
	Human Heritage Resources	
	Residential Property Values	
	Accidental Events	
	Flooding	
	Visual Resources	
	Recreation	

These predictions are contingent on proper implementation of the mitigative measures outlined in Section 8.0. If mitigative measures are improperly addressed during the construction and operation phases of the project, contingency plans will have to be enacted, as outlined in Section 10.0.

The Project is predicted to yield a net positive impact, with proper implementation of mitigative measures described in Section 8.0.

10.0 COMPLIANCE AND EFFECTS MONITORING PROGRAM

Environmental management is an important part of the everyday Project management responsibilities of TPW. The objective of TPW environmental management efforts is to implement safe, environmentally responsible, and sound engineering, construction, and operation practices. The major components of the environmental management structure for this Project that will ensure environmental matters are considered throughout all phases of the Project include:

- Environmental Protection Plans; and
- Contingency Plans.

10.1 Environmental Protection Plan

TPW will develop a detailed EPP for implementation along the length of Highway 113. This EPP will be completed prior to construction and will outline specific environmental and engineering measures that must be employed during construction. The EPP will be completed with consultation from government agencies, stakeholder groups, interested parties, and landowners, to ensure the needs and requirements of the local area are met. The EPP will recognize specific scheduling requirements of appropriate regulatory agencies, such as scheduling watercourse crossings within applicable construction windows. When construction can not be accommodated within specified construction windows, arrangements will be made with the appropriate agencies to review the proposed environmental protection measures and revise the measures as required for the specific crossings.

TPW will continue discussions throughout construction with government agencies, stakeholder groups, interested parties, and landowners, to ensure the effectiveness of the proposed mitigation measures. A team of environmental inspectors will ensure the success of the mitigation measures.

The EPP will address environmental matters during all Project activities and will include environmental inspection and environmental monitoring programs.

10.1.1 Project Activities

Specific environmental management measures will be employed throughout all phases of the Project, including construction and operation.

10.1.1.1 Construction

All Contractors will be required to have supervisors or foremen involved with grading jobs attend an erosion and sedimentation control workshop before construction begins. During the workshop, plans and procedures will be emphasized for minimizing impacts on sensitive features and areas. Specific environmental commitments related to the Highway 113 Project will be highlighted during pre-construction meetings with TPW and a reporting system will be created to track implementation. Contractors' staff will also be briefed by TPW environmental personnel to ensure environmental protection measures are identified and understood by all personnel involved in the Project.

10.1.1.2 Operations

Once the highway is in service, on-going environmental training programs will be established. TPW will provide regular employee training on environmental awareness, spill handling and reporting, clean-up procedures, waste management, easement maintenance activities, and hazardous material handling.

The highway will be designed, operated, and maintained to provide safe and efficient service over the long term.

10.2 Environmental Monitoring Plans

There are two general types of monitoring which are considered in environmental planning and impact assessment: environmental compliance monitoring (ECM); and environmental effects monitoring (EEM). Compliance monitoring refers to demonstration of adherence to environmental regulations while effects monitoring refers to demonstrating the accuracy of predictions and the effectiveness of proposed mitigation measures.

ECM and EEM programs will be implemented to ensure that pre-construction commitments are fulfilled; that the highway is built and maintained to the satisfaction of all stakeholders, including regulatory authorities; and that public health, safety, and environment are protected during the operation and maintenance of the highway.

The detailed ECM and EEM programs, as well as a Contingency Plan, will be developed during the detailed design phase of the Project. Environmental monitoring programs for the highway will continue during operations and maintenance activities. TPW employees will continuously improve environmental protection systems and monitoring programs.

The monitoring program outlined below for the construction and operation phases of the Project is conceptual. A detailed Environmental Management Plan (EMP) will be developed during the detailed design phase of the Project. The EMP will include a general Environmental Protection Plan (EPP), a specific Environmental Construction Plan (ECP), a detailed monitoring program, and a contingency plan which will be put in place based on the results of the monitoring program.

10.2.1 Environmental Compliance Monitoring

ECM can be divided into two distinct elements:
- regulatory environmental surveillance; and
- self-regulatory environmental compliance monitoring.

The component of ECM carried out by regulatory authorities consists of monitoring to verify compliance with applicable legislation and conditions of regulatory authorizations issued in respect of a Project. Self-regulatory ECM is that which a proponent undertakes to monitor its own activities against internal commitments, such as those contained in the EMP, and external environmental standards (*i.e.*, legislation and authorizations). Self-regulatory ECM can involve:
- monitoring of all environmentally-sensitive activities to ensure compliance with all applicable laws and regulations, and permits issued in respect of the Project;

- monitoring of all environmentally-sensitive activities to ensure compliance with internal (*i.e.*, EMP commitments) and external non-regulatory environmental standards;
- coordination and communication with regulatory authorities;
- provision of on-site environmental advice to Project personnel; and
- assistance with EEM studies and other environmental programs associated with the Project.

Numerous guidelines, policies, and standards aimed at minimizing the effects of highway construction, operation, and maintenance, have been produced by regulatory agencies including the NSDOE. These guidelines are, for the most part, very specific and in some cases set parameter specific values which must be adhered to by TPW. Examples of such policies include:

- Nova Scotia Water Approvals;
- Guidelines for Sampling of Domestic Water Supplies in Conjunction with Construction of Highways (1988); and
- Guidelines for Environmental Noise Measurement and Assessment (1990).

It is likely that the regulatory environment including Federal, Provincial, and Municipal legislation, regulations, and by-laws, as well as the guidelines, policies, and standards will change over the next 10 to 15 years, when construction of the highway is expected to begin. TPW is fully committed to implementing an effective ECM program and commits to meeting the regulatory requirements at the time of construction. TPW also recognizes that without effective ECM, implementation of successful mitigation cannot be assured.

The prime vehicle for ECM will be the EMP, the EPP (including the ECP), and permits issued for construction and operation activities. The EPP will provide the practical framework for implementing the environmental requirements of the proposed Project activities, and will facilitate both regulatory environmental surveillance and self-regulatory ECM, and provide a common reference document against which compliance can be judged. The ECP will include all temporary erosion and sediment controls that will be incorporated in the Project during construction and the permanent controls that will be integrated into the highway design during its operation.

A detailed ECM program will be developed during the detailed design stage for construction and operation of the proposed Project with the objectives of:

- ensuring compliance with all applicable government acts, regulations, and permits issued in respect of the Project;
- ensuring that the environmental commitments are met; and
- ensuring that established environmental policies and standards are maintained.

The ECM program will ensure that pre-construction commitments made to regulatory agencies and other stakeholder groups are fulfilled during construction. This will include, but is not limited to, requests for a specific watercourse crossing technique, regulatory Conditions of Approval to complete construction across a river during a specific time period, or a stakeholder's request to be notified in advance of construction in a particular area. Compliance monitoring will ensure that preventative and protective environmental measures are in place throughout construction.

10.2.2 Environmental Effects Monitoring

EEM will be conducted to validate impact predictions, and to evaluate the effectiveness of and identify the need to alter or improve mitigative measures. As part of its EMP, TPW will be committed to and responsible for the development and implementation of a focused EEM program for the Project. The process by which the EEM program will be developed will be outlined in the EMP.

An EEM program normally involves the collection of repetitive measurements of environmental variables to detect changes caused by external influences directly or indirectly attributable to a specific human activity or development, in this case, the construction and operation of Highway 113.

An EEM program will be developed and implemented to meet the following primary objectives:

- to provide baseline data so the construction schedule can be refined to avoid conflict with VECs.
- to verify earlier impact predictions;
- to evaluate the effectiveness of mitigation and to identify the need for improved or altered mitigation; and
- to provide an early warning of undesirable change in the environment.

Each EEM program component will have clear and achievable objectives and hypotheses, temporal and spatial controls, and practical methodologies. Careful consideration will be given to the availability of previously collected parameters or ability to collect baseline data. Potential cumulative effects will also be considered in the EEM program.

The boundaries of each program component will be defined to ensure that the potential interaction of the Project with each VEC is adequately assessed. Boundaries will vary for each VEC according to the nature and extent of the potential interaction or impact.

Generally, the process for EEM program implementation will include:

- Visual examination of the environmental features near the highway, after construction;
- Identification of recovery trends and sites that require more detailed study, based on aerial observations and field surveys;
- Development of air, land, and water sampling programs, where necessary, to monitor site conditions; and
- Development of site specific rehabilitation programs, where required, based on the results of sampling programs and controlled on-site experiments.

The results of EEM program will allow correction of any construction-related problems and assist in preparing post-construction regulatory reports.

10.2.3 Monitoring Programs - General

The aspects described below are those which will be included in the preparation of the detailed environmental monitoring program.

10.2.3.1 Air Quality

Rather than focusing on the ambient air quality which may result from the construction phase, the goal of this aspect of the monitoring program will be to ensure, to the degree possible, that equipment used during the construction phase is in good operating condition. The responsibility for this will rest with the contractor under direction from TPW.

10.2.3.2 Noise

Baseline noise measurements will be conducted by TPW along the proposed highway alignment and near residential areas during the detailed design stage, prior to construction. Additional noise monitoring will be conducted during construction and operation of the highway.

10.2.3.3 Sensitive Terrestrial Habitat

The construction activity in the vicinity of environmentally significant/sensitive areas will be monitored to ensure that the spatial extent of physical disturbance is limited to the extent possible.

10.2.3.4 Aquatic Habitat

Water Quality

Baseline water quality information has been collected for many of the significant water courses along the alignment. Additional water quality information will be collected prior to construction to ensure that environmental conditions at that time are fully documented.

Water quality will be monitored during and after construction to ensure that levels of parameters of concern do not exceed levels identified for the protection of aquatic life. Samples will be obtained at regular intervals during the construction period. Particular emphasis will be placed on information pertaining to levels of suspended solids, pH, chlorides, and heavy metals. Details of the sampling program will be finalized during the detailed design phase.

Populations of Fish and Invertebrates

Information will be collected prior to and after construction on populations of fish and fish food organisms at particular locations along the alignment. Should significant adverse impacts to fish habitat be observed, remedial measures will be recommended and applied.

10.2.3.5 Stream Crossings

The impact analysis identified stream crossings as being locations of particular interest with respect to potential impacts. A program will be designed and implemented during the construction phase to determine the potential for erosion and increased sedimentation at stream crossings. Where erosion and/or increased sedimentation are noted, corrective action will be implemented.

10.2.3.6 Wetlands

A program will be designed to assess the impact to wetlands disturbed by construction to monitor the effectiveness of mitigative measures and any changes in wetland functions.

10.2.3.7 Accidental Events

The approach identified for the mitigation of impacts due to accidental events was to reduce the likelihood of the event and to ensure that, where possible, effects of the accidents are minimal. A program will be designed during the detailed design phase, to monitor the design, installation, and effectiveness of the mitigative measures,.

10.2.4 Monitoring Programs - Specific

In addition to the general monitoring activities stated above, sufficient detail is available on which specific monitoring activities can be recommended. Specific environmental monitoring, described below, will be undertaken in areas where a known potential exists for environmental impacts. These specific activities will include:

- A detailed survey and sampling of all potentially affected water supplies;
- A pre-blast survey of all structures and water supplies within a predetermined distance of blasting activities, based on the blast design and approved by TPW;
- A detailed survey and sampling of dust and noise levels in areas potentially affected by construction;
- Ongoing detailed water sampling (for suspended sediment and general chemistry) of all potentially affected watercourses in proximity to the highway alignment;
- Pre- and post-construction monitoring of fish habitat in areas where blasting is to occur;
- Pre- and post construction monitoring of benthic invertebrate populations in watercourses crossed by the highway;
- A detailed pre-construction survey of four-toed salamander habitat in proximity to the highway alignment to identify the presence of nesting sites; and
- A detailed pre-construction survey and sampling program to accurately delineate the presence or absence of archaeological resources in areas identified to have a high potential for the occurrence of such resources.

10.2.5 Operational Monitoring

Monitoring the effects of Highway 113 will continue during operations and maintenance activities. TPW employees will continuously improve environmental protection systems and monitoring programs.

Routine inspections during operations will be conducted to monitor general environmental conditions such as soil erosion or water ponding. Environmental conditions and practices will be assessed through comprehensive internal reviews to ensure the protection of the environment, the public, and employees, while ensuring all legislative requirements are met.

10.3 Contingency Plans

The purpose of the EEM and ECM programs described above are to check the effectiveness of impact mitigation. Nonetheless, a contingency plan will be required that outlines the additional actions needed in the event that the impact predictions put forward in this document are inaccurate, or if mitigation fails to reduce impacts, or if the case of an unforseen occurrence (accident).

The goal of such a plan will be to reduce the frequency, extent and duration of accidental events and to reduce the risk to the environment from such events. A contingency plan will be prepared for both the construction and operation phases of the Project. The nature of the activities involved in the construction, operation, and maintenance phases of the Project will be similar to those normally associated with highway projects and therefore the contingency planning will be developed to a level similar to that for highway projects elsewhere in the region.

Contingency and emergency response plans will maximize the efficiency of response to unforeseen events, and therefore minimize the potential magnitude and extent of resulting impacts. This will be achieved by ensuring that personnel are trained in emergency response procedures, that response resources are available, and that an effective communications and reporting system is in place.

Contingency and response plans will be incorporated into the ECP prepared for this Project, to ensure that prevention and response measures are integrated with environmental protection procedures. Specific actions to be taken by Project personnel, including first response, reporting, coordination, development, personnel contact, and priorities for action will be clearly stated.

10.4 Compensation for Losses

The objective of TPW will be to reduce environmental impacts to acceptable levels, if they cannot be completely eliminated. However, in the event of predicted significant residual impacts or in the case that mitigation and contingency plans fail to protect a component(s) of the biophysical or socio-economic environments, restoration of the environment may be achieved through compensation for specific items.

Typical items for which compensation may be warranted include the following:
- loss of property;
- restricted or altered access to property;
- degradation of domestic water supplies;
- destruction of aquatic habitat; and
- destruction of wetland habitat.

It is recognized that compensation will be dealt with by TPW using the normal method of handling, investigating, and processing such issues associated with highway construction, operation, and maintenance.

A brief description of some of the more obvious claims for compensation is included below.

10.4.1 Loss of Property

The requirements governing TPW's response to claims for loss of property are set out by the ***Expropriation Act***. The criteria applied in determining claims of this nature are as follows:

- The damages must result from an act rendered lawful by statutory powers of the person performing the act;
- The damages must be such as would have been actionable under the common law;
- The damages must be an injury to the land itself and not a personal injury; and
- The damages must be causally related to the construction of the highway.

It is likely that most landowners along the highway alignment will successfully negotiate a settlement with TPW. Owners of property(s) expropriated by the Province for construction of the proposed highway will be compensated at a fair market value for the loss of their lands and/or structures. The process by which expropriation and compensation is undertaken is set out in detail in the ***Expropriation Act***.

10.4.2 Access

Access to adjacent properties or to pieces of property severed by the new highway may cause undue hardships and/or economic costs to individuals or businesses affected. Such hardships or economic costs may be quantified in sufficient detail to make a case for compensation. The existing policies and procedures within TPW would be brought to bear in dealing with such claims.

10.4.3 Water Supplies

Water supplies are particularly vulnerable to highway construction activities in the short-term and to highway operations and maintenance activities in the long-term. Sources of water used for supplies in residential areas along the alignment could include streams, ponds, springs, dug wells, drilled wells, and municipal systems. Residual negative impacts may result to any of the above stated sources of water as a result of construction activities. There are a number of mitigative techniques available to restore an impacted water supply including: water treatment; reconstructing the supply; locating a new source; developing storage for rain water collection. Ineffective mitigation, or failed attempts to correct water supply impacts could lead to claims against TPW for compensation.

10.4.4 Aquatic Habitat

In areas where a residual impact is considered to affect fish habitat, compensation may be required by DFO. The guiding principle of the DFO Fish Habitat Conservation Policy is that no net loss of the productivity capacity of habitat will be tolerated. Where unavoidable habitat losses occur, DFO will strive to balance the loss with habitat replacement. The method of compensation is negotiable with DFO in terms of a mutually agreeable form of restoration.

10.4.5 Wetland Habitat

Loss of wetland habitat resulting from construction of the highway will be compensated for by a means to be determined in consultation with NSDOE.

11.0 PUBLIC INFORMATION PROGRAM

As part of the preliminary planning process for the proposed Highway 113 and throughout the environmental assessment process, including during the preparation of the draft and final guidelines for this EIA, the public and regulators have had opportunities to voice their concerns regarding the Project and the potential impacts. All of the concerns and items brought forward during the public meeting of July 16, 1998 were noted and reviewed during the course of the study. In some instances those concerns identified issues that became VECs - focal points for the Assessment.

In addition, the public, including interested parties with concerns about the Project, will have additional opportunities to make comments during the formal Environmental Impact Assessment process conducted by NSDOE.

11.1 Public Meeting

A Public Consultation Open House was held July 16, 1998 for the Proposed Highway 113 Project. The purpose of the Open House was to provide information to the public on the Project and to obtain input from local residents, businesses and landowners. During that session, the approximately 150 people in attendance were requested to complete a questionnaire, designed by TPW. Sixty-nine completed questionnaires and formal responses were received. The questionnaire provided an opportunity for the public, and especially local residents, to voice their opinions regarding matters such as:

- perceived effects of the Project on properties and businesses;
- concerns with respect to the proposed location;
- benefits with respect to a new highway; and
- general approval or disapproval of the proposed alignment.

Table 11-1 summarizes the general responses to the questionnaire.

TABLE 11-1
General Questionnaire Responses

Item	# of Questionnaire Responses
Total Number of Questionnaires Returned	69
Approved of proposed highway location	34
Approved with some reservations (primarily about the Environment)	7
Disapproved of proposed highway location	28

The following presents a brief summary of the opinions noted on the questionnaires:

- people affected by existing traffic on Hammonds Plains Road were very positive about the Project; and
- people living in the Sheldrake Heights subdivision had the following concerns:
  - increased highway noise;
  - high traffic volumes, in particular landfill bound truck traffic, on the Connector;
  - loss of existing access to Maple Lake;

- increased public access to Maple Lake;
- environmental degradation of the area, in particular the lakes;
- loss of property value;
- remaining a small, isolated subdivision; and
- decreased warrant for public park space due to size of the subdivision.

Following the receipt of the resident's concerns, TPW undertook additional analysis to determine the extent of impacts with respect to traffic concerns. A letter was sent to residents in nearby subdivisions acknowledging their concerns and presenting additional information on traffic volumes and an evaluation of the potential for landfill bound truck traffic on the Connector.

11.2 Public Awareness

As a result of the open process of public consultation and because of the small, close-knit, suburban nature of the communities involved, most residents are fully aware of and have formed an opinion about the proposed Project. It is important that TPW keep interested persons informed of Project developments, because of the heightened awareness in the communities immediate to the Project and of the expectations held by residents of Kingswood and Sheldrake Heights subdivisions. Methods by which TPW can keep in contact with interested parties in the area include:

- holding a public meeting to discuss the final alignment including design and planning considerations;
- issuing press releases to local newspapers and radio stations prior to beginning pre-construction activities;
- erecting road signs notifying the public of the Project commencement and completion dates; and
- establishing a public liaison committee to answer questions and advise local residents of Project modifications.

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12.2 Personal Communications

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APPENDIX A

Archaeological Assessment

Archaeological Resource Assessment

Introduction

The Nova Scotia Department of Transportation and Public Works (TPW) is proposing the construction of a 9.9 km four lane highway (Highway 113) connecting Highway 102 (near Exit 3) and Highway 103 (north of Exit 4) in Halifax County. While the highway is scheduled to be constructed within the next 10 to 15 years, increasing land use pressure in the area requires that the construction corridor be set aside for this future use. Washburn &Gillis Associates Ltd. (WGA) was retained by TPW to complete an Environmental Assessment Registration for the proposed Highway 113, a component of which was an archaeological assessment.

The objective of the assessment was to examine the proposed Right of Way (RoW) for Highway 113 (Hwy 113) for heritage and archaeological resource potential. This involved a pre-field determination of areas of high potential based on predictive modelling, followed by a walk through and surface reconnaissance of the RoW (50 m either side of a presumed centre line). Judgmental shovel testing of high potential areas had been anticipated although no sections within the proposed route warranted such due to the shallow soil deposits and exposed bedrock.

The following presents the results of the archaeological assessment conducted from September 10 to September 14, 1999, under Heritage Research Permit A1999NS43.

Development Area

The Project area generally consists of uneven terrain which varied between low laying wetlands consisting mostly of marshland along streams and elevated rocky hills and knolls. The RoW crosses Black Duck Brook, Stillwater Run, Fishers Brook, an unnamed stream between Maple Lake and Frasers Lake, plus a number of other small unnamed still water brooks. The proposed route passes in the vicinity of several lake systems, which increases the potential for archaeological resources. The proposed centre line is within 500 m southeast of Ragged Lake, approximately 500 m south of Ash Lake, less than 200 m southeast of Maple Lake, approximately 100 m northwest of Fraser Lake, and less than 100 m from Upper Sheldrake Lake. Sections of lake shorelines (Upper Sheldrake, Maple, Frasers, and Ragged) which occurred less than 300 m of the presumed centre line, were surveyed. These generally exhibited exposed boulders (greater than 30 cm diameter). The rocky nature of the shorelines are not typical encampments or canoe landing areas. The range of elevation of the RoW included wetlands at approximately 55 m above sea level to rugged bedrock outcrops and large glacial erratic boulders at 150 m asl in the area of Blue Mountain Hill. Vegetation in low wet areas consisted of mixed immature to mature coniferous (spruces, pines, balsam fir) and in more elevated areas, a mix of coniferous and deciduous (maples, birches, poplars) trees.

The study area may have offered food resources to pre-contact groups. The afore mentioned lakes and streams would have provided sources of fish especially the thoroughfare between Frasers and Maple lakes. Points of high elevation such as the Blue Mountain Hill area would have provided a vantage point for sighting large game within the surrounding areas including several of the major lakes. The Nova Scotia Museum (NSM) reported that although there are no known pre-contact sites within the proposed corridor, a recorded Susquehanna Period (BeCw-1, ca. 4000 years before present BP) grooved axe found in a stream bed in Bedford 10 km northeast of the study area. The discovery of the Bedford Barrens petroglyphs (BeCw-2), 3 km northeast of the study area, suggests similar sites could be present on exposed bedrock outcrops (D. Christianson, NSM).

On A. F. Church's 1865 map of the area, a paper mill (BeCw-3, c.1818) was located near Paper Mill Lake to the east of the corridor. Moss covered cut stumps indicative of timber harvesting were found throughout the study area. Present land use includes timber cutting, in the vicinity of Stillwater Run. There are a number of subdivisions (Sheldrake Heights, Kingswood and Blue Mountain Estates) which are located outside the study are but within 1 km of the centre line.
No sections of the proposed route showed evidence of land alteration from previous agricultural activity. Shallow soil development, wetlands, and uneven terrain would have rendered the area undesirable for crop farming.

Study Area

The study area begins at approximately 600 m southwest of Exit 3 on Hwy 102. At this local the corridor is 850 m in width. At 1.5 km from the northeast boundary of the corridor Kearney Lake road is intersected 1.0 km northwest of Kearney Lake. The corridor width at this point is 800 m. At 2.6 km from the northeast boundary, Black Duck Brook is crossed. The corridor width at this point is approximately 550 m. The corridor continues on a southwest bearing between Ragged Lake and Blue Mountain Hill. The northern slope of Blue Mountain Hill is transversed at 4.5 km from the northeast boundary.

Methodology

Background research was conducted prior to fieldwork in order to identify recorded sites within the study area. Archival, and museum databases were consulted. A number of individuals were contacted based on their knowledge and heritage interest in the study area. These included Museum personnel, Government officials, historical society members, and Native contacts.

Due to the extent of the study area and limited available information on heritage resources, predictive modelling was utilised to identify areas of elevated potential. The modelling criteria adapted from Cox (1989), is based on historical, cultural, and environmental factors frequently associated with the occurrence of heritage sites. The following criteria was applied to the study area:

- distance to existing, or the maximum, limit of ancient waterways/land margins;
- drainage order of watercourses;
- environmental features of canoeable waterways;
- presence of a confluence of watercourses or outlets of waterbodies;
- lithic sources;
- vantage areas;
- coastal features;
- transportation routes; and
- known heritage resource areas.

Using 1:50 000 mapping as a working base, the 9.9 km long corridor was divided into 500 m long sections. Weighted criteria, based on the cultural and environmental data outlined above, were applied to each section. Then the 500 m sections were ranked according to resulting scores.

The predictive model identified four areas as having elevated potential for heritage resources. Three archaeologists conducted a surface reconnaissance and walk through of the proposed ROW. Focussing upon the centre line and expanding the survey at points of high potential (streams, lake shores, vantage points), the three crew members were spaced at 25 m to 35 m abreast, covering an area 75 m to 105 m in width. Exposed rock faces were examined for the possible location of petroglyphs or lithic raw material source.

No artifacts were collected or observed during the heritage resource assessment. Based on a surficial investigation, the study area was evaluated as being low potential for heritage resources.

No potential impact to heritage resources was identified during the surficial survey of the study area. The slope of Blue Mountain Hill, however, possess elevated potential for pre-contact resource because of the vantage provided of the lakes and surrounding areas. Although the surficial examination of area did not identify suitable locations for testing (bedrock with very little soil development) there remains potential for impact on potential hunting or camp sites on isolated ridges or terraces on the hill slope.

Resource Inventory

The poor soil development over bedrock prevented adequate shovel testing in areas deemed as high potential. The exposed bedrock and rocky nature of the terrain is rarely associated with cultural activity.

Resource Evaluation

No resources were identified during the assessment.

Results and Discussion

The archaeological assessment and background historical research did not identify any heritage resource or archeological site within the study area. The initial predictive model identified four areas of high potential; a 500 m section south of Upper Sheldrake Lake, a 1 km section between Maple Lake and Frasers Lake, a 1 km section along the northern slope of Blue Mountain Hill, and a 500 m section northeast of Ragged Lake.

In general, the area was evaluated as having too low potential for heritage resources. Certain areas, however, may have been used as vantage or “lookout” points (Blue Mountain Hill) or travel routes (thoroughfare between Maple Lake and Frasers Lake).

Interpretation

As mentioned in the previous section, the study area does not appear to have been used historically. No evidence of pre-contact or historic resources were observed during the field assessment and background research.

Evaluation of Research

The background research include examination of archival literature and Museum site database to identify recorded heritage resource sites. It was determined that little research had been done in the area and that no recorded site is located within the study area.

Conclusions and Recommendations

An heritage resource assessment was undertaken for the proposed 9.9 km long four lane Highway 113 which will connect Highway 102 with Highway 103. Historical and background research was undertaken prior to fieldwork to identify recorded sites in the area. Three recorded sites were previously identified outside the study area consisting of a Susquehanna isolated find (4000 BP), historic petroglyphs, and a historic paper mill. These sites, being located outside the study area, will not be impacted.

The entire length of the proposed RoW was examined for heritage resources with the focus on the four high potential areas identified by the predictive model. Although a testing program was anticipated for the high potential areas, poor soil development and rocky terrain prevented any shovel testing. No heritage resources were identified within the study area during the investigation.

The following recommendations are provided to mitigate potential impacts to heritage resources that may be present in the Blue Mountain Hill and Maple Lake/Frasers Lake areas:

- A thorough surface survey of the Blue Mountain Hill area within the RoW to identify potential heritage sites and artifacts.
- Construction monitoring for heritage resources in the area between Maple Lake and Frasers Lake, for a distance of 100 m on both sides of the stream.

Since construction of the highway is scheduled within 10 to 15 years, it is also recommended that data bases be reviewed prior to construction, to verify that sites have not been identified within the study area.

APPENDIX B

Wetland Assessment Results

(Available in hard copy at the Nova Scotia Department of Environment and Labour Library)